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Gaizka Ormazabal, Torsten Jochem and Anjana Rajamani

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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

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Abstract

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JEL Classification: G3, G34, G38, M12, M52

Keywords: Clustering of executive pay, pay diversity, competitive benchmarking, pay transparency, pay disclosure, tournament incentives

Gaizka Ormazabal - gormazabal@iese.edu
IESE Business School, Barcelona and CEPR

Torsten Jochem - t.jochem@uva.nl
Amsterdam School of Business University of Amsterdam

Anjana Rajamani - rajamani@rsm.nl
Rotterdam School of Management Erasmus University

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Why Have CEO Pay Levels Become Less Diverse?*

Torsten Jochem
Amsterdam School of Business
University of Amsterdam
t.jochem@uva.nl

Gaizka Ormazabal
IESE Business School
University of Navarra
GOrmazabal@iese.edu

Anjana Rajamani
Rotterdam School of Management
Erasmus University
rajamani@rsm.nl

October 2020

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1 . Introduction

This paper documents a new stylized fact; over the last decade, the cross-sectional variation in CEO pay levels (i.e., the "second moment" of pay) has declined precipitously (see Figure 1). We obtain this result from a wide sample of over 5,000 U.S. public firms, spanning from 2002 to 2018. The decrease in cross-sectional variation in CEO pay levels (henceforth "pay variation" or "pay dispersion") not only holds at the economy-level; we find a similar pattern within industry groups (see Figure 2.A) and even within groups of firms formed based on industry affiliation and size (see Figure 2.B). The decline in pay dispersion cannot be attributed to changes in firm characteristics such as size or profitability (see Figure A.8), or to changes in the measurement of total compensation (see footnote 11).

We provide one explanation for this secular decrease in pay variation; reciprocal benchmarking (i.e., firms including each other in the disclosed set of peers used to benchmark pay levels). Reciprocal benchmarking likely leads to less pay variation because the mutual consideration of peers results in similar compensation peer groups, and pay levels are often set based on the median pay level of the compensation peer group (with deviations above the median pay level of the compensation peer group being difficult to justify). This idea is illustrated in Figure 3; in the extreme case that a group of firms only benchmark against each other and the firms set their pay levels at some common pay percentile (e.g., at the median level of the benchmark group), there is no group-level variation in pay levels.

Our empirical firm-level tests are based on a broad sample of U.S. public firms including the constituents of the Russell 3000 index from 2002 to 2018. We start by providing descriptive evidence supporting the notion that reciprocal benchmarking has increased significantly in recent years, and that this increase leads to less

pay variation. Figure 4 plots the compensation peer networks for a random sample of firms in two years of our sample period: 2008 and 2013. The figure shows a decrease in "star formations" (i.e. nodes that are solely connected with a central node) and an increase in "benchmarking clusters" (i.e., clusters of firms referencing each another). The simulation exercise in Figure 5 explores a hypothetical situation of reciprocal benchmarking in which all firms switch to choosing their compensation peer group based on industry and size (this selection criterion – supported by proxy advisers and a number of asset managers – is increasingly common among public firms). The simulation departs from actual compensation values and actual peer groups in 2007 and sets subsequent compensation levels at randomized target percentiles of synthetic peer groups based on industry and size. As shown in Figure 5, the result is a significant decrease in pay variation in the economy.

The first set of systematic tests of our hypothesis is conducted at the "group-year level". That is, we compute our measures for groups of firms in the same industry and in the same size-quintile in a given year (i.e., we construct observations at the industry-size-year level). Our group-year level measure of pay variation is the standard deviation of CEO pay scaled by the median level of CEO pay.[1] Our group-year level measure of reciprocal benchmarking is based on the social network literature; we construct three well-established metrics of the "degree of clustering" or "closedness" of a set of nodes in a network (in our case, a group of firms); "reciprocity", "transitivity", and "density" (see Figure 6 for an illustration of these measures). In our setting, a linkage in the network of sample firms is defined by whether one firm includes the

[1]We scale the standard deviation since CEO pay has a non-stationary distribution (because average pay is increasing over time). To compare dispersion across time hence requires a dimensionless measure of dispersion (see, e.g., Cox and Lewis, 1966). This is achieved by scaling the standard deviation of pay by the average level of pay.

other in its compensation peer group. As such, a double linkage between a pair of firms would indicate the presence of reciprocal benchmarking. We construct these measures for the period 2007-2018, as before 2007 the public disclosure of compensation peers was not mandatory and 2018 is the latest year with the available information. Using these measures, we obtain the following results. First, there is a statistically significant increase in the values of our measures of the "degree of clustering" of sample firms, indicating an increase in reciprocal benchmarking (see Table 2). This pattern is visualized in Figure 7.[2] Second, we find a strong negative and statistically significant association between the "degree of clustering" and pay variation at the industry-size level (see Table 3).

To further sharpen identification, we fully exploit the granularity of our data by conducting a parallel analysis at the "firm-year level" (which allows us to control for firm-specific variation). That is, we compute our measures for a given firm in a given year. Pay variation at the firm-year level is the standard deviation of CEO pay of the firm's compensation peers scaled by the median level of CEO pay of these peers in that year. In parallel to previous tests, we also construct the three measures of network clustering (i.e., "reciprocity", "transitivity", and "density") at the firm-year level (using peer group information from the firm's compensation peers). Consistent with the patterns documented at the group-year level (i.e., industry-size-year level), we find a significant decline in pay variation within firms' compensation peer groups, significant increases in the three network clustering measures of firms' peer groups, and a significant negative relationship between pay variation and the three measures of network clustering (see Table 4).

[2] As shown in Figure 7, the increase in the degree of clustering is also present when we construct our measures at the economy-level; that is, when we consider a single group including all the Russell 3000 sample firms.

We also conduct the previous firm-year level analysis using an alternative, more direct and straightforward measure of reciprocal benchmarking; the fraction of compensation peers that include the firm in their respective compensation peer group. As shown in Appendix A.3, this alternative measure is closely related to the three measures of network clustering, and is equivalent to constructing "reciprocity" at the firm-year level. Consistent with the previous tests, we find a stark increase in reciprocal benchmarking during the 2007-2018 period (see Figure 8) and a strong negative association between reciprocal benchmarking and pay variation (see Table 5).

We next examine three institutional developments potentially contributing to the recent increase in reciprocal benchmarking. The first one is the recent SEC mandate to publicly disclose the component companies of compensation peer groups (i.e., a set of firms selected by the board to benchmark compensation levels).[3] The mandatory disclosure of compensation peers could have induced reciprocal benchmarking because, under the public disclosure regime, it becomes publicly observable that a firm deviates from the standard practice of benchmarking compensation to firms in the same industry and size group, and such deviation is often interpreted as poor governance.[4] The second institutional development is the introduction of "say on pay" regulation, namely the requirement introduced by the Dodd-Frank Act that the compensation packages of public firms' top executives be subject to consultative votes by shareholders. In our context, deviations from benchmarking compensation to peers in the same industry-size group could trigger negative say on pay votes. The third institutional

[3]The SEC mandate came into effect in 2007. Almost no firm voluntarily disclosed its compensation peers before.

[4]Asset managers frequently mention industry and size as objective criteria for appropriate compensation peers and use them to arrive at say on pay vote decisions (e.g., Blackrock, 2019, 2; T. Rowe Price, 2019, 6-7).

development is the growth of passive investing and the increasing reliance on proxy advisory firms. This is important in our setting because proxy advisers' voting recommendations are commonly based on benchmarking the firm's compensation to that of peer firms in the same industry and size percentile.[5] Appendix B provides anecdotal evidence on how these institutional developments conjointly increase reciprocal benchmarking.

These three contributing institutional developments find support in the data. First, we examine changes in reciprocal benchmarking around the introduction of the SEC mandate to publicly disclose compensation peers. Our test makes use of the rule's regulatory process that did not leave firms with time to modify their compensation peer groups in expectation of the disclosure mandate (Faulkender and Yang, 2013). At the group-year level (i.e., industry-size-year), we find that pay dispersion only starts dropping in the years after the disclosure regime came into effect, and industry-size groups with less reciprocal benchmarking in the first year of the mandate had greater pay dispersion prior to the mandate and experienced larger declines soon after the mandate (see Table 6, Panel A). Similarly, at the firm-year level, we find that firms that had peer groups that were less aligned with asset managers' and proxy advisers' policies in the first year of disclosure – and which may therefore have faced a greater urgency to adjust them – increased more rapidly in reciprocal benchmarking (see Table

[5]ISS (the largest proxy advisory firm) primarily uses industry classifications and relative size thresholds to identify a set of 'appropriate' market peers (ISS, 2012; 2017). Glass Lewis uses Equilar's Market Peers to formulate their say on pay vote recommendations for investors, which are based on the reciprocity of disclosed compensation peer references in the Russell 3000. Some other approaches to define compensation peers are more sophisticated. For example, Equilar determines the 15 companies with the strongest connections to a target firm as judged by incoming peer references and the peers of (incoming) peers. In 2017, ISS Corporate Solutions launched a similar product ("Peer Architect") for its clients. However, these "wisdom of the crowd" (ISS, 2018) and "who you know, and who knows you" (Equilar, 2018) approaches also have the potential to further increase reciprocal benchmarking and nurture the emergence of compensation peer clusters to the extent that a large number of firms adopt the same approach.

6, Panel B).

Second, we examine the potential effect of say on pay legislation. While say on pay proposals are not binding, failing to obtain majority support can trigger lawsuits and cause reputational losses for directors (Brunarski, et al., 2017). Prior literature documents that firms respond to weak say on pay votes by changing controversial pay components and reducing executive pay (Ferri and Maber, 2013; Denis, Jochem, and Rajamani, 2020). Using a difference-in-differences framework, we examine how firms modify their compensation peer groups after receiving a weak say on pay vote and find significant increases in reciprocal peer benchmarking in the two years following the weak vote (see Table 7).[6]

Third, we test the potential role of proxy advisors in the secular increase in reciprocal benchmarking.[7] Following the regression discontinuity design proposed by Malenko and Shen (2016), we exploit that ISS's scrutiny on executive pay policies in 2010 and 2011 was based on an arbitrary performance threshold. We find that firms whose performance falls below the threshold likewise modify their compensation peer groups in ways that result in a strengthening of reciprocal benchmarking (see Table 8). To further relate reciprocal benchmarking to the growth of passive investing and proxy adviser influence, we examine the effects of ownership concentration and investors' historic reliance on proxy advisers' voting recommendations. We find that reciprocal benchmarking decreases with block ownership, increases with ownership dispersion, and increases with the fraction of a firm's investors who routinely vote with proxy adviser recommendations (see Table 9).

[6]Two of the anecdotes in Appendix B illustrate the effect of a weak say on pay vote a negative proxy advisory recommendations on reciprocal benchmarking.

[7]Prior literature provides evidence consistent with the notion that proxy advisers are influential. For example, Iliev and Lowry (2015) find that 25 percent of mutual funds rely on proxy advisor recommendations for their proxy voting decisions and Ertimur, Ferri, and Oesch (2013) document that a negative ISS vote recommendation leads to large reductions in support on shareholder proposals.

Our last set of tests analyze whether the documented decline in pay variation has meaningful consequences on firm outcomes. In a first step, we explore whether the decline in pay variation affects managerial incentives, and more specifically "tournament incentives" among top executives in the industry. As explained by Coles, Li, and Wang (2018), if a CEO leads a company that delivers outstanding performance, then that CEO is more likely to be a strong candidate for a higher-paid position at another company. Accordingly, these authors measure "external" tournament incentives as the compensation gap between a CEO at one firm and the highest-paid CEO among similar industry firms.[8] In our context, a reduction of pay variation in the industry would likely entail a smaller gap between the highest-paid CEO and other CEOs in the industry. Consistent with this, we find strong evidence of declining tournament incentives within compensation peer groups as well as within industries over time (see Figure 9), and a significant negative relationship between reciprocal benchmarking and external tournament incentives (see Table 10).

A reduction in tournament incentives is important because, as shown by prior research (e.g., Coles, Li, and Wang, 2018) such incentives have a significant effect on firm outcomes, and in particular on corporate risk-taking (external tournament incentives induce managers to improve performance through greater risk-taking). Consistent with this, we find that firms' future realized equity return volatility is positively related to pay variation in the peer group, and negatively related to reciprocal benchmarking (see Table 11). These patterns also hold when we replace realized equity return volatility

[8]Prior literature uses the expression "external" tournament incentives to avoid confusion with "internal" tournament incentives, often measured as the compensation gap between the CEO of a firm and the rest of the top executives in the firm, who are candidates to become replace the CEO in the future.

with alternative measures of corporate risk-taking (ROA-, earnings- or cashflow volatility; see Table A.6).

While much of the existing work has focused on explaining the growth in CEO pay levels in the time series or in the cross-section (e.g., Jensen and Murphy, 1990; Hall and Liebman, 1998; Murphy, 1999; Bebchuk and Grinstein, 2005; Gabaix and Landier, 2008; Frydman and Jenter, 2010; Frydman and Saks, 2010; Shue and Townsend, 2017), this paper is, to our knowledge, the first that examines in-depth the evolution of pay dispersion. Our paper contributes to the prior literature by documenting a new, striking fact; the cross-sectional variation in CEO pay levels has dramatically decreased recently, which we empirically link to the introduction of new SEC disclosure rules on executive pay which came into effect in 2007.

Second, our study contributes to the literature on compensation benchmarking. Prior literature examines the motivations underlying peer selection and finds evidence consistent with peer group choices reflecting the market for managerial talent (Bizjak, Lemmon, and Naveen, 2008; Albuquerque, De Franco, and Verdi, 2013; Cadman and Carter, 2014). However, other papers suggest that compensation benchmarking could be contributing to pay inflation among firms with weak governance (Bizjak, Lemmon, and Nguyen, 2011; Elson and Ferrere, 2013; Faulkender and Yang, 2010, 2013). We complement this literature by providing evidence that recent institutional developments have induced an increase in reciprocal benchmarking among firms in the same industry and with similar size that entails first-order consequences on the cross-sectional variation of pay.

Third, our results add to recent work on the effects of pay transparency. Analyzing the 1934 transparency mandate to disclose public firms' executives' wages, Mas (2016) finds pay compression due to executive pay increases in the lower tail

but no reduction in the upper tail of the pay distribution. Baker, et al. (2019) and Bennedsen, et al. (2018) analyze the effects of pay transparency on the gender wage gap among Canadian and Danish workers and find wage compression between male and female workers. We contribute to this literature by showing that recent institutional developments (i.e., disclosure requirements about the process used to determine executive pay, say-on-pay, and the rise of passive investment) have contributed to a significant decline in the cross-sectional variation of executive pay, a pattern driven – at least in part – by an increase in reciprocal benchmarking of compensation practices.

We propose one explanation for the recent secular decrease in the cross-sectional variation of executive pay, but there could be others. We hope that our analysis helps to promote a debate on the causes and consequences of the declining diversity in CEO pay levels. The rest of the paper proceeds as follows. Section 2 provides a brief review of the institutional background in which boards set executive pay and introduces our hypothesis. Section 3 describes the data. Section 4 discusses the evolution of pay dispersion and reciprocal benchmarking at the industry-size level and at the firm-level. Section 5 provides the analysis for three potentially contributing institutional factors while Section 6 discusses consequences to industry tournament incentives and managerial risk-taking. Section 7 concludes.

2. Institutional background and hypothesis

Attracting and retaining managerial talent is a key challenge to companies and their boards. To offer competitive pay to their executives, compensation committees routinely engage in compensation benchmarking that ties the benefits offered to executives to those of their labor market competitors. Compensation consultants play an

important role in this process by advising the board in choosing compensation peers and compiling their pay information (Murphy and Sandino, 2020).

Responding to investor concerns about powerful CEOs manipulating the peer groups by selecting highly-paid peers, the SEC issued in December 2006 new regulation that mandated firms to disclose the identity of their compensation peers. Researchers have found mixed evidence on the effect of this regulation on firms' opportunistic selection of compensation peer groups. Bizjak, Lemmon, and Nguyen (2011) and Faulkender and Yang (2010, 2013) provide evidence that compensation benchmarking contributes to pay inflation among weakly governed firms while Bizjak, Lemmon, and Naveen (2008), Albuquerque, De Franco, and Verdi (2013), and Cadman and Carter (2014) find that, for the average firm, peer group choices reflect features of the managerial labor market and help with the design of pay packages to attract and retain talent. However, transparency on compensation peers may have other, more complex effects. Choi, Cicero, and Mobbs (2019) report evidence that the compensation peer disclosure regulation by the SEC reveals information to executives about their outside opportunities, and has led to compensation increases and a greater likelihood of moving to better positions among executives whose companies are more often cited.

Mandatory disclosure may also increase the influence of outside parties. Notably, since the disclosure of compensation peers, proxy advisors include compensation peer groups in their assessments and voting recommendations (proxy advisors' policies usually define compensation peers based on industry affiliation and size). As shown in prior literature, such vote recommendations are highly influential on vote outcomes (e.g., Ertimur, Ferri, and Oesch, 2013; Iliev and Lowry, 2015; Malenko and Shen, 2016) and a number of firms therefore conform to proxy advisors' policies to avoid

negative voting recommendations (see Larcker, McCall, and Ormazabal, 2013, 2015, and Hayne and Vance, 2019 for examples of proxy advisory influence on stock option repricing and say on pay).

Using a uniform criterion to select compensation peers across the economy – for example, selecting firms from the same industry and of similar size – faces the usual trade-off of imposing one-size-fits-all rules. On the one hand, such a criterion could reduce the scope for powerful CEOs to manipulate their own pay. On the other hand, however, the rule limits boards' discretion for tailoring pay policies to firm-specific needs. But regardless of one's view on this tradeoff, an identical selection criterion mechanically increases the overlap between compensation peer groups, as under this criterion similar-sized firms in the same industry include each other in their respective compensation peer groups. In other words, a uniform peer selection criterion increases "reciprocal referencing" and leads to the formation of "clusters" of compensation peers. To the extent that firms target their executive pay at the average pay level of the compensation of the peer group, an increase in reciprocal referencing would result in a convergence of pay levels within these clusters of compensation peers.

3. Data

Our sample for computing CEO pay at the group-level (i.e., industry-size level) contains all US firms in the Russell 3000 index from 2002 to 2018, which includes 5,927 distinct firms. We start in 2002 because prior to that year the executive compensation data readily available in commercial data sets is mainly restricted to the cross-section of firms in the S&P 1500. We obtain CEO compensation data from Execucomp (*TDC1*), Equilar, and GMI.

For the firm-level tests, we supplement this sample with compensation peer group

data from Equilar, AuditAnalytics and ISS IncentiveLab. When firm coverage overlaps and peer group information conflicts between databases, we manually verify disclosed peer groups in companies' DEF 14A filings. Imposing non-missing data on the firm's compensation peer group restricts our sample period for the firm-level tests to 2007 to 2018. The reason is that information on compensation peer groups (which is essential for our tests) is not available prior to 2007 when the disclosure of compensation peer data was not mandatory. This data requirement also excludes some Russell 3000 firms because small reporting companies with a public equity float of less than $75 million (or, if unavailable, with less than $50 million in annual revenues) are exempted from the requirement to disclose their compensation peer groups (17 CFR § 229.402 section l). We further collect accounting information from COMPUSTAT; stock prices from CRSP; information on firms' corporate governance practices from ISS RiskMetrics, Equilar, GMI, and BoardEx; data on CEO characteristics from Equilar and GMI; institutional ownership information from Thomson Reuters; and shareholder vote outcomes from ISS Voting Analytics.

After requiring non-missing data on firm characteristics we obtain a final sample of 24,996 observations for 3,879 distinct firms from 2007 to 2018, with an annual cross-section of about 2,200 firms per year (see Table 1). Table 1 provides further details of the sample characteristics, including yearly coverage and descriptive statistics of the variables used in our tests. The sample contains fewer observations in 2007 because many firms did not disclose compensation peers in the first year of the mandate (see White, 2007, 2008).

4. Pay dispersion and reciprocal benchmarking

4.1. Pay dispersion

We start by descriptively analyzing the evolution of CEO pay dispersion in the cross-section. We conduct this analysis using our initial sample of Russell 3000 firms between 2002 and 2018 (which includes 5,927 distinct firms), as this descriptive test does not require data on compensation peers.[9] For each year, we define pay dispersion as the standard deviation of total CEO pay divided by the median of total CEO pay. Total CEO pay is measured as the sum of salary, bonus, long-term incentive pay (including restricted stocks and stock options) and all other pay (such as pension contributions and the value of perks). We scale the standard deviation because executive pay has a non-stationary distribution, that is, its average is increasing over time. To compare dispersion across time requires a dimensionless measure of dispersion, which is achieved by scaling the standard deviation by average pay (e.g., Cox and Lewis, 1966).[10]

Figure 1 plots pay dispersion and its 95 percent confidence interval for the Russell 3000 sample firms since 2002. The figure shows that executive pay dispersion remains roughly similar throughout fiscal years 2002 to 2009 but drops precipitously thereafter.[11] Figure 2, Panel A repeats the analysis at the GICS 2-digit industry level.

[9]Some analyses in the Online Appendix shows pay trends extending back to 1994. Prior to 2000, coverage drops to Execucomp's S&P 1500 firms due to data availability. Data availability drops also in 2018 to Execucomp's S&P 1500 firms. All our results are robust to excluding 2018.

[10]Standard deviation and variance are not dimensionless measures of dispersion because both increase mechanically as the magnitude of the underlying data increases. Hence, while the standard deviation may be increasing due to larger magnitude of the underlying values, actual dispersion may be declining if it increases by less than the shift in the distribution. For example, the median CEO pay level in our sample more than doubled between 2002 and 2016 from $1.8 million to $3.9 million while the standard deviation of CEO pay remained almost identical at $6.3 million in 2002 and $6.4 million in 2016. We use the median (rather than the mean) for scaling the variation in CEO pay because we are interested in the "typical" CEO's pay levels and not in the aggregate level of CEO pay (Murphy, 2013, 9).

[11]The SEC also mandated a change in the reporting of executive stock and option awards in December

We see large variation in within-industry pay dispersion in the cross-section as well as in the time-series. At the start of our sample, the difference across industries in their within-industry pay dispersion levels is large, ranging from 1.2 (in the materials industry) to 2.5 (in the financial industry). By the end of our sample period, this cross-sectional difference shrinks to values between 0.5 and 1.0. In the time-series, there is a pervasive decline in within-industry pay dispersion across each of the 2-digit industry groups. Panel B of Figure 2 repeats the analysis at the industry-size level, using size-quintiles based on firms' market capitalization. Panel B plots the average of the within industry-size group pay dispersion across years (plotting all groups separately would be confusing). Again, we find a noticeable decline in pay dispersion also within industry-size groups; Panel A of Table 2 confirms that these declines are statistically significant within industry-size groups (i.e., when including industry $\times$ size fixed effects) with t-statistics of 4.4 or above.

The Online Appendix presents the results of a battery of additional analyses to better understand the secular decline in CEO pay dispersion. First, we explore whether the decreasing pattern in Figure 1 reflects a temporary increase in pay dispersion prior to the start of the sample period (i.e., 1994-2001). Figure A.1 shows that this is not the case (although this analysis is restricted to S&P 1500 firms due to data limitations). Second, we analyze whether the pattern in Figure 1 is driven by the

2006. This change is unlikely to explain our finding for several reasons. First, a reporting change in the calculation of stock and option awards that affected all firms would have had an immediate, one-time effect on pay dispersion. In contrast, the documented pay dispersion decline has a two-year delay followed by a continuing decline over many years. (Our later analysis also includes year and *year* $\times$ *industry* fixed effects that would absorb a reporting change that impacts all firms.) Second, experts expected the 2006 change in the reporting of stock and option packages to *increase* rather than decrease pay dispersion due to "year-to-year swings in reported compensation even though the executive is earning a consistent level of compensation" (Whiteford, Taylor and Preston, 2007, 1). Third, the decline in pay dispersion occurs also to the salary and annual bonus components that did not see a reporting change (see Figures A.6 and A.7 and Table A.2). Finally, in numerous tests throughout the paper, we link the magnitude and the speed of change of pay dispersion to measures on peer group clustering and reciprocal benchmarking.

smaller firms in the Russell 3000. Figure A.2 repeats the analysis for S&P 1500 firms (i.e., a subset of Russell 3000 including relatively larger firms) and finds a similar pattern as in Figures 1 and 2A.[12] Third, Figure A.3 repeats the within-industry and within industry-size group analyses from Figure 2 for alternative industry classifications (GICS2, GICS4, SIC1, SIC2, SIC4, FF12 and FF48) and finds very similar results.

Fourth, we decompose pay variation into its two components, the standard deviation of pay and median pay. As shown in Figure A.4, prior to 2009, the standard deviation of CEO pay grows alongside mean and median pay, which is expected as the standard deviation is mechanically affected by the magnitude of the underlying quantity (Cox and Lewis, 1966). Post 2009, mean and median CEO pay then show a strong upwards trend while the standard deviation remains largely unchanged, resulting in an effective reduction of pay dispersion. Fifth, Figure A.5 plots the trajectory of the skewness of CEO pay between 2002 and 2018, which is a dimensionless measure of dispersion (i.e. it is unaffected by a change in its average without the need for scaling). The figure shows a gradual and persistent decline of CEO pay skewness since 2007.[13]

Sixth, because compensation peers are also used to determine pay structure, we examine changes in the variation of short- and long-term incentives. We find a considerable reduction in the variation of long-term incentives (defined as the sum of stock awards, stock options and multi-year non-equity incentives) and short-term incentives (defined as the sum of salary and annual bonus). This holds for the median-scaled standard deviation of incentives in dollar terms and also for the standard deviation of

[12] In this test, CEO total compensation uses only Execucomp's *TDC1* data field.

[13] To avoid that extreme outliers are responsible for the decline in skewness (rather than a change in the overall distribution), we show results with different levels of winsorization of CEO pay.

the (already-scaled) short- or long-term incentives-to-total-pay ratio. While Figure A.6 shows this for the (S&P 1500) economy-level, Figure A.7 confirms this to be true also for within firms' compensation peer groups. Furthermore, Table A.2 confirms that the decline in variation in pay structure is significantly correlated to the amount reciprocal referencing within peer groups.

Finally, we explore whether the pattern in Figure 1 is driven by changes in variation of other pay-relevant firm characteristics across time (for example, the decline in pay dispersion could simply reflect that firms are getting more similar in size over time). Figure A.8, shows no evidence of a negative trend in key firm characteristics over the sample period.[14]

4.2. Reciprocal benchmarking and clusters of compensation peers

4.2.1. Descriptive evidence

We next explore the validity of our conjecture that reciprocal benchmarking is one important factor (although probably not the only one) driving the documented decrease in pay dispersion. We start by providing descriptive evidence supporting the notion that reciprocal benchmarking has increased significantly in recent years, and that this increase leads to less pay variation.

Graphical evidence

We first conduct a graphical exercise to visualize whether there is an increase in reciprocal benchmarking resulting in the formation of "benchmarking clusters" (i.e., clusters of firms referencing each other as compensation peers). Figure 4 plots the compensation peer networks for a random sample of S&P 1500 firms in two years of

[14]To further mitigate this concern, we control for firm characteristics in the firm-year level tests in later tables.

our sample period: 2008 and 2013. We select 2008 for our early period because a substantial number of firms did not yet disclose compensation peer groups in 2007, the first year of the mandate (White, 2007, 2008). We select 2013 (several years after compensation peer disclosure became mandatory) to ensure that firms had sufficient time to modify their peer groups. To keep the figure readable, we plot the network graphs for a random sample of firms. The drawing procedure is as follows: we sort sample firms by their firm identifier (*gvkey*) and draw every 20$^{\text{th}}$ firm. We then add their compensation peers, the references among all selected firms, and plot the graphs using a Fruchterman-Reingold layout.

Figure 4 shows a marked shift in peer referencing decisions between 2008 and 2013. In the earlier part of the sample, firms frequently picked compensation peers that did not reference any of the firms' other peers. This is visible in the graph in form of "star formations" (see, for example, the bottom right corner of Figure A). Five years later, we observe many fewer of such star formations and many more instances in which the peers of a central node reference other peers (see, for example, the top left corner of Figure B). This visual change is consistent with firms increasingly referencing firms that reference them back.

Evidence from simulations

To gauge the empirical validity of our reasoning that the increase in reciprocal benchmarking leads to less economy-wide pay variation, we conduct a simulation exercise. While reciprocal benchmarking should lead to pay convergence *within* clusters, it is theoretically less clear what should occur to pay dispersion *across* clusters. The effect of reciprocal benchmarking on pay dispersion is not straightforward ex-ante, as it depends on the number and size of compensation benchmarking clusters, the remain-

ing connections across clusters (along which within-cluster pay changes can propagate), and the frequency with which compensation peers change year by year (which could be due, among other reasons, to differences in firm growth resulting in changes in the composition of the size quintiles).

We explore a hypothetical situation of reciprocal benchmarking in which all Russell 3000 firms switch to choosing their compensation peer group based on their industry and size. In particular, we define synthetic compensation peer groups by following the methodology of ISS, a major proxy advisory firm, which is based on industry and size criteria.[15] The simulation departs from actual compensation values and actual peer groups (which did not necessarily follow the industry-size criterion) in 2007. Subsequently we set compensation (in year $t+1$) at some randomized target percentile of pay levels (in t) of the synthetic peer group (defined based on industry and size). That is, we simulate that boards mechanically set CEO compensation at a given target percentile of peers' pay (for example, at the median of peers' pay).[16] Firms' target percentiles are drawn from a normal distribution with mean 50 and standard deviation of 12.5 and retained throughout the simulation.[17]

[15] We choose ISS's peer selection methodology for two reasons. First, ISS is the largest proxy advisory firm. Second, unlike other proxy advisors, ISS publicly discloses its peer group methodology. ISS's methodology selects for each firm (at least) 14 to (at most) 24 peers by choosing the most similar-sized firms from the same GICS6-industry and that are within 0.45-2.1 times relative sales (assets for financial firms) and within 0.2-5 times relative market capitalization. In cases when there are less than 14 potential peers from this procedure, ISS supplements peers by widening the industry definition to GICS4, and (rarely) further to GICS2 (see, e.g., ISS, 2012).

[16] We start the exercise in 2007 because this is the first year in which data on compensation peer groups became publicly available due to a new SEC disclosure rules. Starting in 2008, for each firm-year we reproduce the compensation peer group that ISS would have assigned following their peer group methodology based on firm characteristics (ISS, 2012).

[17] We draw from a normal distribution with mean 50 and standard deviation 12.5 so that 95 percent of the drawn target percentiles lie between the 25 and 75, which roughly matches available data on pay target percentiles. The inferences we draw from the simulations do not depend on those parameters (see also Figure A.9).

Figure 5 shows the simulated economy-wide pay dispersion between 2007 and 2018. As in Figure 1, we compute the economy-wide pay dispersion by pooling all observations and plot the annual pay dispersion of all Russell 3000 sample firms (solid line). We also compute the (averaged) pay dispersion in firms' compensation peer group and plot the annual average thereof (dashed line). As in Figure 1, we rescale the two measures of pay dispersion relative to their starting levels in 2007 (that is, before the first time the synthetic peer groups are formed in the simulation exercise). Figure 5 shows a precipitous and persistent drop of pay dispersion for economy-wide pay dispersion as well as within firms' compensation peer groups in the first two years. The results in Figure 5 demonstrate that, although synthetic peer groups may vary over time due to differences in firm growth and changes in industry composition, this variation is not large enough to offset the drop in pay dispersion generated by reciprocal benchmarking.[18]

4.2.2. Systematic evidence

Prompted by the previous graphical and simulation-based evidence, we next conduct systematic tests of the hypothesis that reciprocal referencing leads to lower pay dispersion. We conduct these tests at the group-year level and at firm-year level.

Analysis at the industry-size level

The first set of tests is conducted at the group-year level. In particular, we compute our measures for groups of firms in the same industry and the same size-quintile in a given year. Our group-year level measure of pay variation, *CEO pay dispersion*,

[18] In Figure 5 we set compensation at randomized target percentiles of pay levels of the synthetic peer group. In Figure A.9, we show the results are qualitatively the same if all firms target the same percentile (e.g., the median). Figure A.9 also reveals that the decline in pay variation is largely unaffected by whether boards benchmark compensation to the median pay of their peer group (thick lines) or to an alternative percentile of peers' pay levels (e.g., the 65^{th} percentile; see gray-dashed lines). This implies that the exact pay target percentile matters only for the *first* moment of pay – i.e., average pay (see Figure B in A.9) – with the potential outcome of pay ratcheting, but it does matter not for the *second* moment of pay, or pay dispersion, which we investigate (see Figure A in A.9).

is defined as the standard deviation of CEO pay of the industry-size group scaled by the median level of CEO pay in the group in that year. We use the GICS6 industry classification because GICS is commonly used by proxy advisers and compensation consultants. To measure the degree of clustering at the group level, we borrow from the social network literature and construct three well-established metrics of the "degree of clustering" or "closedness" of a set of nodes in a network (in our case, a group of firms).[19] In our setting, a "linkage" in the network of sample firms is defined by whether one firm includes another firm in its compensation peer group.

The first measure, Reciprocity, is defined as the ratio of linkages in a given (directed) network that point in both directions to the total number of existing linkages. *Reciprocity* captures the notion that, in a directed network, information propagates faster among a set of nodes with bidirectional linkages than when they are connected with unidirectional linkages. The second measure, *Density*, is defined as the ratio of existing linkages to the number of possible linkages in a network. The measure is zero for a network without any linkages and one for a complete network. Density quantifies the completeness of a network, relates to the shortest path between any two random nodes and to how fast information transmits between them. The third measure, *Transitivity*, is defined as the ratio of the number of "triangles" found in a network over the number of possible "triads" that exist in the network. Triangles are groups of three nodes that are completely connected with each other, while triads are not. Transitivity captures the notion of close-by nodes being tightly connected, thereby revealing con-

[19] Intuitively, a cluster is a set of nodes that has a greater number of in-group ties relative to between-group ties. Moody and Coleman (2015) review theory and concepts for measuring the degree of network clustering and conclude that there is no single detection method that can reliably pin down the number of clusters or identify their constituents. Instead, studies require a variety of concepts that quantify the degree to which networks are inter-connected.

nected communities. The computation of these three metrics is illustrated in Figure 6.

We compute these metrics for each year for the entire compensation peer network defined by our sample of Russell 3000 firms starting in 2007 – the first year of public disclosure of compensation peers – as well as annually for the networks defined by industry-size groups (GICS6-industries and size-quintiles based on market capitalization). In many applications, these metrics are affected by network size (Moody and Coleman, 2015); this is also the case in our context, as not every node/firm can practically be linked to all other nodes.[20] Hence, it is difficult to decide whether some value should be considered high or low. To overcome this difficulty, we rebase the measures to 2007 and focus on the changes of those metrics within networks across time.

As shown in Figure 7, the value of all three measures – *reciprocity*, *density*, and *transitivity* – exhibits significant increases during the sample period. This is true at the economy level (Figure 7.A) and within industry-size groups (Figure 7.B). Panel B of Table 2 shows that these increases are also statistically significant, even within industry-size groups (i.e., when adding industry-size group fixed effects). The increase is not driven by firms simply adding more peers to their compensation peer group as the average size of compensation peer groups remains stable across years (see Table A.1). Rather, it is consistent with firms replacing compensation peers to comply with the industry-size peer selection criteria.[21]

Next, we test the relationship between *Pay dispersion* and the three network clus-

[20] For example, in the Russell 3000 network of compensation peers, *density* would only equal one if each firm had 3,000 compensation peers. In practice, the average firm in our sample has 18 compensation peers (see Table A.1).

[21] Figure A.10 confirms that since 2007, compensation peers have become more similar in industry and size; and Appendix B provides several anecdotes that illustrate some likely reasons for those changes.

tering measures. Since both pay dispersion and the three clustering metrics exhibit general annual trends, we add year fixed effects in all specifications and use two-way clustering of standard errors at the year and industry-size group level. As shown in Table 3, we find a negative relationship between *Pay dispersion* and the three group-level clustering measures, all of which are significant at the 1 percent level.[22]

Analysis at the individual firm level

We fully exploit the granularity of our data by replicating the previous analysis at the individual firm-year level (which allows us to control for firm-specific variation). That is, we compute our measures for a given firm in a given year. In parallel to the previous tests, *Pay dispersion* at the firm-level is defined as the standard deviation of CEO pay of the firm's compensation peers scaled by the median level of CEO pay of these peers. Conducting the test at the firm-year level offers two advantages. First, it addresses the limitation that industry-size groups may lump together firms that are very different among other characteristics that matter for executive labor markets. And second, a firm-year level analysis allows us to control for firm characteristics and to exploit within industry-year variation and within-firm variation. This is important to control for potentially confounding firm-year variation as well as industry conditions.

Consistent with the results documented at the group-year level, we find decreasing pay variation in firms' compensation peer groups over time alongside stark increases in the three clustering metrics of compensation peer groups. These patterns hold even after adding a large set of time-varying firm characteristics and firm fixed effects (see Panels A and B of Table 4). Mirroring the results from the previous tests at the group-

[22]We obtain the same inference when we repeat the test using industry-only groups or broader industry-size group levels (e.g., at the GICS 2-level).

year level, we find a negative and highly significant relation between the clustering metrics and pay variation within firms' peer groups, even after controlling for time trends via year fixed effects and when adding firm controls and firm fixed effects (see Panel C of Table 4). In economic terms, a one interquartile increase in reciprocity, density, and transitivity in models 2, 4, and 6, respectively, corresponds to a reduction in the pay variation of firms' peer groups by 7.1 percent, 23.0 percent, and 22.3 percent, respectively.

We also conduct the previous firm-year level analysis using an alternative measure of reciprocal benchmarking; the fraction of compensation peers that include the firm in their respective compensation peer group. We refer to this measure as *Fraction of reciprocating peers*. This alternative metric offers some advantages. First, it is intuitive and straightforward. Second, it requires less information on compensation peers as it only considers the reciprocal linkages between a firm and its peers and not the linkages among the peers. As shown in Table A.3, *Fraction of reciprocating peers* is highly correlated with the three previous measures of network clustering.

We verify in Table 5 that this measure is correlated with pay dispersion at the firm level, even after controlling for common time trends.[23] Figure 8 plots *Fraction of reciprocating peers* and pay dispersion in peer groups for firms with data throughout the sample period. It shows that the average firm roughly doubles the fraction of reciprocating peers from 20 percent in 2007 to 40 percent in 2018, while the pay variation within their compensation peer groups simultaneously dropped by roughly one-third from 0.9 to 0.6.

[23] To conserve space in Table 5, we suppress all the coefficients of the control variables and show them instead in the Appendix; see Table A.4. We keep the same set of firm controls throughout the paper.

In summary, the evidence in Figures 1 to 8 and Tables 2 to 5 draws a consistent picture of declining executive pay variation within compensation peer groups, within industry-size groups, and across the economy alongside a growing emergence of compensation peer clusters and reciprocal benchmarking.

5. Institutional developments driving reciprocal benchmarking

We next examine the empirical validity of three factors potentially contributing to the recent increase in reciprocal benchmarking; i) the SEC's mandate to disclose compensation peer groups as of 2007, ii) the introduction of "'say on pay", and iii) the growth of passive investing and greater reliance on proxy advisory firms.

5.1. The SEC's mandate to disclose compensation peer groups

To analyze the potential effect of the 2006 SEC disclosure rule, we first test whether there is a change in pay dispersion at the group-year level before and after the introduction of the SEC rule that mandated the public disclosure of compensation peers as of 2007. In models 1 and 2 of Panel A in Table 6, we find that industry-size groups did not exhibit any trend towards lower pay dispersion between 2004 and 2007; the coefficient on a linear time trend is close to zero in the univariate model (-0.004 with t-statistics of -0.37) and remains close to zero when examining changes within industry-size groups (i.e., with industry $\times$ size fixed effects; coefficient of -0.001 with a t-statistic of -0.02). This changes in models 3 and 4 for the 2008-2011 period; the univariate model finds an annual decrease in pay dispersion of -0.048 percent (t-statistic of -5.25) and an average annual decrease after adding industry $\times$ size fixed effects of -0.051 (t-statistic

of -2.47).[24] Models 5 and 6 confirm the significant difference using a *post* indicator variable.

A direct comparison of reciprocal benchmarking before versus after the introduction of the rule is not possible because there is no available data on compensation peers prior to the 2006 SEC disclosure mandate. However, Faulkender and Yang (2013, 809) contend that, due to the regulatory process of the rule, firms' first-time disclosures in 2007 were still free of strategic motives as firms did not expect to have to report their peer groups already in 2007. As such, firms whose compensation levels in that year were not benchmarked to those of same-industry and similar-size peers likely experienced a greater urgency to change their benchmarking policies. Such an adjustment would likely result in a more pronounced increase in reciprocal benchmarking for those firms. Hence, in models 7 and 8, we sort firms into industry-size groups with above- versus below-median initial levels of reciprocal benchmarking measured via the fraction of reciprocation peers. Consistent with a greater need to adjust compensation benchmarking under the disclosure regime, we find that industry-size groups with lower initial levels of reciprocity (i.e., fewer within-group and greater out-of-group peer referencing) have significantly higher pay dispersion in years prior to the disclosure rule but experience significantly stronger declines in pay dispersion in the years after peer group disclosure becomes mandatory. For example, in model 7, while the annual pay variation decline common to all industry-size groups is -0.037***, those industry-size groups with low initial reciprocal benchmarking see an additional drop of -0.063***

[24] We include 2007 in the pre-disclosure period because pay dispersion in 2007 is yet unlikely to be affected by the SEC disclosure rule. This is because compensation committees obtain information about peers' prior fiscal year pay approximately two quarters prior to the end of their fiscal year (Pearl Meyer and Partners, 2014; Meridian, 2015; WillisTowersWatson, 2019). As such, a compensation package of a firm with December fiscal year end (disclosed in April 2007) was probably designed in September 2006 based on available information on peers' pay levels as of June 2006, namely before the implementation of the new disclosure requirements.

per year (in 2006, the interquartile range of pay variation at the industry-size level is 0.556).

In Panel B of Table 6 we conduct a parallel analysis at the firm-year level. We restrict the sample of firms in this test to those that already disclosed compensation peer groups in 2007. We impose this restriction because a considerable number of firms chose to not yet disclose their compensation peers in 2007 (White, 2007, 2008) and hence had additional time to adjust their first publicly-observable peer groups. We add firm fixed effects in all models to control for the time-invariant characteristics of these firms. We separate firms into those with i) above- versus below-median levels of reciprocal benchmarking measured via the fraction of reciprocation peers in 2007 (models 1 and 2); ii) above- versus below-median levels of compliance with asset managers' same-industry and same-size criteria in 2007 (models 3 and 4); and iii) above- versus below-median levels of compliance with ISS's methodology for selecting appropriate compensation peers in 2007 (see footnote 15 for details; models 5 and 6). We then analyze how reciprocal benchmarking changed between 2007 and 2009. Across all specifications, we find average annual increases in the fraction of reciprocating peers between 0.058** and 0.065*** that are common for all 2007 disclosers. In addition, firms that have lower initial levels of reciprocal benchmarking as of 2007, or that in 2007 comply to a lower degree with asset managers' or proxy advisers' policies for appropriate peer selection increase their fraction of reciprocating peers by an additional 0.014* to 0.017** in fiscal years 2008 and 2009.

Taken together, the evidence in Table 6 shows that pay dispersion starts to decline soon after compensation peer disclosure became mandatory and that it is stronger for firms with initially lower levels of reciprocal benchmarking or showed less compliance in

their compensation peer groups with commonly accepted standards for peer selection (i.e., benchmarking based on industry and size).

5.2. Say on pay

Introduced in 2011 as part of the Dodd-Frank Wall Street Reform and Consumer Protection Act, "say on pay" (SOP) stipulates that any publicly listed corporation in the U.S. must submit the compensation plan of its top executives to shareholders for an advisory vote. Firms are required to disclose the results and report back on changes that they have made in response to a low result. Prior literature provides evidence consistent with the notion that boards make substantial changes to compensation practices after obtaining weak shareholder support in SOP proposals (e.g., Ferri and Maber, 2013; Ertimur, Ferri, and Oesch, 2013; Correa and Lel, 2016; Denis, Jochem, and Rajamani, 2020). There is also evidence that SOP has labor market consequences for directors. For example, Brunarski, et al. (2017) find that directors at firms receiving low SOP support experience reductions in external directorships, compensation committee positions and director compensation.

Since the introduction of SOP, the appropriateness of compensation peer groups is a criterion used by proxy advisers and asset managers to evaluate firms' compensation packages. The policies of proxy advisers and asset managers often mention benchmarking based on industry and size as an objective criterion to select compensation peers (e.g., Equilar, 2015, 14; Blackrock, 2019, 2; T. Rowe Price, 2019, 6-7). After receiving a weak SOP vote, boards may therefore see the need to increase their compliance with this criterion, thereby inducing an increase in reciprocal benchmarking and clustering in the compensation peer network. The anecdotal evidence in Appendix B provides two such examples.

Table 7 examines changes in the fraction of reciprocating peers in a narrow two-year window after a firm's first weak SOP vote. We define weak support as those cases that rank in the lowest 10 percent of the SOP vote distribution, which corresponds to 75 percent in our sample.[25]

Models 1 and 2 show the effects for weak-vote firms only, while models 3 and 4 include a control group of firms. We show univariate effects in models 1 and 3 and include a large set of firm controls and industry × year fixed effects in models 2 and 4. In particular, since firms that receive a weak SOP vote typically also experience worse performance (e.g., Ferri and Maber, 2013; Fisch, Palia, and Solomon, 2017), models 2 and 4 further include several performance controls such as annualized stock return, sales growth and market-to-book ratio (see captions of Table 4 for the complete list of included controls). We find significant increases in the fraction of reciprocating peers in models 1 and 2 in the two years after a firm experiences a weak SOP vote (with t-statistics of 5.3 or above) and which persist also after the inclusion of a set of control firms in models 3 and 4. The economic magnitude suggests an average of one additional compensation peer that references back the weak-vote firm in the initial two years after the weak-vote.

5.3. Growth of passive investing and reliance on proxy advisory firms

The third institutional development potentially affecting reciprocal benchmarking is the growth of passive investing with a corresponding increased reliance on proxy

[25] Voting support in SOP proposals is highly skewed. In our sample covering over 13,000 such votes, the mean (median) support is 90.9 percent (95.8 percent), and only 2 percent of SOP proposals obtain less than 50 percent support. However, voting support below 70 percent is generally considered a negative view of firms' compensation practices by proxy advisory firms and compensation consultants. ISS, for example, adopted a policy in November 2011 to provide case-by-case voting recommendations on compensation committee members if a company's prior year say on pay vote outcome was below 70 percent. In 2016, Glass Lewis and ISS established so-called "red zones" that trigger greater scrutiny when opposition votes exceed 20-25 percent. The results in Table 7 are robust to using 70 percent as a weak-vote threshold.

advisory firms. It is well known that passive investing has experienced a spectacular growth in recent years thanks to popular investment vehicles such as index funds and ETFs (e.g., Sushko and Turner, 2018). While passive investing offers significant advantages to investors (notably diversification and low management fees), it is also well known that this investment strategy generates relatively weak incentives to monitor portfolio firms (e.g., Almazan, Hartzell, and Starks, 2005). As such, a number of passive institutional investors rely partially or completely on proxy advisors' voting recommendations.[26] This is important in our setting, as proxy advisors commonly scrutinize the constituents of firms' compensation peer groups when examining whether firms pay their executives market level wages. In particular, proxy advisors compare firms' executive compensation levels to the median pay of peer groups defined based on industry affiliation and size (see footnotes 5 and 15). Deviations from these criteria are often considered poor governance practices by proxy advisers and investors.[27]

5.3.1. Quasi-experiment

To sharpen the empirical identification of the effect of passive investors' reliance on proxy advisors on reciprocal benchmarking, we conduct Malenko and Shen (2016)'s quasi-experiment in our setting. Following these authors, we use a regression discon-

[26] Prior literature provides abundant evidence of this. For example, Brav, Cain, and Zytnick (2019) report that institutional investors are much more likely to follow general ISS recommendations than retail investors. Iliev and Lowry (2015) find that over 25 percent of funds almost entirely rely on ISS recommendation. In the context of say on pay votes, Ertimur, Ferri, and Oesch (2013) show that proxy advisor recommendations are the key determinant vote outcomes while Malenko and Shen (2016) estimate that a negative ISS vote recommendation reduces shareholder support by 25 percentage points.

[27] For example, in a joint whitepaper with Equilar, Frederic W. Cook & Co. (the largest U.S. compensation consultancy) writes: *"Peer companies should generally operate in similar industries and to the extent possible have similar cost structures and business models. The stronger the match on these characteristics, the more robust and meaningful the resulting compensation and performance data will be. Compensation opportunity levels are strongly correlated with company size and it is important to avoid peer companies that are substantially larger or smaller. (..) Taken in isolation, any one peer company may be singled out or criticized as not a great comparator."* (Equilar, 2014) See also Appendix B for anecdotal evidence in ISS research reports.

tinuity design based on ISS's decision to subject firms to greater scrutiny based on an arbitrary performance cut-off. As shown by Malenko and Shen (2016), such greater scrutiny has a material effect; firms falling below the performance cut-off exhibit a higher probability of receiving a negative vote recommendation by ISS and receive 25 percentage points lower shareholder support.

More specifically, we exploit ISS's 2010-2011 policy to subject companies to an in-depth review of their compensation policies if both their 1- and 3-year total shareholder return is below the median of peers in their 4-digit GICS group (ISS, 2014, 4). We compare companies below the threshold to those above the threshold and examine if the former increase the number of reciprocating peers in their group by a larger degree than the latter. Since ISS followed this policy only in its 2010-2011 proxy season, we limit the sample for this test to 2009-2012 (i.e., we include one year before and one year after the period of the policy).

Table 8 presents the results from the analysis. *Below ISS performance cutoff* is an indicator variable that equals one for firms below ISS's performance threshold in 2010 or 2011 while *Post* is an indicator variable equal to one for 2011 or 2012. As performance differs across firms, all models include firm controls that include stock performance, sales growth and the market to book ratio (see captions of Table 4 for a complete list of controls). We further include either year or industry $\times$ year fixed effects to control for the general upward trend in the fraction of reciprocating peers. We find a significant positive coefficient on *Below ISS performance cutoff* $\times$ *Post* across all specifications. In the tightest specification in model 3 that includes firm controls and industry $\times$ year fixed effects, firms that fall below the performance cutoff increase the fraction of reciprocating peers by 4.8 percentage points. This is a meaningful increase as the median value (interquartile range) of the fraction across all firms at the start of

the reporting mandate is 20.0 (24.2) percent.

5.3.2. Cross-sectional tests

Iliev and Lowry (2015) analyze the effect of proxy adviser recommendations on mutual fund voting. The authors find that when mutual fund investors own larger equity blocks – and hence have a greater incentive to engage in their own vote analysis – they rely less on the vote recommendation by proxy advisers. Building upon this finding, we next relate variation in firm-level reciprocal benchmarking to ownership dispersion and investors' reliance on proxy advisors. We define five firm-level measures. *Institutional ownership* is the sum of shareholdings reported by 13F filing institutions in a firm divided by its total shares outstanding. *Ownership concentration* is the Herfindahl-Hirschman index of ownership using the fraction of shares owned in a given firm by 13F filing institutional shareholders. *Ownership of largest blockholder* is defined as the size of the largest equity block by a single owner. *Propensity to vote with ISS* is the fraction of times that a firm's mutual fund investors historically voted with ISS across all their shareholdings, with each investor weighted by the fraction of shares it owns in the firm. Finally, *Propensity to vote with ISS when management and ISS disagree* is the fraction of times that a firm's mutual fund investors voted with ISS when ISS and the firm's management disagreed on a vote recommendation (see Larcker, McCall, and Ormazabal, 2013, 2015 for prior literature using the latter two measures).

Table 9 presents the results. In models 1 to 4, we observe that institutional ownership is positively related to a firm's degree of reciprocal benchmarking, measured via its fraction of reciprocating peers. Further, greater ownership concentration – measured via a Herfindahl-Hirschman Index or by using the largest ownership block size – is neg-

atively associated with reciprocal benchmarking. Models 5 to 8 also show a positive relationship between the degree of reciprocal benchmarking and the probability that investors vote alongside ISS recommendations. These results corroborate the idea that firms engage in greater reciprocal benchmarking when their investors have fewer incentives to analyze in detail firms' compensation practices and are more likely to follow proxy advisors' voting recommendations (which encourage compensation benchmarking based on industry and size).

6 . Economic consequences

Our last set of tests focus on the potential economic consequences of an increase in reciprocal benchmarking. In particular, we examine the possibility that the documented increase in reciprocal benchmarking reduces external tournament incentives and corporate risk-taking. We conduct our analyses measuring external tournament incentives at the industry level and within peer groups.

6.1 . Tournament incentives

As a first step to analyze the economic consequences of the secular decline in pay variation documented in section 4, we focus on the effect of such decline on managerial incentives. Pay dispersion naturally relates to external tournament incentives, defined as the pay gap between a CEO's compensation level and the highest compensation level in her industry.[28] As explained by Coles, Li, and Wang (2018), this pay gap reflects managers' compensation growth opportunities. That is, if the manager is successful, she could receive an offer by the industry peer paying the highest amount

[28]The literature distinguishes between "external" and "internal" tournament incentives. The former refers to the gap between the pay of the firm's CEO and that of other firms' CEOs. The latter refers to the gap between the pay of the firm's CEO and that of other executives in the firm.

and/or has an external benchmark for a wage renegotiation with her board. To retain the executive the incumbent firm may then have to match this alternative pay offer.

Figure 9 confirms that external tournament incentives decrease significantly over the sample period. The metric *Tournament incentives* is defined as in Coles, Li, and Wang (2018), namely as the gap between the firm's CEO pay and that of the second-highest paid CEO in the firm's industry. We also compute *Tournament incentives* at the firm-level as the gap between the firm's CEO pay and that of the second-highest paid CEO in the firm's compensation peer group. At the industry-level, Figure 9.A shows a decline in industry tournament incentives after the introduction of mandatory reporting of compensation peers. Figure 9.B documents that this decline also holds at the compensation peer group level.[29]

To corroborate that the decrease in external tournament incentives is indeed related to reciprocal benchmarking, Table 10 tests the empirical association between these two variables. Measuring tournament incentives at the industry-level, models 1 to 3 show that the association between the two variables is indeed negative and highly significant. In economic terms, a shift from the 25th to the 75th percentile in reciprocal benchmarking in model 3 (i.e. an interquartile range of 0.323) is associated with a decline in industry tournament incentives of -1.872 (=0.323*-5.795), which corresponds to a 27.1 (=-1.872/6.905) percent decrease of an interquartile range in industry tournament incentives. We repeat the analysis in models 4 to 6 while measuring tournament incentives within firms' compensation peer groups (i.e., using the pay gap between a CEO and the second-highest CEO pay in the compensation peer group). We find sim-

[29] As compensation peers are only disclosed as of 2007, the analysis runs from 2007 to 2018. To maintain consistency in the industry classifications throughout the paper, we use GICS6 industries in Figure 9. Appendix Figure A.11 repeats the analysis while using instead – as in Coles, Li, and Wang (2018) – FF30 industries.

ilar results; a shift from the 25th to the 75th percentile in reciprocal benchmarking is associated with a 33 percent decrease (=0.323*-1.916/1.866) of an interquartile range in compensation group tournament incentives.[30]

6.2. Corporate risk-taking

As a second step to analyze the economic consequences of the secular decline in pay variation documented in section 4, we focus on the effect of such decline on firm outcomes. We focus on firm risk, as external tournament incentives have been found to be strongly associated with risk-taking (Coles, Li, and Wang, 2018). The rationale is that external tournament incentives induce managers to improve performance through greater risk-taking.

As is standard in the literature, we measure corporate risk-taking via firms' realized equity return volatility (e.g., Guay, 1999; Gormley, Matsa, and Milbourn, 2013; Low, 2009; Shue and Townsend, 2017). In particular, we measure corporate risk-taking as the standard deviation of residuals of a firm's daily idiosyncratic stock returns estimated from the Fama-French 3-factor model over the 12 months following the current fiscal year. We refer to this variable as *Corporate risk-taking*. In Appendix Table A.6, we show similar results as in Table 11 for alternative risk measures: forward-looking ROA volatility, cash flow volatility and earning volatility (see John, Litov, and Yeung, 2008; Acharya, Amihud, and Litov, 2011; Ljungqvist, Zhang, and Zuo, 2017).

First, we estimate the association between *Corporate risk-taking* and *Pay dispersion* in the compensation peer group, as previously defined. Firm controls are the

[30]The results are unaffected when re-defining the tournament incentives as the pay gap to the highest-paying (rather than second-highest paying) industry firm or compensation peer (see Table A.5). The results are very similar when computing industry tournament incentives using alternative GICS-, SIC- or FF-based industry classifications.

same as in Table 4 and industry fixed effects are based on FF48 industry classification. As shown in models 1-3 of Table 11, we find a positive relation between these two variables: the greater pay dispersion in the peer group, the greater corporate risk-taking over the next fiscal year. Second, we estimate the association between reciprocal benchmarking and corporate risk-taking over the subsequent fiscal year. As shown in models 4-6, the relation is negative and significant. The magnitude of the effect is also substantial; a shift from the 25th percentile to the 75th percentile in reciprocal benchmarking (i.e., an interquartile range of 0.319) in model 6 is associated with a decline in risk taking of -0.22 (=0.319*-0.688), which corresponds to a decline in the interquartile range of risk-taking of 15.4 percent (-0.22/1.427).

In summary, the findings in Tables 9 and 10 are consistent with the notion that a reduction in pay variation reduces risk-taking by weakening managers' external tournament incentives.

7. Conclusions

Using a wide sample of over 5,000 U.S. public firms spanning from 2002 to 2018, this paper documents a new stylized fact; over the last decade, the cross-sectional variation in CEO pay levels (i.e., the "second moment" of pay) has declined precipitously. We provide one explanation for this secular decrease in pay variation; reciprocal benchmarking (i.e., firms including each other in the disclosed set of peers used to benchmark pay levels). We examine the empirical validity of this explanation by conducting tests at the group-year level (we aggregate observations within the same industry and size quintile in a given year), and at the firm-year level (which allows to control for firm characteristics).

At the group-year level, pay variation is measured as the standard deviation of CEO pay within each industry-size group scaled by the median level of CEO pay. To measure reciprocal benchmarking, we use three well-established metrics of the "degree of clustering" or "closedness" of a set of nodes in a network (a "linkage" in the network of sample firms is defined by whether one firm includes the other in its compensation peer group). At the firm-year level, pay variation is the standard deviation of CEO pay of the firm's compensation peers scaled by the median level of CEO pay of these peers. The fraction of compensation peers that include the firm in their respective compensation peer group is our measure for reciprocal benchmarking. At both levels of analysis, we observe a strong association between pay variation and reciprocal benchmarking.

We next examine three institutional developments potentially contributing to the recent increase in reciprocal benchmarking; the recent SEC mandate to publicly disclose the component companies of compensation peer groups, the introduction of "say on pay" regulation, and the growth of passive investing with an increasing reliance on proxy advisory firms.

These three contributing institutional developments find support in the data. First, we find that pay dispersion only starts dropping in the years after the disclosure regime came into effect. The pattern is stronger when reciprocal benchmarking in the first year of the mandate is lower (i.e., when there is more urgency to adjust). Second, we find that reciprocal benchmarking increases significantly in the two years after firms receive a weak say on pay vote, relative to a set of control firms without weak votes. Third, we find that greater ownership concentration decreases reciprocal benchmarking while it increases with the fraction of a firm's investors who routinely vote with proxy adviser recommendations.

Finally, we analyze whether the documented decline in pay variation has meaningful consequences on firm outcomes. We find a significant negative relationship between reciprocal benchmarking and external tournament incentives. We also find a negative (positive) association between reciprocal benchmarking (pay variation) and firms' future realized equity return volatility.

Overall, our evidence suggests that recent institutional developments have induced a decrease in pay variation, with meaningful consequences for firms' outcomes. We provide evidence consistent with one explanation for this drop in pay dispersion; an increase in reciprocal benchmarking to define CEO pay levels. While meaningful, reciprocal benchmarking is not the only possible factor driving the recent decrease in pay variation. We look forward to further research uncovering other, potentially more important, drivers of this pattern.

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Appendix A: Variable construction

Variable	Definition	Source
I. Pay measures		
CEO pay dispersion (economy-level)	Standard deviation of CEO pay scaled by the median level of CEO pay. Either computed for Russell 3000 firms or for S&P 1500 firms.	Execucomp; Equilar; AuditAnalytics; GMI
CEO pay dispersion (industry or industry-size level)	Standard deviation of CEO pay scaled by the median level of CEO pay at either the GICS6-level or at the GICS6 x Size quintile level (with size depending on a firm's market capitalization).	Execucomp; Equilar; AuditAnalytics; GMI; Compustat
CEO pay dispersion (firm-level)	Standard deviation of CEO pay of a firm's compensation peers scaled by the median level of CEO pay in a firm's compensation peer group.	Execucomp; Equilar; AuditAnalytics; GMI; Compustat
Annual time trend	Linear time trend, computed as the current fiscal year minus the first fiscal year in the sample.	-
Tournament incentives in compensation peer groups	Defined as the difference between the second highest CEO pay in a firm's compensation peer group and the firm's own CEO pay, divided by the firm's own CEO pay.	Execucomp; Equilar; AuditAnalytics; GMI
Tournament incentives in the industry	Defined as the difference between the second highest CEO pay in the FF48 industry minus the firm's CEO pay, divided by the firm's CEO pay.	Execucomp; Equilar; AuditAnalytics; GMI; Compustat
Below-cutoff	Indicator variable that is 1 if a firm underperforms the 1- and 3-year median total shareholder return of its Russell 3000 4-digit GICS industry peers.	Equilar; Compustat; CRSP
II. Graph clustering measures		
Fraction of reciprocating peers	The fraction of a focal firm's compensation peers that are referencing back the focal firm.	Equilar; AuditAnalytics; ISS IncentiveLab
Reciprocity	The fraction of compensation peer references that are bidirectional in the graph that includes all the references among a given set of firms. At the group-level, the graph consists of all firms in a given industry and within a given size quintile in a year. At the firm-level, this is the graph of a focal firm's compensation peers that includes the references among the compensation peers themselves.	Equilar; AuditAnalytics; ISS IncentiveLab

Appendix A: Variable construction *(cont'd)*

Variable	Definition	Source
Density	The number of compensation peer references that exist divided by the number of references that could exist in the graph that includes all the references among a given set of firms. At the group-level, the graph consists of all firms in a given industry and within a given size quintile in a year. At the firm-level, this it is the graph of a focal firm's compensation peers that includes the references among the compensation peers themselves.)	Equilar; AuditAnalytics; ISS IncentiveLab
Transitivity	The number of triangles divided by the number of triads in the graph that includes all the references among a given set of firms (see Newman, 2010, Ch. 7). At the group-level, the graph consists of all firms in a given industry and within a given size quintile in a year. At the firm-level, this is the graph of a focal firm's compensation peers that includes the references among the compensation peers themselves.	Equilar; AuditAnalytics; ISS IncentiveLab
III. Firm, board and CEO characteristics		
Total assets	Total book assets.	Compustat
Total sales	Net sales or revenue.	Compustat
Market-to-book ratio	The ratio of market value of equity to book value of equity.	Compustat
Cash holdings	Cash and short-term investments.	Compustat
Leverage	Current liabilities plus long-term debt minus cash and short-term investments, divided by total assets.	Compustat
Investments	Capital expenditures (CAPX) divided by total assets.	Compustat
Equity	Common equity.	Compustat
R&D indicator	Indicator variable that is 1 if firm has disclosed any R&D expenditures, else 0.	Compustat
Stock performance	Buy-and-hold stock performance over fiscal year. (Averaged across share classes when a firm has multiple classes of shares outstanding.)	CRSP
Sales growth	Year-on-year fractional change in net sales.	Compustat
S&P 1500 indicator	Indicator variable that is 1 if it is part of the S&P 1500 index, else 0.	Compustat
Realized equity return volatility over next fiscal year	The standard deviation of residuals of a firm's daily stock returns over its next fiscal year estimated from the Fama-French 3-factor model.	CRSP
ROA volatility over next 3 years	The standard deviation of a firm's return on assets over fiscal years $[t+1, t+3]$.	Compustat
Cash flow volatility over next 3 years	The standard deviation of a firm's cash flow (i.e., earnings before interest and taxes minus extraordinary items plus depreciation over assets) over fiscal years $[t+1, t+3]$.	Compustat
Earnings volatility over next 3 years	The standard deviation of a firm's earnings before interest and taxes over assets over fiscal years $[t+1, t+3]$.	Compustat
Institutional ownership	Sum of shareholdings reported by 13F filing institutions divided by total shares outstanding.	Thomson Reuters

Appendix A: Variable construction *(cont'd)*

Variable	Definition	Source
Ownership concentration (HHI)	Herfindahl-Hirschman index of ownership using the fraction of shares owned by 13F filing institutional shareholders.	Thomson Reuters
Ownership of largest blockholder	Shareholdings of largest blockholder as disclosed in 13F filings.	Thomson Reuters
Propensity to vote with the ISS	The fraction of times that a firm's given mutual fund investors voted with ISS in the past, averaged across all shareholdings since data availability starts in 2003.	Thomson Reuters Mutual fund holdings; ISS mutual fund voting
Propensity to vote with the ISS when management and ISS disagree	The fraction of times that a firm's mutual fund investors voted with ISS in the past when ISS and the firm management disagreed on the vote recommendation, averaged across all shareholdings (data availability starts in 2003).	Thomson Reuters Mutual fund holdings; ISS Mutual fund voting; ISS Voting Analytics
Fraction of independent directors	Fraction of directors that are classified as independent.	Equilar; BoardEx
Lead director	Indicator variable that is 1 if firm has a designated lead director in a given year, else 0.	Equilar; BoardEx
Classified board	Indicator variable that is 1 if the board is classified, else 0. For S&P 1500 firms taken from RiskMetrics. For non-S&P 1500 firms, identified via annual director voting at annual meetings.	RiskMetrics; ISS Voting Analytics
Number of committees	Number of board committees.	Equilar; BoardEx
CEO age	Age of the CEO.	Equilar; Execucomp; GMI
CEO tenure	Tenure of the CEO in years.	Equilar; Execucomp; GMI
CEO-chairman duality	Indicator variable that is 1 if the firm has a CEO that serves as the board's chairman too, else 0.	Equilar; BoardEx
CEO turnover	Indicator variable that is 1 if the firm has a new CEO taking over within the last one year, else 0.	Equilar; Execucomp; GMI

Appendix B: Anecdotal evidence of Peer Group Revisions and Consequences to Reciprocal Benchmarking

1. AUTODESK, INC. *(GICS 45: Information Technology industry)*

At its 2012 annual meeting, Autodesk Inc. received 54 percent shareholder support in its advisory vote for its executives' compensation packages (the "say on pay" vote), which ranked that year in the bottom five percent of say on pay vote support in the Russell 3000. In the same year, Autodesk Inc. had also received an "against" vote recommendation by ISS for its say on pay vote. In its research report, ISS singled out two areas of concerns about compensation: pay for performance alignment and peer group benchmarking policies. On the latter concern, ISS specifically criticized that Autodesk Inc.'s compensation peers did not fit with ISS's relative-size criteria and compared Autodesk's CEO pay to the median of its own peer group:

> *"The company's fiscal 2012 pay review and determination group comprises mainly of companies that are larger in terms of revenues. Moreover, several peers are more than two times larger in terms of revenue, and fiscal 2012 CEO pay was 2.18 times ISS's peer group median. Making pay determinations based on companies that are primarily larger in terms of revenue may escalate pay irrespective of company performance."* (ISS research report on Autodesk, 18 May 2012, p.13)

In a proxy filing for a Special Meeting in January 2014, Autodesk Inc. summarized the actions it had taken in response to shareholders' disapproval in prior say on pay votes:

> *"Continuing with its focus on instituting best practices for executive compensation, the Committee took a number of actions during fiscal 2012 aimed at evolving and improving Autodesk's executive compensation programs. These actions included: i Designing a Performance Stock Unit program; ii Revising Autodesk's compensation peer group to more closely align with companies of Autodesk's financial size and performance; and iii Mandating stock ownership for all executive officers."* (Autodesk DEF14A, Dec 3, 2013, p.18)

Autodesk continues that after another disappointing say on pay vote in fiscal year 2013 with just 64.7 percent support, its management had contacted its largest stockholders, representing over 60% of the outstanding shares, to understand their views and concerns about Autodesk's executive compensation policies. In response, the compensation committee decided to (among other things):

> *"regularly review and identify compensation peer group companies of appropriate size and pay philosophy"'* and to *"further refine Autodesk's compensation peer group"* so to have *"companies in the compensation peer group more closely match Autodesk based on key financial criteria, such as revenue and market capitalization."* (ibid., pp.19-20).

The revised compensation peer group in 2013 reduced the number of non-ISS compliant peers from 9 to 5, in that process increasing the fraction of reciprocal references by 16 percentage points. The following year, Autodesk Inc. removed an additional four peers and added six new one so to further increase the fit of the compensation peer group with its own size. Thereafter, Autodesk had only two non-ISS compliant peers remaining in its peer group with 12 of its 14 compensation peers representing 'reciprocal references' (i.e., the peers also referenced Autodesk in their respective compensation peer groups). After two consecutive "against" say on pay vote recommendations, ISS again issued a "for" vote recommendation for Autodesk's say on pay vote in 2014 and shareholder support climbed from 64.7 percent in 2013 to 88.3 percent in 2014. Over the whole sample period, Autodesk increased reciprocal benchmarking in its peer group from a low of 18 percent in 2007 to 76 percent in 2018, with an intermediate high of 86 percent in 2015.

2. MINERALS TECHNOLOGIES, INC. *(GICS 15: Materials industry)*

In its 2012 annual meeting, Minerals Technologies Inc. received 56.4 percent shareholder vote support in its say on pay vote, thereby ranking in the Russell 3000 bottom five percent of say on pay vote outcomes in that year. In the same year, the company had also received an "against" vote recommendation by ISS for its say on pay vote. In its research report, ISS pointed to two areas with a high level of concern: pay for performance evaluation and peer group benchmarking policies. In regards to the latter, it commented:

> *"The proxy states that the company intends to have direct remuneration at the 75th percentile of comparators for the high levels of performance that the company targets. Shareholders should note, however, as illustrated in 'Company Selected Peers' [a chart on p.5 of the report that shows that only 1 of the 14 peers is smaller in revenues] the company's competitive benchmarking peer group includes a number of companies that are significantly larger in terms of revenue. Above-median benchmarking and the inclusion of larger companies may have the effect of increasing compensation without providing a strong link to performance."* (ISS research report on Minerals Technologies, May 2, 2012, p. 13)

In response, Minerals Technologies writes in its subsequent proxy filing in April 2013 that it consulted with major shareholders and with ISS and implement changes to its peer group so that it aligned more in firm size and industry classification:

> *"At our 2012 Annual Meeting, our shareholders approved the 2011 compensation of our named executive officers with 56.4% of the shares voting on the matter at the meeting voting in favor. While our 2012 "Say-on-Pay" proposal passed, there were a significant number of votes against the proposal, which likely resulted from a negative recommendation the proposal received from Institutional Shareholder Services (ISS). We conducted an extensive outreach program in connection with our 2012 Say-on-Pay proposal, including contacting all of our top 25 shareholders, to explain the compensation program to our shareholder base. We were pleased that, as a result, a majority of our shareholders voted in favor of the proposal. Since our 2012 annual meeting of shareholders, we have continued our extensive engagement with our shareholders, including contacting all of our top 45 shareholders, as well as with ISS to determine how our corporate governance and compensation practices can be improved. While many of our shareholders were pleased with the overall design of our compensation program, other shareholders had suggestions for improvement. Our Board of Directors and Compensation Committee carefully reviewed these suggestions, and made the following changes to our executive compensation program during 2012:*
>
> - *Most significantly, we performed a careful analysis of the peer companies we use to provide benchmarks regarding remuneration through our executive compensation program at a level appropriate for the markets we compete in. This has resulted in significant changes to the composition of our peer group to ensure that we use the most appropriate comparators for designing our program and making appropriate compensation decisions. See page 49 for further discussion of our peer group."*

[On page 49 then]

> *"As a result of our outreach to our shareholders in 2012, we substantially revised the comparator group used for determining our compensation program. The Company's primary business competitors are foreign companies, privately held firms or subsidiaries of publicly-traded companies. Accordingly, compensation data for most of our primary business competitors is not publicly available. Therefore, based on information and analysis provided by the Committee's independent executive compensation consultant, Steven Hall & Partners, we identified the following group of comparator companies for reference in setting compensation. We selected these companies because they are primarily in the specialty chemical industry, they provide a broad measure of compensation in the market in which we compete for talent, they are similar to the Company in the scope of their operations, and they reflect a generally accepted range of revenue and market capitalization for an appropriately-sized peer group. Our independent compensation consultant has reviewed and supports this peer group."* (DEF14A filing by Minerals Technology Inc., April 3, 2013; pp. 4, 49)

For the following fiscal year, ISS again recommended a "for" vote recommendation for the company's say on pay vote and shareholder vote support climbed to 87.0 percent. The 2012 peer group restructuring led to an increase reciprocal benchmarking from 21 percent to 52 percent.

3. AMERICAN ELECTRIC POWER COMPANY INC. *(GICS 55: Utilities)*

American Electric Power is an example of cases where a compensation committee decided to align its peer group more closely with "the majority practice in the utility industry" without any external shareholder pressure. (Its most recent say on pay vote at the time from 2012 had a support rate by shareholders of 95.3 percent, which was approximately the median support among Russell 3000 firms.)

In its proxy filing sent on March 12, 2014, the company describes the process by which it creates a compensation peer group (while noting that its most recent peer group consisted of almost equally industry-peers and non-industry peers) and how to target executive pay relative to its peers.

> *"The HR Committee, supported by its independent compensation consultant, annually reviews AEP's executive compensation relative to a peer group of companies that represent the talent markets with which AEP must compete to attract and retain executives. The companies included in the Compensation Peer Group were chosen from utilities and industrial companies that were comparable in size to AEP. At the end of 2012, the HR Committee used the Compensation Peer Group consisting of the 14 utility industry companies and the 12 general industry companies shown in the table below in setting the compensation for our named executive officers for 2013. [..] The standard benchmark is the median value of compensation paid by the Compensation Peer Group. The HR Committee considers percentiles other than the median and may select any percentile as a benchmark if, in their judgment, such other benchmarks provide a better comparison based on the specific scope of the job being matched. Broader energy and general industry data is used when sufficient data is not available in the Compensation Peer Group to provide a comparison, but this was not the case in 2013 with respect to any of the named executive officers."* (DEF14A filing by American Electric Power, March 12, 2014, pp. 29-30)

It then described the motivation for an extensive revision of its compensation peer group that occurred in September 2013 and which removed all peers from other industries so to retain only same-industry and similar-sized peers:

> *"As part of the HR Committee's independent compensation consultant's comprehensive review of the Company's executive compensation in September 2013, the consultant noted that the Company's practice of using a mix of electric utility and general industry peers differed from the majority practice in the utility industry. Therefore, the HR Committee approved changing the composition of the Company's peer group. It retained all of the existing utility peer companies, added three utility peer companies, and removed all of the general industry companies, thereby creating a compensation peer group consisting entirely of utility companies. The HR Committee made these changes because it determined that an all utility peer group provides more meaningful compensation comparisons and because other similar utility companies are the primary competitors for the company's executive talent. Recent consolidations and mergers in the utility industry increased the size of a number of the utility peer companies. This provided for a sufficiently sized peer group of companies with revenues in a suitable range as compared to the Company's. The peer group set forth below serves as our peer group for 2014." (ibid, pp. 30)*

The revision of its peer group decreased the number of non-ISS compliant peers from 14 in 2012 to just 1 in 2013, while simultaneously increasing the fraction of reciprocal references from 46.4 percent to 83.3 percent. In subsequent years, American Electric Power maintained high levels of shareholder support in say on pay votes of 94 percent or above.

Figure 1. CEO pay variation

This figure shows variation in CEO pay levels among Russell 3000 firms between 2002 and 2018. CEO pay variation is defined as the median-scaled standard deviation of CEO pay in a given year (winsorized at the 5th and 95th percentile). The dashed lines show the 95 percent confidence interval. To show the relative pay decline, CEO pay variation is rebased to 2002.

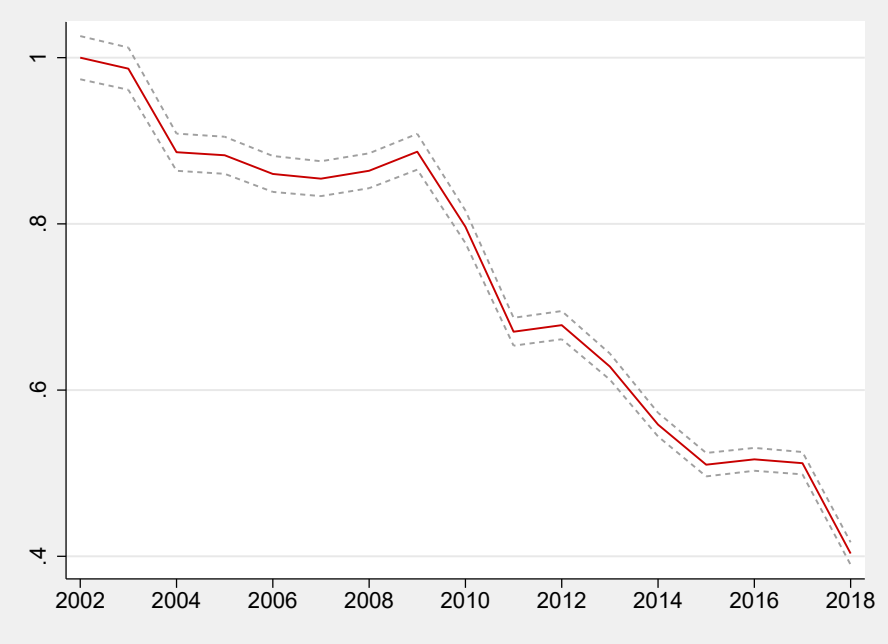


Figure 2. Within-industry CEO pay variation

The figures show the average CEO pay variation for Russell 3000 firms in industry- and industry-size groups. Pay variation is defined as the median-scaled standard deviation of CEO pay in a given year and group. Industry groups are based on GICS2 industry definitions. Figure A measures within-industry variation. Figure B measures within-industry-size variation. In Figure B, firm-size quintiles are determined by firms' market capitalization. Figure B shows the pay variation of industry and industry-size groups averaged for each year and rebased to 2002.

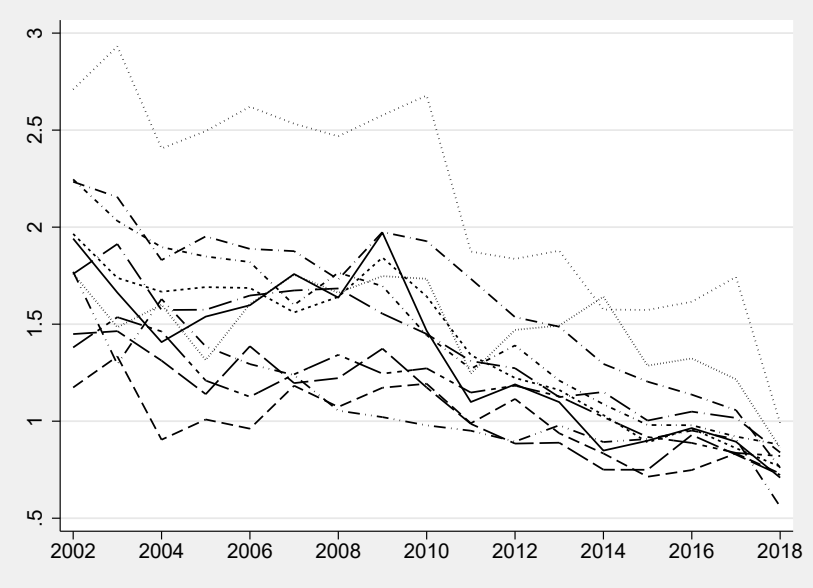


Figure A. Within-industry CEO pay variation

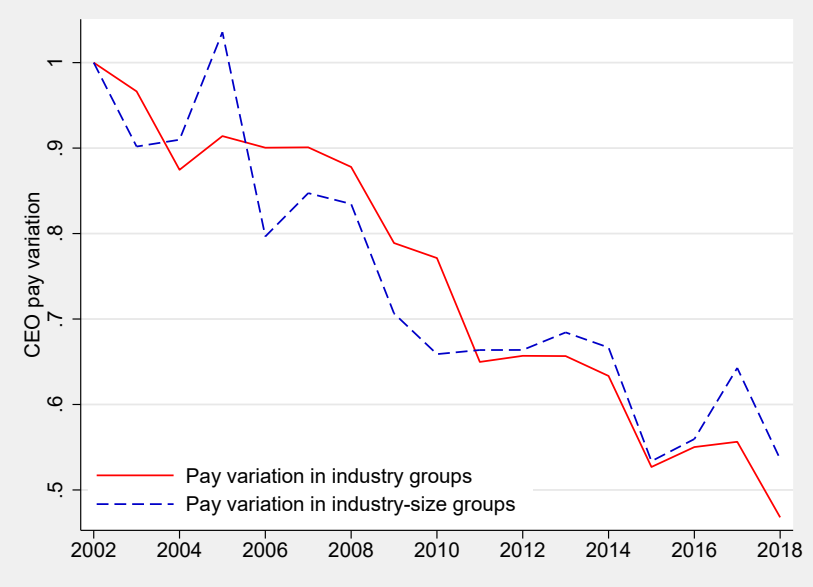


Figure B. Averaged within-industry and within industry-size CEO pay variation

Figure 3. Illustration of reciprocal benchmarking

This figure illustrates how the emergence of a common industry- and sized-based benchmarking policy affects compensation peer network. Figure A shows two industry-size firm groups prior to the emergence of a common benchmarking policy; hence companies reference across industry-size groups such that executive pay changes in one group affect pay at the other group. Figure B illustrates the extreme case when peer referencing completely follows an industry- and size-based benchmarking policy, leading to closed industry-size compensation networks. Firms typically set executive pay levels near the median of their compensation peers (Bizjak, Lemmon, and Naveen, 2008; Denis, Jochem, and Rajamani, 2020). If firms in Figure B set own pay to the median of its peers, then executive pay fully converges within each industry-size group to the median with no pay variation within industry-size groups.

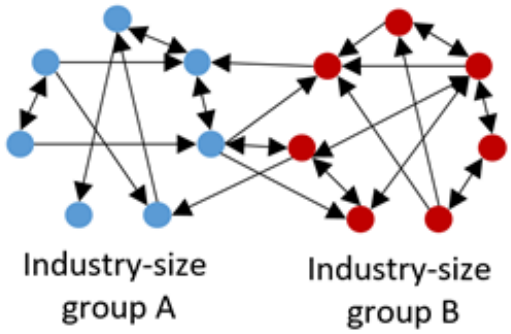


Figure A. Low degree of reciprocal benchmarking *prior to* the emergence of a common benchmarking policy

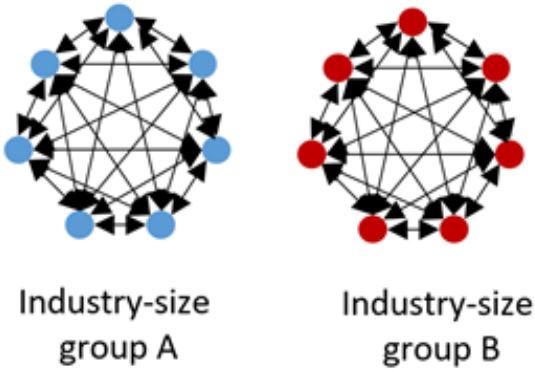


Figure B. High degree of reciprocal benchmarking *after the* emergence of a common benchmarking policy

Figure 4. Changes in compensation peer group networks

The graphs show compensation peer references between a random sample of S&P 1500 firms and their peers in 2008 and 2013. Firms are systematically randomly sampled by sorting firms by their *gvkey* identifier and then taking every 20th firm. Then, all their compensation peers and the references among them are added to the dataset. Graphs are drawn using the Fruchterman-Reingold graphing algorithm.

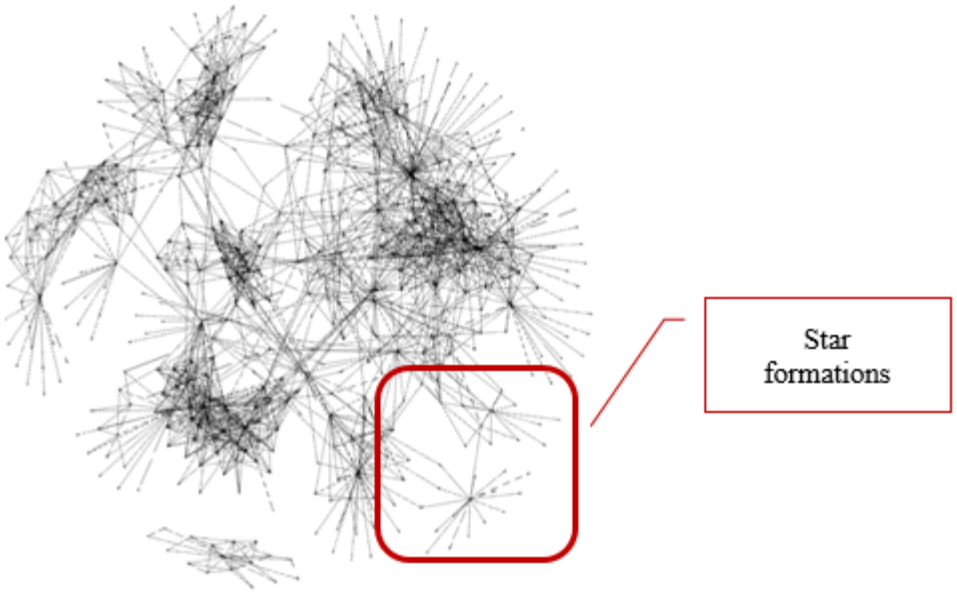


Figure A. Compensation peer group network in 2008

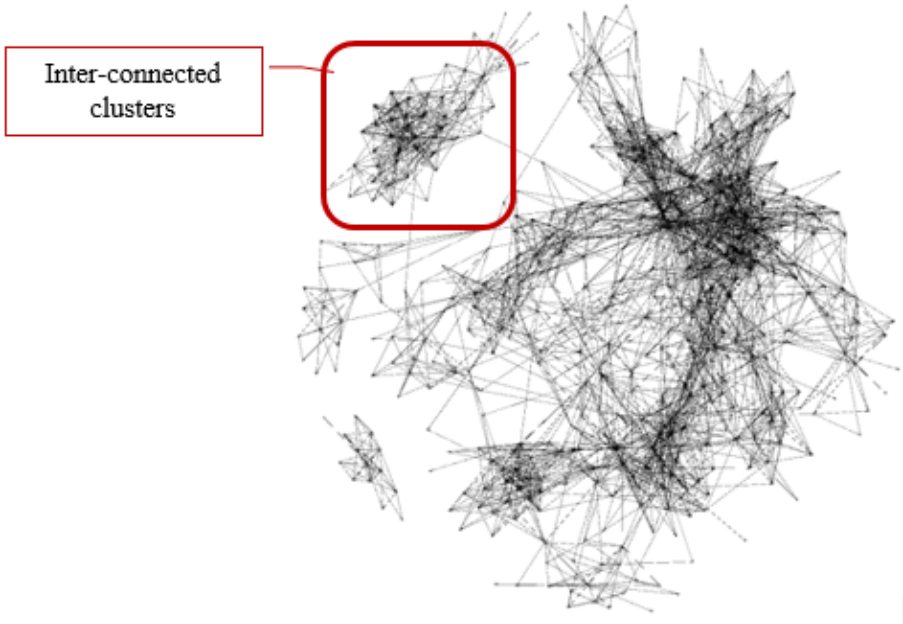


Figure B. Compensation peer group network in 2013

Figure 5. Simulation

This figure shows the simulated trajectory of CEO pay dispersion and peer group pay variation for the average Russell 3000 firm if firms based their compensation peer selection on industry and size criteria only (synthetic peer groups are constructed following ISS's 2007 peer group methodology as discussed in the text). The red solid (blue long-dashed) line shows the trajectory of pay variation in the economy (in the peer group) if each firms sets next year's pay at a random percentile of the distribution of pay level in the corresponding ISS-compliant synthetic compensation peer group (percentiles are randomly drawn at the start of the simulation from a normal distribution with mean 50 and standard deviation 12.5).

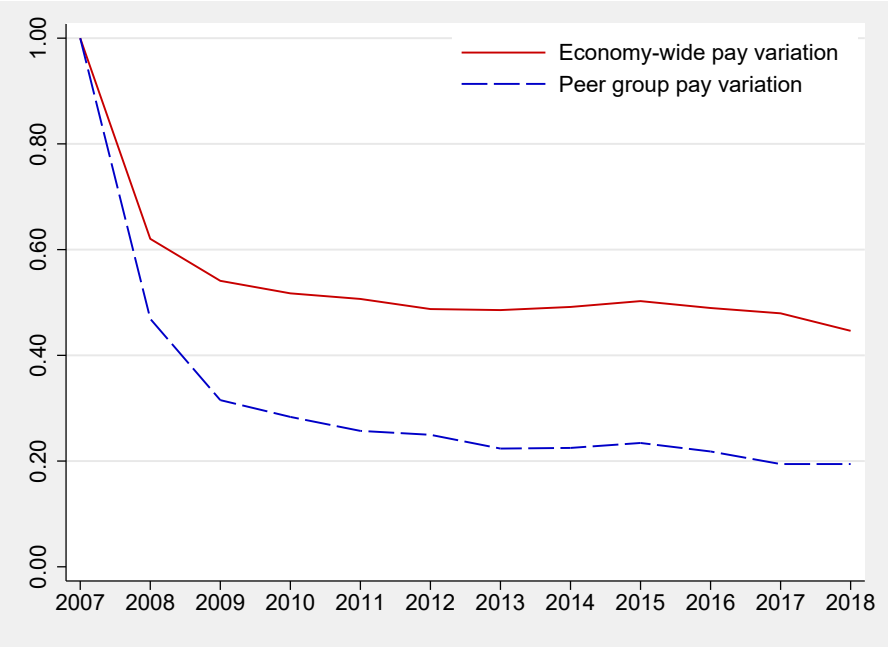
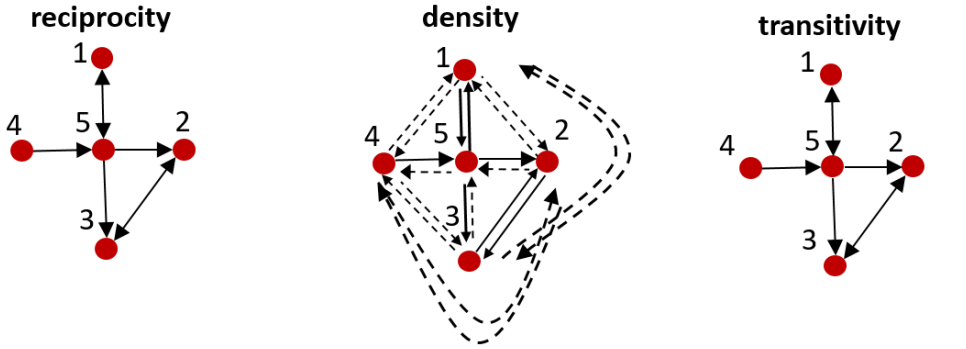


Figure 6. Illustration of graph clustering metrics

This figure illustrates the clustering metrics *Reciprocity*, *Density* and *Transitivity* in a simple graph of six nodes. *Reciprocity* is the number of linkages that are bidirectional to the number of overall linkages. *Density* is the number of existing linkages to the number of potential linkages. *Transitivity* is the number of triangles to the number of triads. Triangles are groups of three nodes that are completely connected with each other, while triads are not.



reciprocity= 4/7 = 0.571 *Density** = 7/20= 0.350 *Transitivity*† = 0.429

*) Density = potential (existing) linkages shown with dashed (solid) arrows

†) Transitivity= 3*triangles/triads (Triangles: 523; Triads: 152, 153, 451, 452, 453, 523, 532)
Triangles are not directional while triads are; see Newman, 2010, Ch. 7.9)

Figure 7. Simulation

This figure shows the change in three network clustering measures – reciprocity, transitivity and density – rebased to the first year in which compensation peer group references are made public. Figure A shows network clustering measures for the compensation peer network of all Russell 3000 sample firms. Figure B shows network clustering measures for industry-size networks (averaged across all groups for a given year).

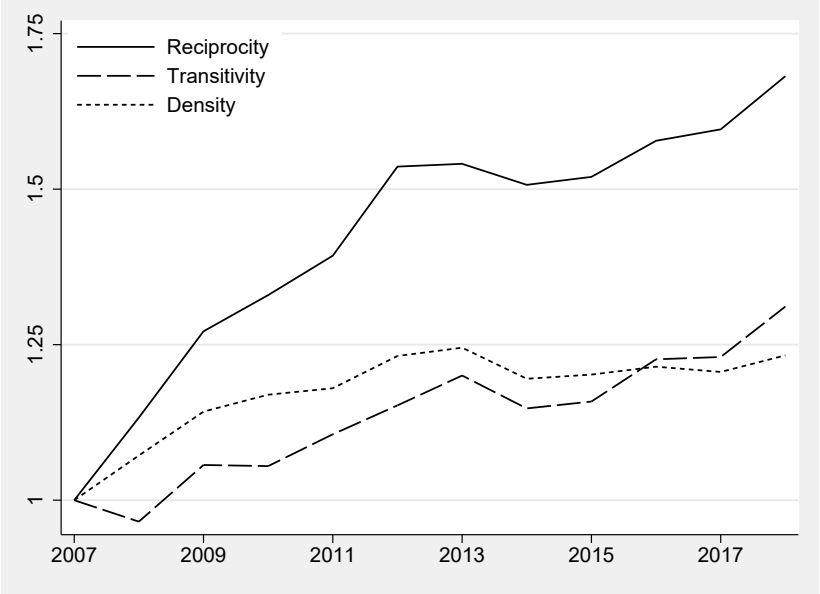


Figure A. Clustering measures for the network of all Russell 3000 sample firms

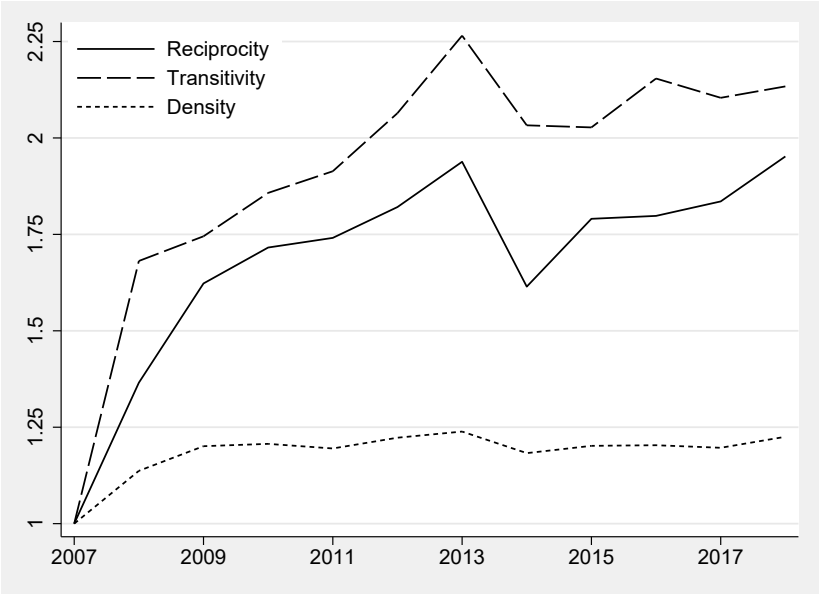


Figure B. Clustering measures for industry-size groups (averaged across all groups)

Figure 8. Individual-level measures of reciprocal benchmarking

The figure shows the evolution of reciprocal benchmarking and pay dispersion in compensation peer groups. *Fraction of reciprocating peers* is the fraction of compensation peers that reference back the base firm, averaged across firms in a given year. *Pay variation in peer group* is the standard deviation of compensation peers' CEO pay scaled by the median CEO pay of those compensation peers. The shaded lines represent the 95 percent confidence intervals.

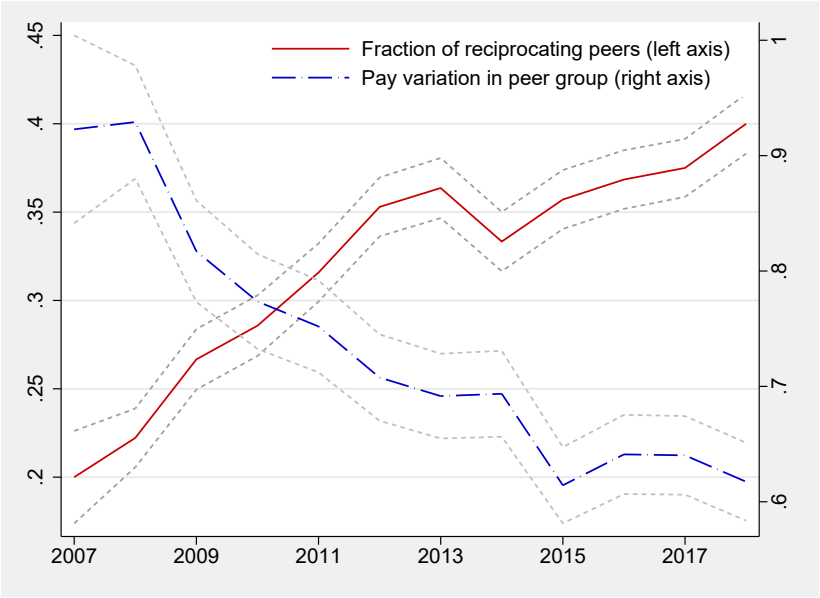


Figure 9. Tournament incentives

This figure shows changes in tournament incentives. Figure A shows industry tournament incentives between 2002 and 2018 at the GICS6-industry level. Industry tournament incentives are defined as the difference of the CEO pay of either the highest or second-highest paying firm in a given industry minus the focal firms' CEO pay, scaled by average pay in the industry that year. Figure B shows those changes within firms' compensation peer groups since 2007 (the first year in which firms had to disclose compensation peer groups).

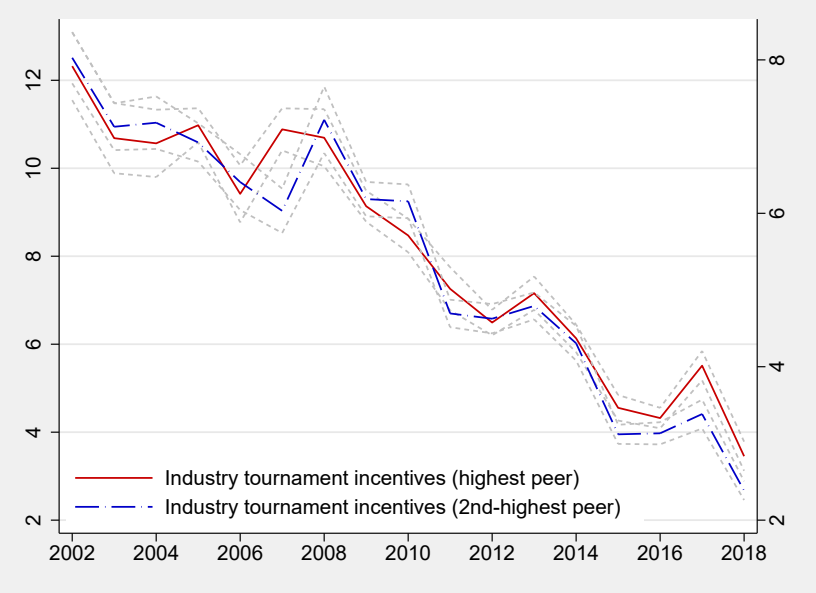


Figure A. Industry tournament incentives

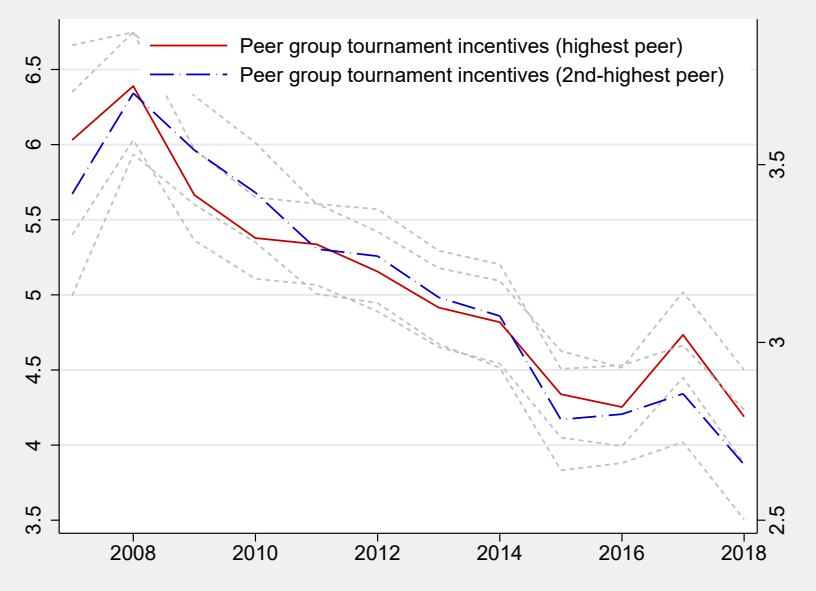


Figure B. Peer group tournament incentives

Table 1: Descriptive statistics

This table shows coverage and firm characteristics for the firm-year level sample. The sample includes firm-year observations from 2007 to 2018. See Appendix A for variable definitions.

	P5	Median	Mean	P95	Std. Dev.	N
CEO pay ($ thousands)	655.9	3,727.5	5,586.5	16,008	6,827.3	23,902
Reciprocity	0.000	0.400	0.412	0.839	0.257	25,264
Transitivity	0.066	0.358	0.360	0.672	0.185	25,264
Density	0.103	0.279	0.304	0.604	0.153	25,264
Fraction of reciprocating peers	0.000	0.250	0.295	0.722	0.223	25,294
Size ($ billion)	0.131	2.098	10.97	45.90	35.06	25,109
Sales ($ billion)	0.052	1.083	5.054	21.99	12.93	25,107
Market-to-book	0.911	1.440	1.908	4.739	1.364	25,055
Cash and short-term investments	0.008	0.156	1.041	4.046	4.541	25,109
Net book leverage	-0.549	0.100	0.083	0.603	0.340	25,003
Investments	0.000	0.024	0.040	0.140	0.052	25,044
Equity	0.018	0.654	2.754	12.61	6.843	25,108
Has R&D expenses	0.000	0.000	0.410	1.000	0.492	25,327
Stock performance	-0.555	0.077	0.126	0.937	0.523	24,639
Sales growth	-0.256	0.055	0.096	0.509	0.310	24,444
Fraction independent directors	0.563	0.833	0.789	0.912	0.124	24,833
Has inside chair	0.000	1.000	0.538	1.000	0.498	24,875
Has classified board	0.000	0.000	0.453	1.000	0.498	24,602
Has lead director	0.000	0.000	0.481	1.000	0.499	24,884
Number of board committees	3.000	4.000	3.904	6.000	1.131	24,875
CEO age	45.00	45.00	56.51	69.00	7.235	24,583
CEO tenure	0.000	6.000	7.653	22.00	7.128	24,595
CEO turnover	0.000	0.000	0.109	1.000	0.313	23,754

Coverage by year:	**Year**	**Firms**	**Year**	**Firms**	**Year**	**Firms**
	2007	617	2011	2,371	2015	2,213
Distinct total	2008	1,991	2012	2,413	2016	2,194
firms: 3,879	2009	2,215	2013	2,378	2017	2,179
	2010	2,329	2014	2,413	2018	2,197

Table 2: Group-level measures of pay dispersion and network clustering

The table shows trajectories for CEO pay dispersion and clustering of compensation peer groups for Russell 3000 firms. The level of observation is industry-size-year. Industry is defined based on GICS6 classifications and size based on quintiles of market capitalization within industry-year. *Time trend* is a linear trend variable defined as the fiscal year minus 2006. Panel A shows the annual trend in CEO pay dispersion within industry-size groups since the introduction of mandatory peer group disclosure. Panel B shows the trend in the clustering of peer group networks within industry-size groups since the introduction of mandatory peer group disclosure. The clustering measures in Panel B (*Reciprocity*, *Density* and *Transitivity*) are computed at the industry-size-year level and defined in Appendix A (for ease of interpretation the measures are multiplied by 100). t-statistics (in parentheses) are based on standard errors two-way clustered at the year and industry-size levels.

Panel A: Group-level pay dispersion

Dependent variable:	*CEO pay dispersion*			
Level:	Industry-size-year level			
Sample:	2007-2018			
Model:	(1)	(2)	(3)	(4)
Time trend	-0.016***	-0.017***	-0.016***	-0.017***
	(-5.274)	(-4.437)	(-5.088)	(-4.545)
Industry FE	No	Yes	No	n/a
Size FE	No	No	Yes	n/a
Industry × Size FE	No	No	No	Yes
Observations	3,813	3,813	3,813	3,806
R-squared	0.009	0.170	0.024	0.314

Panel B: Group-level network clustering measures

Dependent variable:	*Reciprocity*		*Transitivity*		*Density*	
Level:	Industry-size-year level					
Sample:	2007-2018					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Time trend	0.465**	0.528***	0.394***	0.476***	0.546***	0.714***
	(3.034)	(3.237)	(3.318)	(3.594)	(5.025)	(5.008)
Industry × Size FE	No	Yes	No	Yes	No	Yes
Observations	3,355	3,344	3,355	3,344	3,355	3,344
R-squared	0.007	0.598	0.011	0.693	0.011	0.589

Table 3: Network clustering and pay dispersion
Group level analysis

The table shows the relationship between clustering in compensation peer networks and executive pay dispersion between 2007 and 2018. The level of observation is industry-size-year. Industry is defined based on GICS6 classifications and size based on quintiles of market capitalization within industry-year. *CEO pay dispersion* is the standard deviation of CEO pay at the industry-size-year level divided by median pay at the group-level. The clustering measures *Reciprocity*, *Density* and *Transitivity* are computed at the industry-size-year level and defined in Appendix A. t-statistics (in parentheses) are based on standard errors two-way clustered at the year and industry-size levels.

Dependent variable:	*CEO pay dispersion*		
Level:	Industry-size-year level		
Sample:	2007-2018		
Model:	(1)	(2)	(3)
Reciprocity	-0.302***		
	(-3.614)		
Density		-0.307***	
		(-3.452)	
Transitivity			-0.559***
			(-4.643)
Year FE	Yes	Yes	Yes
Observations	3,175	3,175	3,175
R-squared	0.028	0.029	0.035

Table 4: Network clustering and pay dispersion. Firm level analysis

Panels A and B show changes between 2007-2018 in the CEO pay dispersion of firms' peer groups and the clustering of their peer groups. The level of observation is firm-year. *CEO pay dispersion* is the standard deviation of CEO pay in a given firm's compensation peer group divided by median pay in the compensation peer group. *Time trend* is a linear trend variable defined as the fiscal year minus 2006. The clustering measures *Reciprocity*, *Density* and *Transitivity*, computed at the peer group level, are defined in Appendix A. In Panel B, the three measures are multiplied by 100 for ease of interpretation. Industry is defined based on GICS6 classifications and size based on quintiles of market capitalization within industry-year. Firm controls include *size, sales, market-to-book ratio, cash, leverage, investments, equity, R&D expenditures, an S&P 1500 indicator, stock performance, sales growth, CEO age, CEO tenure, fraction of independent directors, the number of board committees* and indicator variables for a *CEO turnover* within the prior 12 months, for *CEO-chairman duality*, for the existence of a *classified board* and the existence of a *lead director*. All variables are defined in Appendix A. t-statistics (in parentheses) are based on standard errors clustered at the firm level.

Panel A: Change in firm-level measures of pay dispersion

Dependent variable:	*CEO pay dispersion*				
Level:	Firm-year level				
Sample:	2007-2018				
Model:	(1)	(2)	(3)	(4)	(5)
Time trend	-0.028***	-0.028***	-0.028***	-0.028***	-0.030***
	(-19.868)	(-17.176)	(-18.057)	(-18.740)	(-17.592)
Firm controls	No	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	n/a	n/a
Industry × Size FE	No	No	No	Yes	n/a
Firm FE	No	No	No	No	Yes
Observations	25,012	22,031	22,031	22,017	21,668
R-squared	0.025	0.070	0.146	0.189	0.429

Panel B: Growth in firm-level measures of peer group clustering

Dependent variable:	*Reciprocity*		*Transitivity*		*Density*	
Level:	Firm-year level					
Sample:	2007-2018					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Time trend	0.750***	1.730***	0.635***	0.999***	0.240***	0.511***
	(11.404)	(25.055)	(13.786)	(20.400)	(6.118)	(11.348)
Firm controls	No	Yes	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes	No	Yes
Observations	25,264	21,879	25,264	21,879	25,264	21,879
R-squared	0.009	0.781	0.012	0.785	0.003	0.758

Table 4: Network clustering and pay dispersion. Firm level analysis *(cont'd)*

Panel C: Relation between firm-level clustering measures and pay dispersion

Dependent variable:	*CEO pay dispersion*					
Level:	Firm-year level					
Sample:	2007-2018					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Reciprocity	-0.248***	-0.082**				
	(-11.332)	(-2.191)				
Density			-0.587***	-0.557***		
			(-17.550)	(-10.185)		
Transitivity					-0.526***	-0.417***
					(-18.025)	(-7.817)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes	No	Yes
Observations	25,043	21,623	25,043	21,623	25,043	21,623
R-squared	0.040	0.496	0.051	0.500	0.054	0.499

Table 5: Reciprocal benchmarking and pay dispersion
Firm level analysis

The table shows the relationship between reciprocal benchmarking and CEO pay dispersion within compensation peer groups between 2007 and 2018. The level of observation is firm-year. *CEO pay dispersion* is the standard deviation of CEO pay at the peer group-level divided by median pay at the peer group-level. *Fraction of reciprocating peers* is the fraction of compensation peers that reference back the firm. Industry fixed effects are based on GICS6 industry classifications. *t*-statistics that are based on standard errors clustered at the firm level.

Dependent variable:	*CEO pay dispersion*		
Level:	Firm-year level		
Sample:	2007-2018		
Model:	(1)	(2)	(3)
Fraction of reciprocating peers	-0.335*** (-14.538)	-0.162*** (-6.687)	-0.126*** (-3.381)
Firm controls	No	Yes	Yes
Industry FE	No	Yes	n/a
Year FE	No	Yes	n/a
Industry × Year FE	No	No	Yes
Firm FE	No	No	Yes
Observations	25,012	22,031	21,649
R-squared	0.017	0.155	0.507

Table 6: The SEC Rule on Compensation Disclosure

This table analyzes pay dispersion and reciprocal benchmarking around the introduction of the December 2006 SEC rule on compensation disclosure. Panel A analyzes pay dispersion at the industry-size-year level. Panel B analyzes reciprocal benchmarking at firm-year level. *CEO pay dispersion* is defined as in Table 3. *Fraction of reciprocating peers* is the fraction of compensation peers that reference back the firm. *Post* is an indicator variable that is 1 for fiscal years after 2007, else 0. *Time trend* is a linear trend variable defined as the fiscal year minus 2006. In Panel A, *Low initial fraction of reciprocating peers* is an indicator variable that equals one (zero) if the average firm in an industry-size group has above-median (has below-median) fraction of reciprocating peers in 2007. In Panel B, *Low initial fraction of reciprocating peers* is an indicator variable that equals one (zero) if a firm has a below-median (an above-median) fraction of peers that do not reference back. *Low initial compliance with asset managers' criteria* is an indicator variable that equals one (zero) if the firm has in 2007 an above-median (a below-median) fraction of peers that are from outside its GICS2 industry or which have more than twice its market capitalization. *Low initial compliance with proxy adviser criteria* is an indicator variable that equals one (zero) if the firm has an above-medium (a below-medium) fraction of peers that are not compliant with ISS's (2011) compensation peer group methodology. Firm controls are defined as in Table 4. In Panel A, t-statistics (in parentheses) are based on standard errors two-way clustered at the year and industry-size levels. In Panel B, t-statistics (in parentheses) are based on standard errors clustered at the firm level.

Panel A: Pay dispersion

Dependent variable:	*CEO pay dispersion*							
Level:	Industry-size-year level							
Sample:	2004-2007		2008-2011		2004-2011		2003-2012	
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Time trend	-0.004	-0.001	-0.048**	-0.051*			-0.037***	-0.039***
	(-0.377)	(-0.022)	(-5.251)	(-2.470)			(-13.654)	(-6.287)
Post					-0.137***	-0.157***		
					(-5.044)	(-3.972)		
Low initial fraction of reciprocating peers							0.144*	–
							(2.100)	–
Low initial fraction of reciprocating peers × *Time trend*							-0.063***	-0.077**
							(-4.142)	(-2.534)
Industry × Size FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,139	1,112	1,144	1,129	2,283	2,267	1,989	1,983
R-squared	0.001	0.490	0.004	0.520	0.006	0.347	0.022	0.370

Table 6: The SEC Rule on Compensation Disclosure *(cont'd)*

Panel B: Reciprocal benchmarking

Dependent variable:	*Fraction of reciprocating peers*					
Level:	Firm-year level					
Sample:	2007-2009, firms with 2007-disclosed peer groups					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Time trend	0.063***	0.062***	0.063***	0.060***	0.065***	0.058***
	(11.763)	(8.248)	(12.937)	(8.004)	(13.536)	(8.312)
Low initial fraction of reciprocating peers × *Time trend*	0.018***	0.014*				
	(2.625)	(1.793)				
Low initial compliance with asset managers' criteria × *Time trend*			0.017**	0.014*		
			(2.514)	(1.771)		
Low initial compliance with proxy adviser criteria × *Time trend*					0.015**	0.017**
					(2.138)	(2.142)
Firm controls	No	Yes	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,689	1,417	1,689	1,417	1,657	1,414
R-squared	0.857	0.868	0.857	0.868	0.858	0.879

Table 7: Say on Pay Voting

This table analyzes reciprocal benchmarking around the time at which a firm receives a weak-say on pay vote. *Fraction of reciprocating peers* is the fraction of compensation peers that reference back the firm. *Weak-vote* is an indicator variable that equals one (zero) if a firm has had at any point in time less (more) than 75 percent on its say on pay vote. *Post* is an indicator variable that equals one in the years after the weak say on pay vote. Industry fixed effects are based on GICS6 industry classification. Firm controls are defined as in Table 4. t-statistics (in parentheses) are based on standard errors clustered at the firm level.

Dependent variable:	*Fraction of reciprocating peers*			
Level:	Firm-year level			
Sample:	Weak-vote firms only; [0,2] around event year		Weak-vote and control firms; [0,2] around event year	
Model:	(1)	(2)	(3)	(4)
Weak-vote	–	–	0.013	0.005
	–	–	(1.446)	(0.547)
Weak-vote × *Post*	0.040***	0.052***	0.040***	0.025***
	(8.939)	(5.376)	(8.944)	(4.650)
Firm controls	No	Yes	No	Yes
Year FE	Yes	n/a	Yes	n/a
Industry × Year FE	No	Yes	No	Yes
Observations	2,323	2,017	17,693	15,975
R-squared	0.007	0.351	0.004	0.241

Table 8: Proxy Adviser Influence

This table analyzes reciprocal benchmarking around times of higher ISS scrutiny on firms' compensation policies. *Fraction of reciprocating peers* is the fraction of compensation peers that reference back the firm. *Below ISS performance cutoff* is an indicator variable which is 1, if a firm underperforms the 1- and 3-year median total shareholder return of its Russell 3000 4-digit GICS industry peers. *Post* is an indicator variable that equals one in the years after the firm fell below ISS's performance cutoff. Since this ISS policy only existed in 2010-2011, we limit the sample to 2009-2012 to include one pre- and post-event year, and include only firms that are close to the performance cutoff. Firm controls are identical to those in Table 4. Industry fixed effects are based on GICS6-industry classification. t-statistics (in parentheses) are based on standard errors clustered at the firm level.

Dependent variable:	*Fraction of reciprocating peers*		
Level:	Firm-year level		
Model:	(1)	(2)	(3)
Below ISS performance cutoff	-0.045*	-0.033	-0.034
	(-1.939)	(-1.479)	(-1.478)
Below ISS performance cutoff	0.057***	0.046***	0.048***
$\times$ *Post*	(3.835)	(3.245)	(3.183)
Firm controls	Yes	Yes	Yes
Year FE	Yes	Yes	n/a
Industry FE	No	Yes	n/a
Industry $\times$ Year FE	No	No	Yes
Observations	4,691	4,691	4,667
R-squared	0.159	0.281	0.288

Table 9: Ownership Characteristics

This table analyzes the relation between reciprocal benchmarking and ownership characteristics. *Fraction of reciprocating peers* is the fraction of compensation peers that reference back the firm. *Institutional ownership* is the fraction of outstanding shares owned by institutional investors. *Ownership concentration* is the Herfindahl-Hirschman index of ownership using the fraction of shares owned by institutional shareholders. *Propensity to vote with ISS* is the fraction of times that a firm's mutual fund investors voted with ISS in the past across all their shareholdings, with each investor weighted by the fraction of shares it owns in the firm. *Propensity to vote with ISS when management and ISS disagree* is the fraction of times that a firm's mutual fund investors voted with ISS when ISS and the firm management disagreed on a vote recommendation (weighted by the fraction of owned shares). Firm controls are defined as in Table 4. Industry fixed effects are based on GICS6-industry classification. *t*-statistics (in parentheses) are based on standard errors clustered at the firm level.

Dependent variable:	*Fraction of reciprocating peers*							
Level:	Firm-year level							
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Institutional ownership	0.286***	0.233***	0.260***	0.213***				
	(16.823)	(11.174)	(16.091)	(10.703)				
Ownership concentration	-1.437***	-0.803***						
	(-11.225)	(-7.297)						
Ownership of largest blockholder			-0.641***	-0.340***				
			(-11.831)	(-6.492)				
Propensity to vote with ISS					0.391***	0.388***		
					(8.193)	(5.600)		
Propensity to vote with ISS when mgmt. and ISS disagree							0.508***	0.532***
							(5.482)	(4.365)
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Industry × Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	18,866	17,580	18,866	17,580	19,517	17,986	19,517	17,986
R-squared	0.067	0.301	0.062	0.299	0.012	0.282	0.003	0.277

Table 10: Tournament incentives

The table analyzes the relation between reciprocal referencing in compensation peer groups and tournament incentives. In models 1-3, *Tournament incentives at the industry-level* is defined as the pay gap to the second highest-paying firm in the GICS6 industry. In models 4-6, *Tournament incentives in compensation peer groups* is defined as the pay gap to the second highest-paying firm in the compensation peer group. *Fraction of reciprocating peers* is the fraction of compensation peers that reference back the firm. Firm controls are defined as in Table 4. Industry fixed effects are based on GICS6 industry classification. In models 1-3, t-statistics (in parentheses) are based on standard errors clustered at the GICS6-industry level. In models 4-6, t-statistics are based on standard errors clustered at the firm level.

Dependent variable:	*Tournament incentives at the industry-level*			*Tournament incentives in compensation peer groups*		
Level:	Firm-year level			Firm-year level		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Fraction of reciprocating peers	-10.341*** (-8.697)	-7.410*** (-8.060)	-5.795*** (-5.139)	-2.392*** (-15.696)	-1.855*** (-9.975)	-1.916*** (-9.942)
Firm controls	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	n/a	No	Yes	n/a
Industry FE	No	Yes	n/a	No	Yes	n/a
Industry × Year FE	No	No	Yes	No	No	Yes
Observations	23,877	21,160	21,108	23,755	21,068	21,049
R-squared	0.050	0.281	0.257	0.025	0.090	0.122

Table 11: Pay dispersion and risk-taking

The table analyzes the relation between firm risk and peer group pay dispersion / reciprocal benchmarking. *Corporate risk-taking over next fiscal year* is the standard deviation of residuals of a firm's daily stock returns over fiscal year $t+1$ estimated from the Fama-French 3-factor model. *CEO pay dispersion* is the standard deviation of CEO pay of a firm's compensation peers scaled by the median level of CEO pay in a firm's compensation peer group. *Fraction of reciprocating peers* is the fraction of compensation peers that reference back the firm. Firm controls are the same as in Table 4. Industry fixed effects are based on FF48 industry classification. t-statistics (in parentheses) are based on standard errors clustered at the firm level.

Dependent variable:	*Corporate risk-taking over next fiscal year (measured via realized equity return volatility)*					
Level:	Firm-year level					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Peer group pay dispersion	0.309***	0.093***	0.080**			
	(14.456)	(5.004)	(4.612)			
Fraction of reciprocating peers				-1.325***	-0.677***	-0.688***
				(-20.700)	(-12.012)	(-12.354)
Firm controls	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	n/a	No	Yes	n/a
Industry FE	No	Yes	n/a	No	Yes	n/a
Industry × Year FE	No	No	Yes	No	No	Yes
Observations	20,625	18,480	18,458	20,753	18,562	18,552
R-squared	0.020	0.432	0.488	0.054	0.431	0.488

ONLINE APPENDIX

— Intended for online publication —

Overview

- Figure A.1: CEO pay dispersion of Russell 3000 firms since 1994
- Figure A.2: CEO pay dispersion of S&P 1500 firms since 1994
- Figure A.3: CEO pay dispersion for alternative industry classifications
- Figure A.4: Mean, median and standard deviation of CEO pay in the S&P 1500
- Figure A.5: Skewness of CEO pay
- Figure A.6: Variation in short- and long-term incentives in the economy
- Figure A.7: Variation in short and long-term incentives in compensation peer groups
- Figure A.8: Changes in variation in firm characteristics
- Figure A.9: Additional simulation results
- Figure A.10: Compensation peer similarity
- Figure A.11: Industry Tournament incentives using FF30 industries

- Table A.1: Compensation peer group size
- Table A.2: Pay variation in short- and long-term incentives
- Table A.3: Alternative measuring of reciprocal benchmarking
- Table A.4: Reciprocal benchmarking and pay dispersion (full results)
- Table A.5: Tournament incentives (Robustness)
- Table A.6: Alternative measures for corporate risk-taking

Figure A.1 CEO pay dispersion of Russell 3000 firms since 1994

Figure A shows a decline in CEO pay dispersion among Russell 3000 firms since 1994. Figure B shows the CEO pay dispersion within GICS2-industries for Russell 3000 firms. Pay dispersion is defined as the median-scaled standard deviation of CEO pay (winsorized at the 5^{th} and 95^{th} percentile).

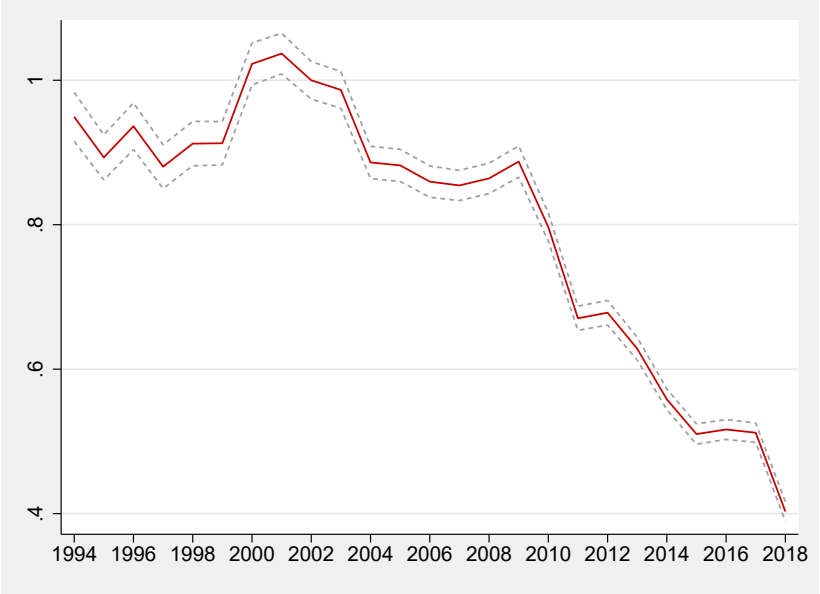


Figure A. CEO pay dispersion in Russell 3000 firms

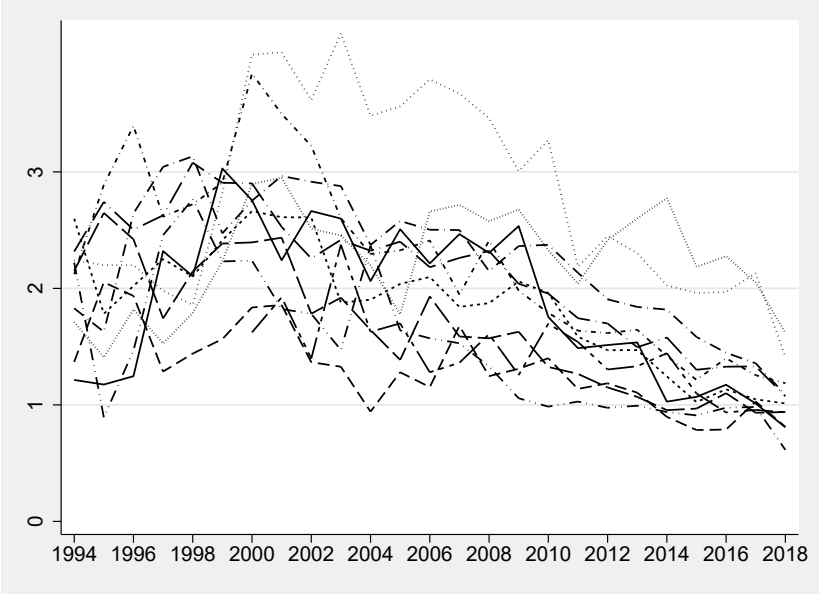


Figure B. Within-industry CEO pay dispersion in Russell 3000 firms

Figure A.2 CEO pay dispersion for S&P 1500 firms since 1994

Figure A shows CEO pay dispersion among S&P 1500 firms since 1994. Figure B shows CEO pay dispersion within GICS2-industries for S&P 1500 firms. Pay dispersion is defined as the median-scaled standard deviation of CEO pay (Execucomp's data field TDC1, winsorized at the 5th and 95th percentile).

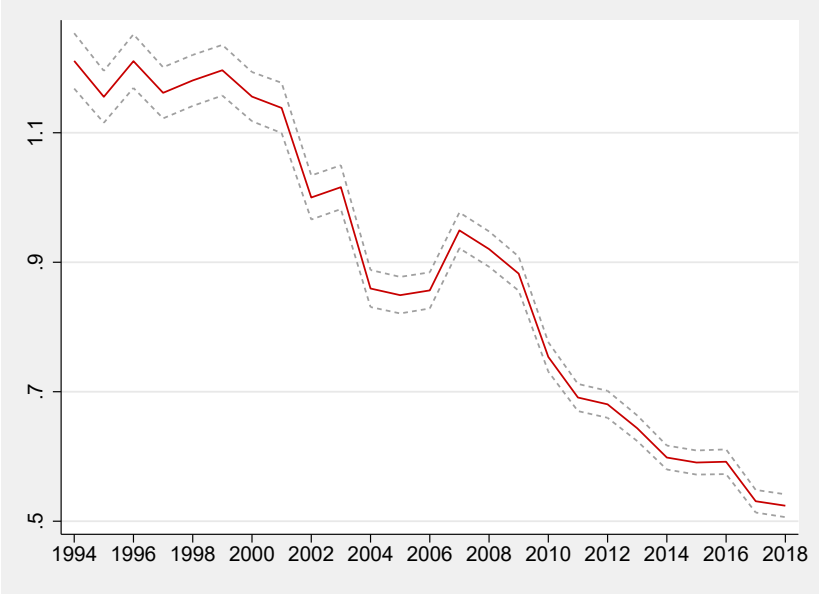


Figure A. CEO pay dispersion in S&P 1500 firms

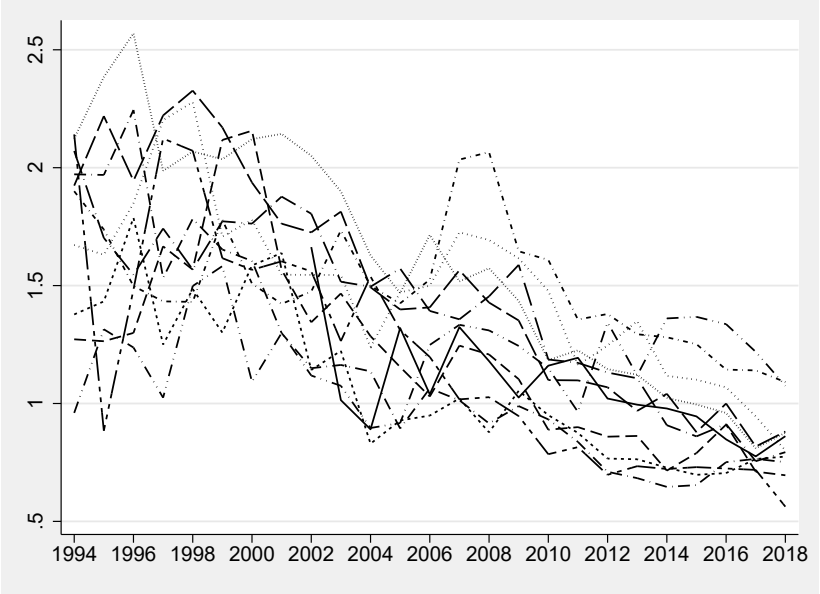


Figure B. Within-industry CEO pay dispersion in S&P 1500 firms

Figure A.3 CEO pay distribution using alternative industry classification

The figures show the average CEO pay variation for Russell 3000 firms in industry- and industry-size groups. Pay variation is defined as the median-scaled standard deviation of CEO pay in a given year and industry group. Figure A shows CEO pay variation for different industry classifications, averaged for each year and rebased to 2002. Figure B shows CEO pay variation of industry and industry-size groups averaged for each year and rebased to 2002. Firm-size quintiles are determined by firms' market capitalization in a given year.

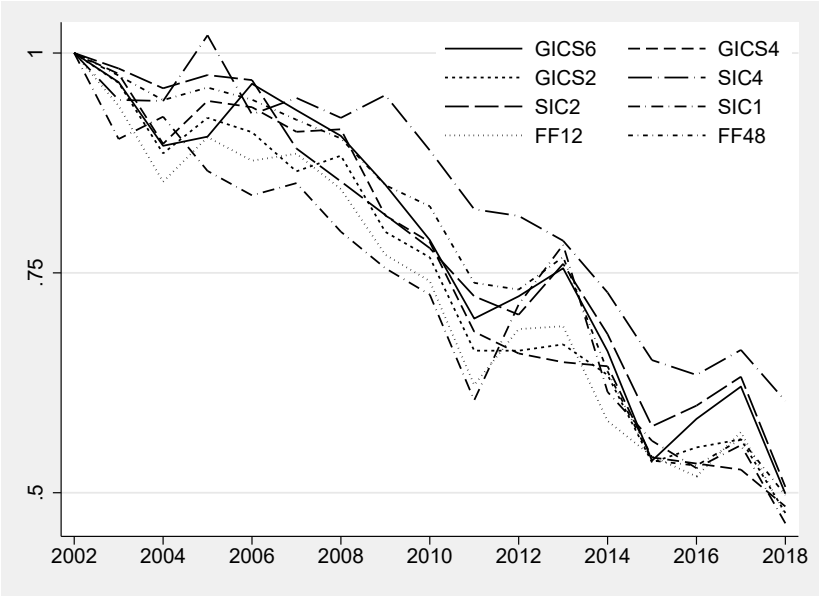


Figure A. CEO pay dispersion in industry groups

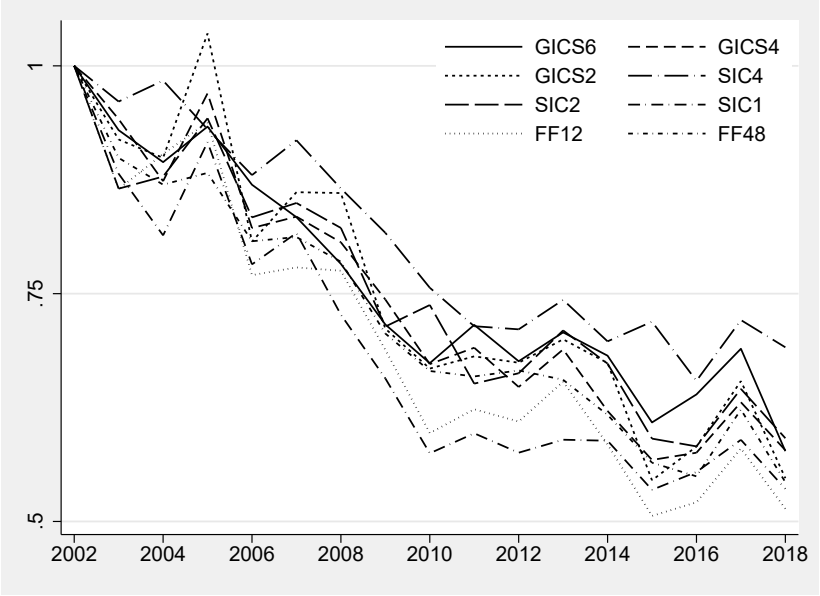


Figure B. CEO pay dispersion in industry-size groups

Figure A.4 CEO pay distribution

This figure shows the mean, median and standard deviation of CEO pay, winsorized at the 1st and 99th percentile and rescaled to 1994, for Russell 3000 firms in Figure A and firms in the S&P 1500 (using TDC1 only) in Figure B.

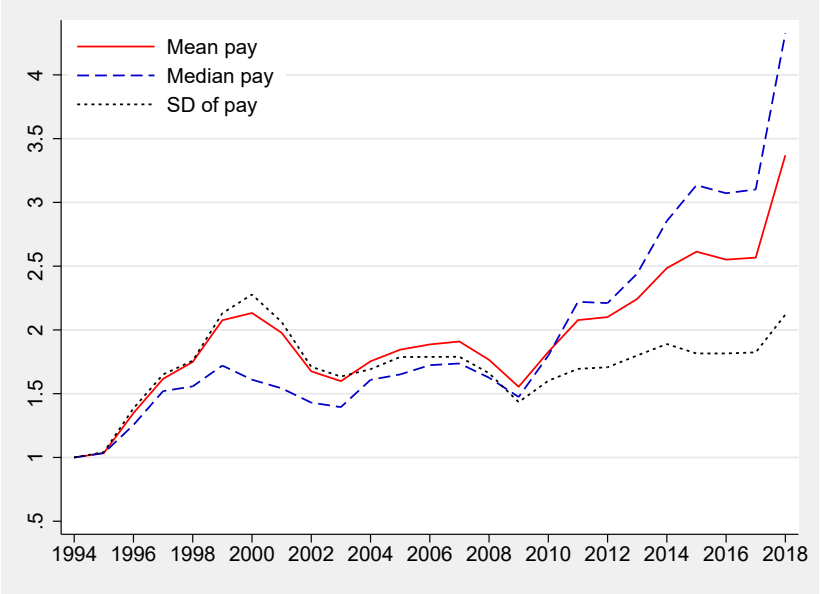


Figure A. Trajectory of mean, median and standard deviation of pay in Russell 3000 firms

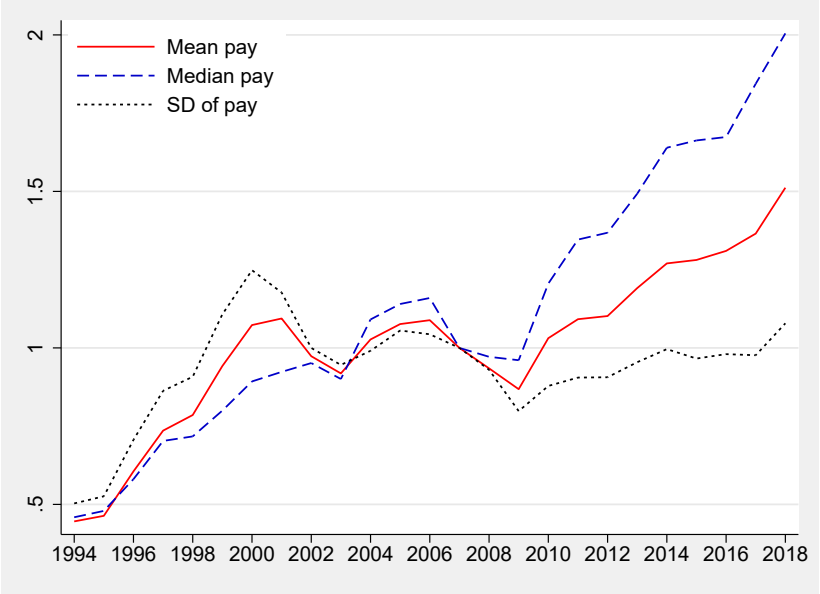


Figure B. Trajectory of mean, median and standard deviation of pay in S&P 1500 firms

Figure A.5 Skewness of CEO pay

This figure shows the change in CEO pay skewness, rebased to 2002, as an alternative (dimensionless) measure of dispersion. To avoid the effect of outliers, Figure A winsorizes CEO pay at the 1st and 99th percentiles before computing annual skewness and Figure B winsorizes CEO pay more aggressively at the 5th and 95th percentile annually before computing skewness

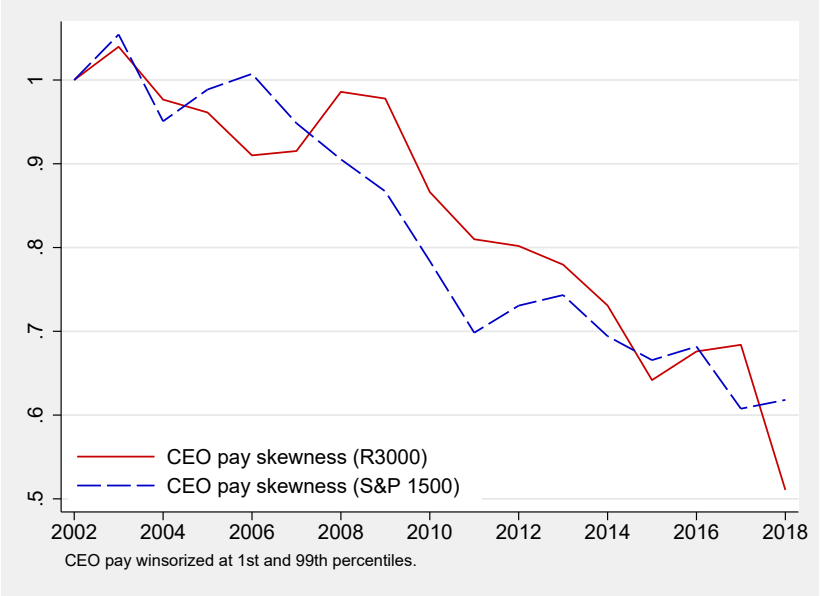


Figure A. Skewness of CEO pay with winsorizing at 1st and 99th percentile

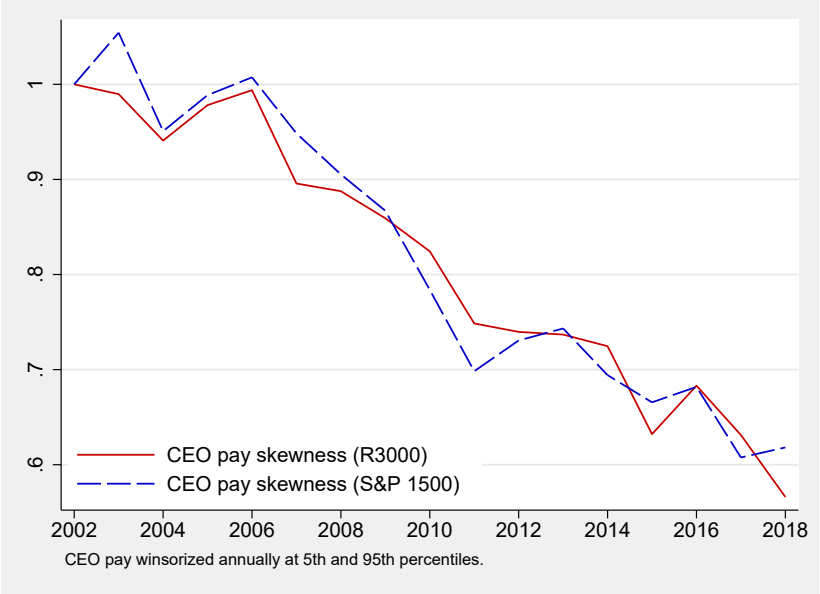


Figure B. Skewness of CEO pay with winsorizing at 5th and 95th percentile

Figure A.6 Variation in short- and long-term incentives in the economy

The figures below show the variation of short- and long-term incentives in S&P 1500 firms. Short-term incentives shown in Figure A are defined as salary plus annual bonus. The long-term incentives shown in Figure B are defined as stock awards plus stock options awards plus multi-year non-equity incentives (available in Execucomp since 2006). The red solid lines show variation of incentives in dollar terms; hence variation is defined via the median-scaled standard deviation of the incentives. The blue dashed lines show variation in incentive-to-total-pay ratios; hence (since ratios are already scaled), variation is defined via the standard deviation of the ratio. The sample consists of S&P 1500 firms with data from Execucomp.

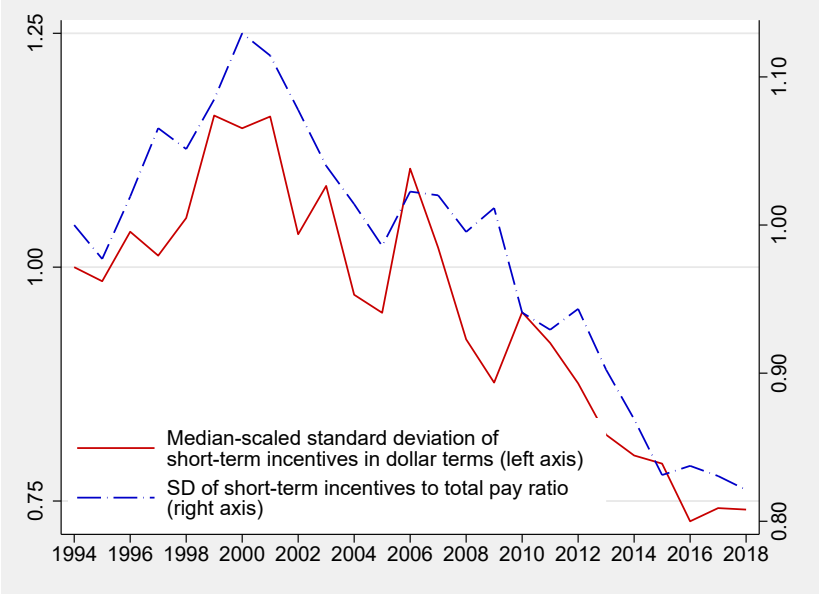


Figure A. Variation in short-term incentives (S&P 1500)

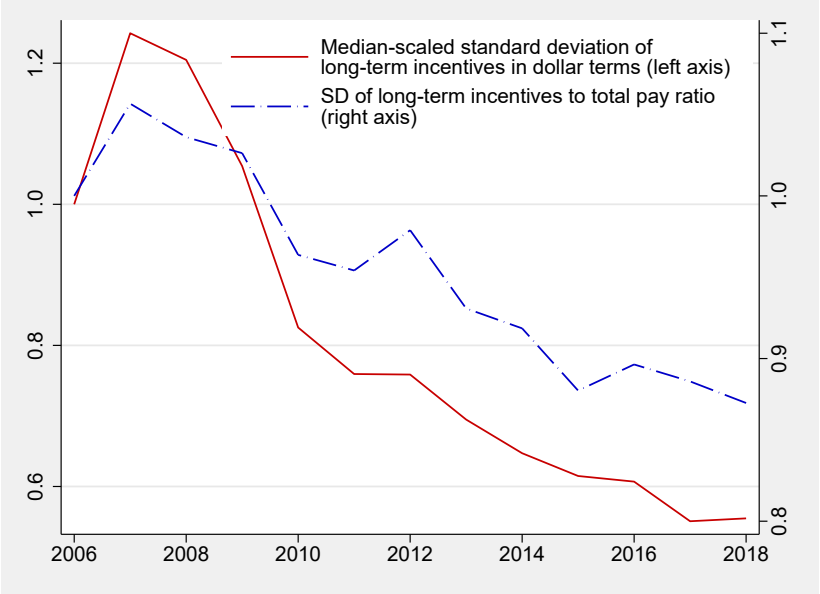


Figure B. Variation in long-term incentives (S&P 1500)

Figure A.7 Variation in short- and long-term incentives within compensation peer groups

This figure shows variation in short- and long-term incentive pay ratios within compensation peer groups. The short-term incentive ratio is defined as salary plus annual bonus, divided by total pay. The long-term incentive ratio is defined as stock awards plus stock options awards plus multi-year non-equity incentives, divided by total pay. We take the standard deviation of peers' incentive ratios (rather than the median-scaled standard deviation) since the variable is already scaled by total pay. The sample consists of S&P 1500 firms and their S&P 1500 compensation peers with data from Execucomp.

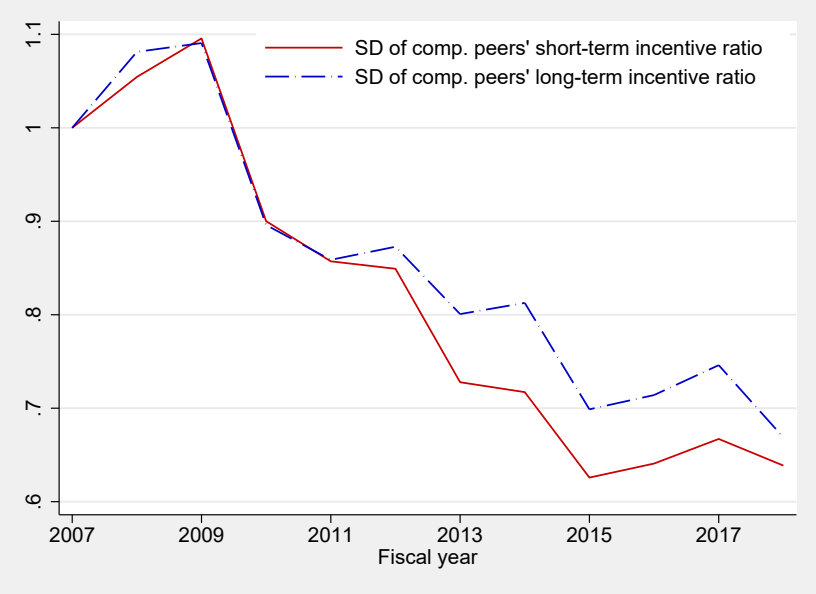


Figure A.8 Changes in variation in firm characteristics

Figure A (Figure B) shows the median-scaled standard deviations for total assets and market value of equity, and the standard deviations of the (already-scaled variables) leverage ratio, profitability ratio, Tobin's Q, stock performance, and idiosyncratic risk for Russell 3000 firms (S&P 1500 firms) between 2002 and 2018, rescaled to 2002. For comparison, the figure superimposes CEO pay dispersion computed as in Figure 1 (in solid, red line).

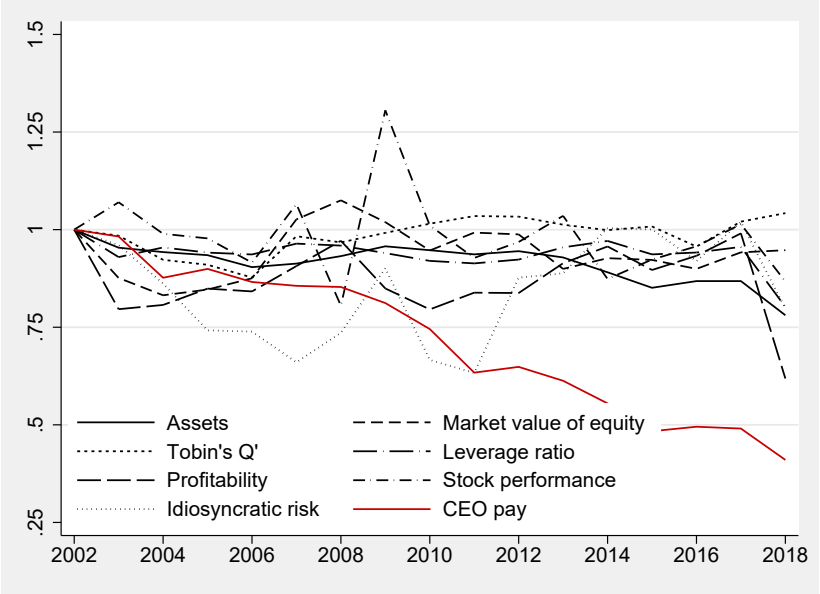


Figure A: Changes in the variation of firm characteristics for Russell 3000 firms

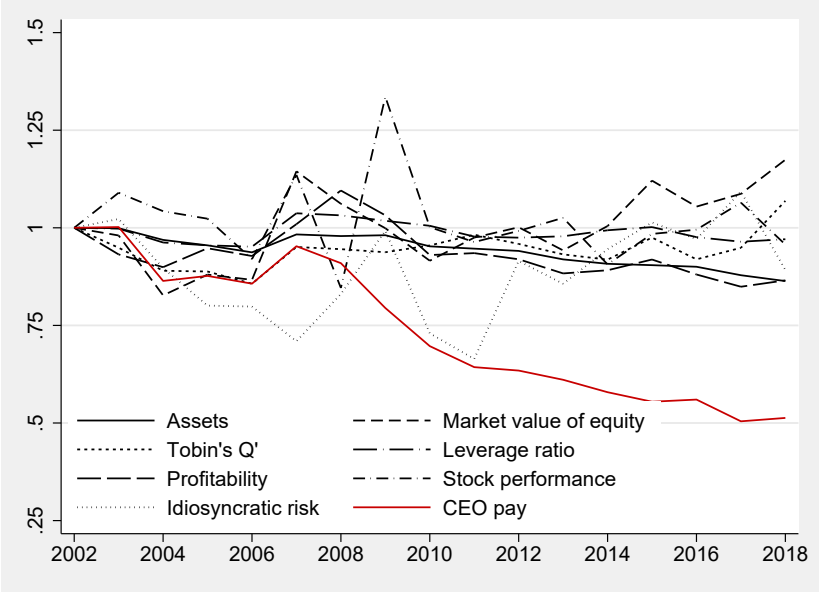


Figure B: Changes in the variation of firm characteristics for S&P 1500 firms

Figure A.9 Mean and median pay level in simulation

Figure A shows the pay variation across all Russell 3000 firms (red solid line), rescaled to 2007, if all firms target pay levels at the 50th percentile of their ISS-compliant peer groups. The blue dashed line shows the pay variation within ISS-compliant peer groups in the simulation. Figure B shows median pay in the simulation among Russell 3000 firms and median pay within the average ISS-compliant peer group, rescaled to 2007. In both figures, the gray-dashed lines show the same results if firms used other target pay percentiles in the simulation (the 35^{th}, 40^{th}, 45^{th}, 55^{th}, 60^{th}, and 65^{th} percentile). In Figure B, higher gray-dashed lines represent higher percentiles.

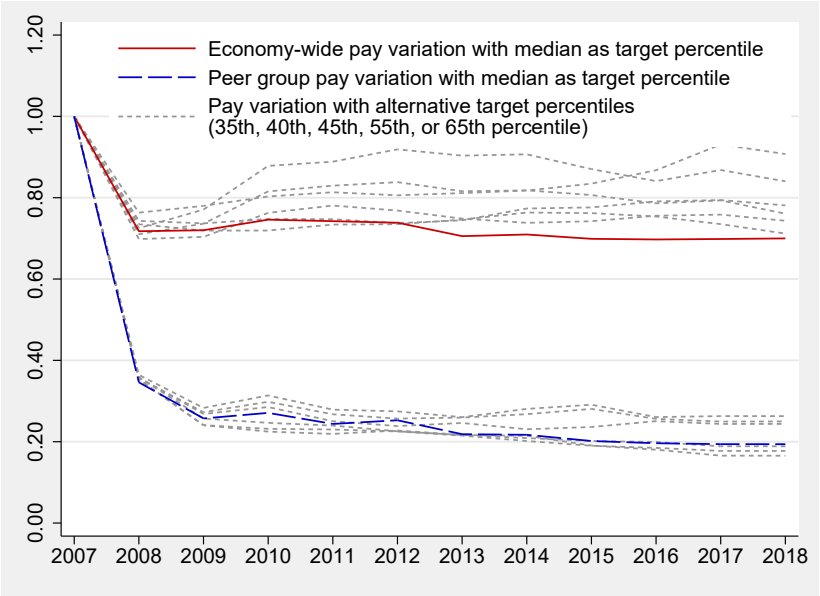


Figure A: Pay dispersion in economy when using identical target percentiles

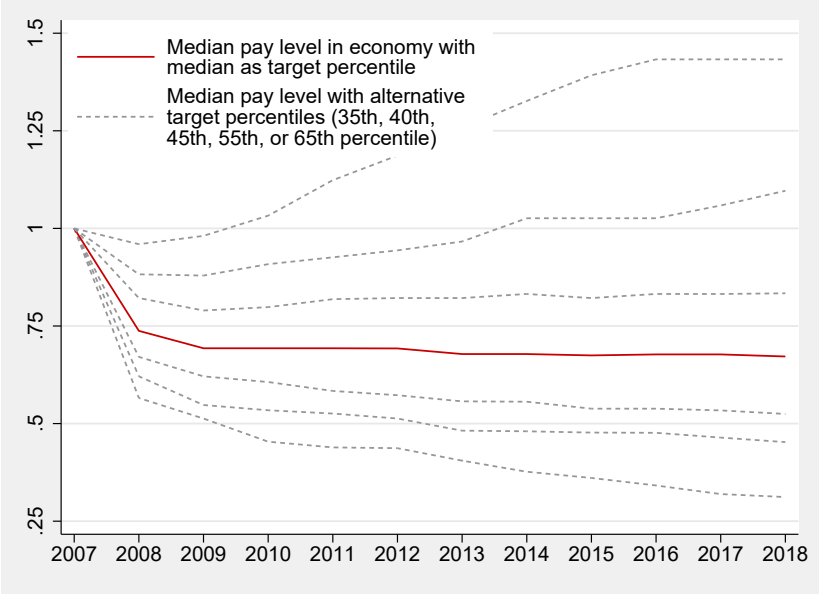


Figure B: Economy-wide median CEO pay in simulation

Figure A.10 Compensation peer similarity

This figure shows the difference in firm characteristics between firms and their compensation peers. *Fraction of dissimilar compensation peers* is the fraction of compensation peers that are at least two times the size of the base firm and from a different SIC1-industry, averaged across firms in a given year. *Average Mahalanobis distance* is the averaged generalized distance between a firm and its compensation peers based on firm size and growth opportunities (measured via revenues, market capitalization and Tobin's Q). Both measures are rebased to 2007.

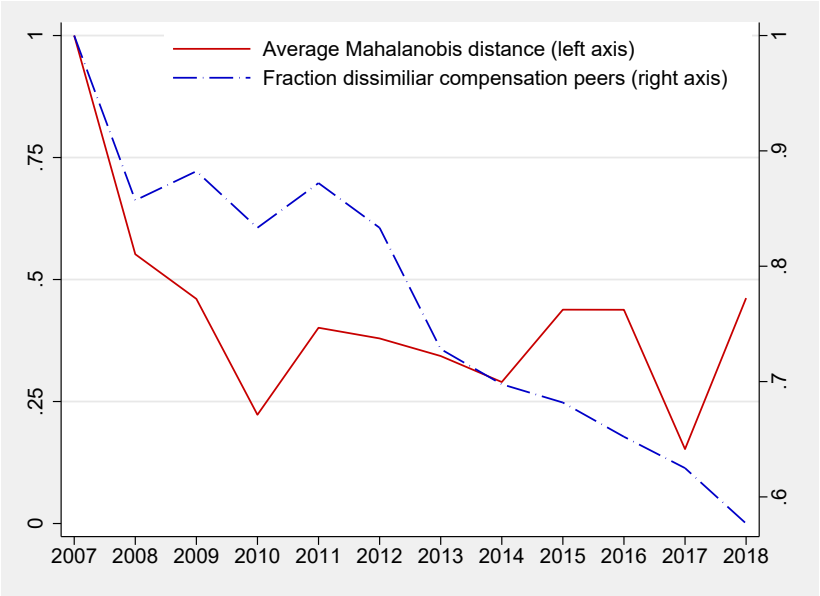
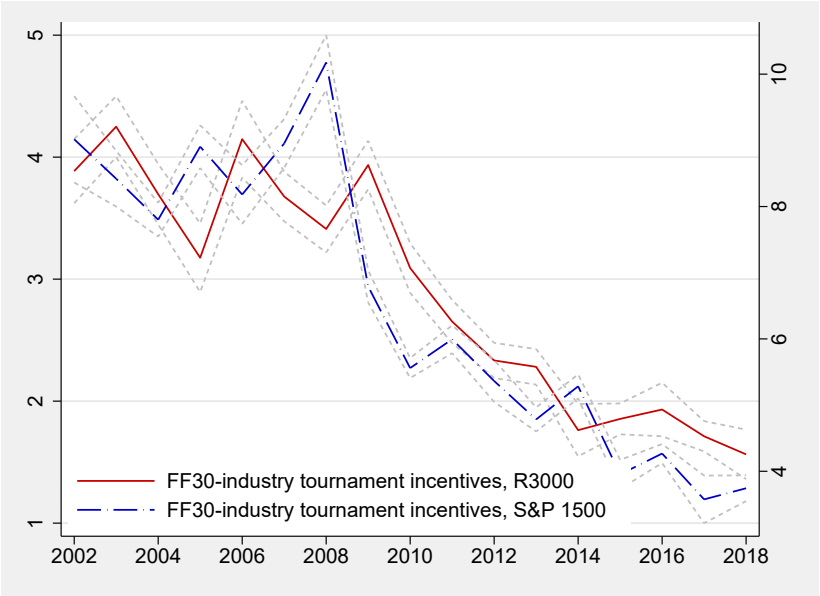


Figure A.11 Industry tournament incentives using FF30 industries

The figure shows industry tournament incentives between 2002 and 2018 at the FF30 industry level (Coles, Li, and Wang, 2018). Industry tournament incentives are defined as the difference of the CEO pay of the second-highest paying firm in a given industry minus the focal firms' CEO pay, scaled by average pay in the industry that year. The sample of S&P 1500 firms uses Execucomp's TDC1.



Appendix Table A.1: Compensation peer group size

This table shows the distribution of compensation peer group sizes across years.

	P5	P25	Median	P75	P95	Mean	Std. dev.	N
2007	7	12	16	22	44	19.7	14.2	617
2008	6	11	15	20	37	17.9	12.6	1,992
2009	5	12	15	20	35	17.5	12.1	2,218
2010	6	12	16	21	33	18.0	13.1	2,332
2011	7	13	17	21	33	18.8	13.4	2,371
2012	7	13	17	21	32	18.3	10.2	2,413
2013	8	14	17	20	32	18.1	11.2	2,379
2014	8	14	17	20	30	18.0	12.6	2,230
2015	9	14	17	20	30	18.5	15.9	2,213
2016	9	14	17	20	30	18.5	15.0	2,194
2017	10	14	16	20	28	18.3	13.8	2,179
2018	9	14	17	20	28	18.0	11.8	2,197
Total	7	13	16	20	32	18.2	13.0	25,335

Appendix Table A.2: Pay variation in short- and long-term incentives

This table shows the relationship between measures of peer group clustering and the variation in incentive pay ratios of compensation peers. The sample consists of S&P 1500 firms with data from and their S&P 1500 compensation peers for which Execucomp provides details on CEOs' compensation packages. *Pay variation in short-term incentive ratio* is the standard deviation of compensation peers' short-term incentive ratios (which is defined as salary plus bonus divided by total CEO pay). *Pay variation in long-term incentives ratio* is the standard deviation of compensation peers' long-term incentive ratios (which is defined as the sum of stock awards, option awards and non-equity incentives divided by total CEO pay). We omit the scaling with average pay since the dependent variables are already ratios. *Reciprocity*, *Transitivity* and *Density*, computed at the peer group level, are defined in Appendix A. *t*-statistics (in parentheses) are based on standard errors clustered at the firm-level.

Panel A: Variation in short-term incentives ratio

Dependent variable:	*Pay variation in short-term incentives ratio*					
Level:	Firm-year level					
Sample:	2007-2018					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Reciprocity	-0.053***	-0.017***				
	(-13.021)	(-2.838)				
Transitivity			-0.110***	-0.064***		
			(-19.016)	(-7.605)		
Density					-0.101***	-0.071***
					(-15.292)	(-7.954)
Firm controls	No	Yes	No	Yes	No	Yes
Industry × Year FE	No	Yes	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes	No	Yes
Observations	19,136	16,635	19,136	16,635	19,136	16,635
R-squared	0.025	0.605	0.054	0.608	0.036	0.608

Panel B: Variation in long-term incentives ratio

Dependent variable:	*Pay variation in long-term incentives ratio*					
Level:	Firm-year level					
Sample:	2007-2018					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Reciprocity	-0.051***	-0.023***				
	(-11.600)	(-3.591)				
Transitivity			-0.111***	-0.071***		
			(-18.422)	(-7.856)		
Density					-0.107***	-0.080***
					(-15.759)	(-8.572)
Firm controls	No	Yes	No	Yes	No	Yes
Industry × Year FE	No	Yes	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes	No	Yes
Observations	19,136	16,635	19,136	16,635	19,136	16,635
R-squared	0.021	0.585	0.050	0.588	0.037	0.589

Appendix Table A.3: Alternative measuring of reciprocal benchmarking

Panel A shows the relation between reciprocal benchmarking firms' compensation peer groups and the three firm-level clustering measures *Reciprocity*, *Density*, and *Transitivity*. Panel B shows the trajectory in reciprocal benchmarking across time. *Time trend* is a linear trend variable defined as the fiscal year minus 2006. Both panels cover the time period 2007-2018 and have t-statistics (shown in parenthesis) that are clustered at the firm-level.

Panel A: Relation with firm-level clustering measures

Dependent variable:	*Reciprocity*			*Density*			*Transitivity*		
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Fraction of reciprocating peers	1.140*** (244.633)	1.121*** (232.622)	1.108*** (185.28)	0.505*** (60.676)	0.498*** (55.727)	0.457*** (40.806)	0.615*** (78.523)	0.553*** (59.206)	0.453*** (35.840)
Firm controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Industry FE	No	Yes	n/a	No	Yes	n/a	No	Yes	n/a
Year FE	No	Yes	n/a	No	Yes	n/a	No	Yes	n/a
Industry × Year FE	No	No	Yes	No	No	Yes	No	No	Yes
Firm FE	No	No	Yes	No	No	Yes	No	No	Yes
Observations	25,327	22,227	21,850	25,327	22,227	21,850	25,327	22,227	21,850
R-squared	0.970	0.972	0.988	0.515	0.581	0.859	0.536	0.616	0.871

Panel B: Growth in reciprocal benchmarking

Dependent variable:	*Fraction of reciprocating peers*		
Model:	(1)	(2)	(3)
Time trend	0.006*** (10.878)	0.006*** (10.109)	0.014*** (22.81)
Firm controls	No	Yes	Yes
Industry FE	No	Yes	n/a
Firm FE	No	No	Yes
Observations	25,327	22,227	21,865
R-squared	0.008	0.229	0.782

Appendix Table A.4: Reciprocal benchmarking and pay dispersion

This table shows the full results from the models in Table 5. Shown in parenthesis are t-statistics that are based on standard errors that are clustered at the firm-level.

Dependent variable:	*CEO pay dispersion*		
Level:	*Firm-year level*		
Sample:	2007-2018		
Model:	(1)	(2)	(3)
Fraction of reciprocating peers	**-0.334*** (14.604)**	**-0.177*** (-7.074)**	**-0.118*** (-3.121)**
Size		-0.001**	0.000
		(-2.011)	(-1.076)
Sales		-0.003***	-0.004***
		(-5.966)	(-3.556)
Market-to-book ratio		0.027***	0.004
		(4.566)	-0.552
Cash holdings		0.000	0.000
		(0.646)	(0.341)
Net book leverage		-0.093***	0.053
		(-4.088)	(1.426)
Investments		0.277*	0.036
		(1.910)	(0.172)
Equity		0.000	-0.002
		(-0.366)	(-1.224)
R&D indicator		-0.020	0.090*
		(-1.009)	(1.825)
S&P 1500 firm indicator		-0.050***	-
		(-3.382)	-
Stock performance (12 months)		-0.003	-0.004
		(-0.363)	(-0.489)
Sales growth		0.008	-0.003
		(0.592)	(-0.184)
Fraction of independent directors		0.053	-0.039
		(1.339)	(-0.942)
CEO duality		0.008	0.013
		(0.573)	(0.933)
Classified board		0.006	0.055***
		(0.542)	(2.865)
Lead director		-0.009	-0.002
		(-0.699)	(-0.118)
Number board committees		-0.014***	-0.001
		(-3.033)	(-0.128)
CEO age		-0.001*	-0.001
		(-1.670)	(-0.680)
CEO tenure		0.002**	0.000
		(2.205)	(-0.043)
CEO turnover		-0.006	-0.008
		(-0.455)	(-0.644)
Firm controls	No	Yes	Yes
Industry FE	No	Yes	n/a
Year FE	No	Yes	n/a
Industry × Year FE	No	No	Yes
Firm FE	No	No	Yes
Observations	25,043	21,960	21,589
R-squared	0.017	0.128	0.484

Table A.5: Tournament incentives (Robustness)

The table repeats the tests in Table 10 using two alternative dependent variables. *Fraction of reciprocating peers* is the fraction of compensation peers that reference back the firm. In models 1-3, *Tournament incentives at the industry-level* is defined as the pay gap to the **highest-paying** firm in the GICS6 industry. In models 4-6, *Tournament incentives in compensation peer groups* is defined as the pay gap to the **highest-paying** firm in the compensation peer group.

Dependent variable:	*Tournament incentives at the industry-level*			*Tournament incentives in compensation peer groups*		
Level:	Firm-year level			Firm-year level		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Reciprocal benchmarking	-16.331***	-11.468***	-9.225***	-4.371***	-3.210***	-3.385***
	(-6.740)	(-5.701)	(-4.615)	(-14.921)	(-9.051)	(-9.286)
Firm controls	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	n/a	No	Yes	n/a
Industry FE	No	Yes	n/a	No	Yes	n/a
Industry × Year FE	No	No	Yes	No	No	Yes
Observations	23,908	21,188	21,137	23,867	21,161	21,144
R-squared	0.044	0.251	0.239	0.021	0.091	0.137

Appendix Table A.6:
Alternative measures for corporate risk-taking

The table repeats the tests in Table 11 using three alternative dependent variables. In Panel A, *ROA volatility over the next 3 years* is defined as the standard deviation of a firm's return on assets over fiscal years $[t+1, t+3]$. In Panel B, *Cash flow volatility over the next 3 years* is defined as the standard deviation of a firm's cash flow (i.e., earnings before interest and taxes minus extraordinary items plus depreciation over assets) over fiscal years $[t+1, t+3]$. In Panel C, *Earnings volatility over the next 3 years* is defined as the standard deviation of a firm's earnings before interest and taxes over assets over fiscal years $[t+1, t+3]$. All dependent variables are winsorized at the 5th and 95th percentile and multiplied by 100 for ease of interpretation. Firm controls are the same as in Table 4. Industry fixed effects are based on FF48 industry classification. t-statistics (in parentheses) are based on standard errors clustered at the firm-level.

Panel A: ROA volatility

Dependent variable:	*ROA volatility over next 3 years*					
Level:	Firm-year level					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Peer group pay dispersion	0.552***	0.223*	0.247**			
	(4.652)	(1.936)	(2.069)			
Fraction of reciprocating peers				-3.257***	-1.454***	-1.397***
				(-7.486)	(-3.750)	(-3.529)
Firm controls	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	n/a	No	Yes	n/a
Industry FE	No	Yes	n/a	No	Yes	n/a
Industry × Year FE	No	No	Yes	No	No	Yes
Observations	19,494	17,393	17,384	19,591	17,469	17,460
R-squared	0.002	0.214	0.250	0.010	0.215	0.250

Panel B: Cash flow volatility

Dependent variable:	*Cash flow volatility over next 3 years*					
Level:	Firm-year level					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Peer group pay dispersion	0.422***	0.127***	0.131***			
	(8.753)	(3.066)	(2.975)			
Fraction of reciprocating peers				-1.188***	-0.433***	-0.437***
				(-6.083)	(-2.898)	(-2.888)
Firm controls	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	n/a	No	Yes	n/a
Industry FE	No	Yes	n/a	No	Yes	n/a
Industry × Year FE	No	No	Yes	No	No	Yes
Observations	19,808	17,674	17,665	19,914	17,757	17,748
R-squared	0.007	0.366	0.395	0.007	0.366	0.394

Appendix Table A.6:
Alternative measures for corporate risk-taking
(cont'd)

Panel C: Earnings volatility

Dependent variable:	*Earnings volatility over next 3 years*					
Level:	Firm-year level					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Peer group pay dispersion	0.394***	0.114***	0.117**			
	(7.972)	(2.855)	(2.746)			
Fraction of reciprocating peers				-1.591***	-0.532***	-0.529***
				(-7.785)	(-3.494)	(-3.434)
Firm controls	No	Yes	Yes	No	Yes	Yes
Year FE	No	Yes	n/a	No	Yes	n/a
Industry FE	No	Yes	n/a	No	Yes	n/a
Industry × Year FE	No	No	Yes	No	No	Yes
Observations	21,116	18,853	18,844	21,224	18,937	18,928
R-squared	0.006	0.395	0.425	0.012	0.394	0.425