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The determinants and effects of CEO–employee pay ratios ☆

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ABSTRACT

We study the determinants and effects of the relative compensation of top executives and lower-level employees. First, we show that CEO–employee pay ratios depend on the balance of power between the CEO (relative to the board) and ordinary employees (relative to management). Second, our results suggest that employees do not perceive higher pay ratios as an inequitable outcome to be redressed via costly behaviors that lower productivity. We do not find a negative relation between relative pay and employee productivity, either in our full sample or in subsamples where employees are well-informed about executive pay and are protected against career retributions. Rather, we find that productivity increases with relative pay when the firm has fewer employees who are well-informed, and when promotion decisions are predominantly merit-based. We also find that firm value and operating performance both increase with relative pay. We conclude that ordinary employees appear to perceive an opportunity in higher pay ratios but the extent to which such perception incentivizes them depends on the likelihood of success in a series of sequential promotion tournaments.

1. Introduction

The popular press has consistently raised the issue of "overpaid" top executives, often with a keen focus on the large and growing gap in the compensation of chief executive officers (CEOs) relative to rank-and-file employee pay. According to a 2005 report by United for a Fair Economy and the Institute for Policy Studies, the average CEO in the U.S. earned 431 times the average pay of a production (i.e., non-management) worker in 2004, up from 301 times in 2003 and 42 times in 1982.[3] Almost without exception, these reports are met with populist anger, motivated by a perception of inequity in corporate compensation practices. What is lacking, however, is a systematic analysis of the causes of this compensation differential and its effects on employee behavior and performance. We address these issues by examining two related questions: (i) What explains top management pay relative to that of lower-level employees? (ii) What effects, if any, does the relative compensation of top executives compared to average worker pay have on employee incentives and performance?

We study these questions using the sample of all Compustat firms that meet data availability restrictions over 1993–2006. Our primary measure of relative pay is (the natural log of) the ratio of total CEO compensation to average non-executive employee pay, where non-executive pay comprises total compensation (including benefits) earned by all employees outside the group of the most highly compensated executives disclosed in corporate filings with the U.S. Securities and Exchange Commission (SEC). We begin our analysis with an examination of the determinants of CEO–employee pay ratio by relating this measure to potential explanatory variables under the hypothesis that relative pay depends on the bargaining power of top executives vis-à-vis the board and of lower-level employees relative to management. Consistent with our hypothesis, we find that relative pay increases with several variables identified in prior work (e.g., Rosen, 1982; Core et al., 1999) as enhancing the bargaining power of CEOs. These include firm size, operating and market performance, firm risk, and

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[3] Executive Excess 2005 by Institute for Policy Studies and United for a Fair Economy. Available on the internet at http://www.faireconomy.org/files/Executive_Excess_2005.pdf. The importance of the CEO–employee pay ratio has also been recognized by policy makers in the U.S.; the *Dodd-Frank Wall Street Reform and Consumer Protection Act* signed into law in July 2010 calls for all firms to disclose the ratio of the CEO's total pay to the median annual total pay of all other employees. For details see Section 953(b) of H.R. 4173 dated July 21, 2010. These rules are yet to be implemented by the SEC as of June 2012.

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CEO–chairman duality. We also find that relative pay is higher among firms in homogenous industries, where employees are presumably more interchangeable and therefore less powerful relative to management. In contrast, relative pay declines with employee unionization and capital intensity.

Next, we propose and evaluate three hypotheses on the effect of relative pay on employee behavior and corporate outcomes, focusing primarily on employee and firm-level productivity. We focus on productivity because it offers the greatest power for assessing how the contrast between executive compensation and rank-and-file employee pay affects lower-level employee incentives and behavior. Traditional measures of firm performance such as Tobin's q and return on assets (ROA) are arguably more affected by top executive incentives and ability, corporate charter provisions, and investor expectations and market dynamics.

Our first hypothesis posits a negative relation between CEO–employee relative pay and workforce productivity based on arguments from inequity aversion (Adams, 1965; Cowherd and Levine, 1992) and relative deprivation (Martin, 1981) theories. These theories suggest that employees will engage in costly behaviors such as shirking and excessive voluntary turnover to resolve perceived inequity in their outcome–input ratios relative to those of others in the same or similar firms. In contrast, sequential rank order tournament theory (e.g., Lazear and Rosen, 1981) suggest that lower-level employees are motivated to exert greater effort in an attempt to win the pay differential associated with promotion to the next rung in the firm's compensation hierarchy, with the pay differential relative to the CEO representing the ultimate prize. Thus, our second hypothesis asserts that employee productivity increases with relative pay. Finally, the third hypothesis posits that CEO–employee pay ratio has no effect on workforce productivity because rank-and-file employees are either uninformed about executive pay or have limited ability and/or incentive to act on such information even if they are so informed.

Overall, we find results that are consistent with the third hypothesis. Specifically, our tests uncover no evidence of a significant relation between relative pay and employee productivity in the full sample, regardless of how we measure productivity or relative pay, or the simplicity or complexity of our econometric procedures. Next, we perform a series of tests to examine potential explanations for the absence of a relation between relative pay and workforce productivity at the average firm. As suggested earlier, it is possible that employees are not cognizant of the gap in their pay relative to those of top executives, for instance, because executive compensation is often reported in dense regulatory filings that are inaccessible to rank-and-file employees. Second, employees may be knowledgeable of such gaps but are constrained from engaging in costly behaviors because of potentially detrimental career implications. Alternatively, it is possible that employees on average perceive no inequity in their compensation relative to executive pay because they consider the remuneration of top management to be commensurate with its contribution to firm performance and/or the compensation risk it assumes. Finally, tournament incentives may not be powerful enough to motivate the average employee at the average firm because of the large number of potential winners or if employees perceive that relative performance is not the primary factor in determining winners.

We evaluate these alternatives by performing additional analyses based on scenarios where each factor offers greater power to find a significant relation between pay ratio and employee productivity. First, we test the information hypothesis by identifying firms whose employees are more likely to be informed on the compensation of their top executives, that is, those whose CEOs were explicitly discussed in popular press articles on executive compensation issues. In the same manner, we employ a highly unionized workforce as a proxy for firms whose employees face a lower risk of managerial retribution, and research and development expenditures and the proportion of highly educated employees as proxies for firms with highly skilled workers who are presumably less likely to perceive high relative pay as justifiable on the basis of higher managerial contribution to firm value. Nevertheless, we continue to find no relation between employee productivity and relative pay in each case. Thus, employees do not respond negatively to higher pay ratios even in organizational settings where they are most likely cognizant of such differentials, are well protected via unionization, and have plausible reasons to believe that top management is not the primary contributor to firm performance. Overall, these results suggest that inequity considerations do not play a significant role in determining the response of rank-and-file workers to higher spreads in the relative compensation of top executives and ordinary employees.

We then focus on scenarios where tournament incentives are presumably stronger to determine whether the lack of significance in full sample results is due to the weakness of tournament incentives at the average firm. As a starting point, we repeat our tests for the sample of firms with relatively fewer employees (i.e., less than the sample first quartile) based on the intuition that the small number of contestants at such firms should strengthen tournament incentives. Consistent with this, we find a positive and significant relation between productivity and relative pay in this subsample, with productivity increasing by 10.5% for an increase of one standard deviation in relative pay. In contrast, the relation is insignificant among larger firms. Furthermore, the positive relation is stronger for firms with fewer employees who are also well-informed on executive pay compared to similar firms whose employees are less informed. We find analogous contrasts when we compare smaller, non-unionized firms with smaller, unionized firms where promotion decisions are likely to be susceptible to non-merit factors such as employee seniority.

Our results extend the literature in two distinct ways. First, we identify several factors that explain the pay differential between top executives and ordinary workers. Thus, we make a significant contribution to the ongoing debate among academics, policy makers, and social activists about the nature and origins of such differentials. More importantly, our results on the effects of relative pay on employee productivity suggest that relative pay has no impact on employee incentives at the average firm. Furthermore, our finding of improved productivity and performance in settings where employees have a reasonable chance of winning sequential promotion tournaments suggests that higher pay differentials generate tournament incentives rather than pervert ordinary employee incentives. These contrasting results provide important insights into the nuances of employee incentives while contributing significantly to an issue of considerable socio-economic importance.

The rest of the paper is organized as follows. In the next section, we develop hypotheses on the causes and effects of the pay differential between top management and lower-level employees. We discuss our sample and data in Section 3, followed by our empirical tests in Section 4. The last section contains concluding remarks.

2. Hypothesis development

2.1. Determinants of executive–employee relative pay

Hayes and Schaefer (1999) argue that wage levels are determined by the relative bargaining powers of the contracting parties, subject to each party's participation constraint. Therefore, our underlying hypothesis on the determinants of executive–employee pay ratios focuses on the bargaining power of executives vis-à-vis the board (since the board typically sets top executive compensation) and of lower-level employees relative to management. All else

equal, we expect higher pay ratios when the CEO has a strong bargaining advantage over the board and lower ratios when employees have a strong bargaining power relative to management.

Basic economic theory implies that the CEO's bargaining power and compensation increase with the demand for top executive talent relative to its supply. Specifically, prior work (e.g., Rosen, 1982; Core et al., 1999) suggests that executive skill requirements and thus compensation increase with firm size, firm risk, growth opportunities, and the complexity of operations. Similarly, since managerial talent and effort are difficult to observe, agency theory suggests that better firm performance increases the CEO's power to bargain for better pay. Prior work (e.g., Faleye et al., 2011; Core et al., 1999) also suggests that CEOs who serve as board chairs have better bargaining powers because they are either more entrenched, more experienced, or more talented. Based on these considerations, we hypothesize that relative pay increases with firm size, growth opportunities, operating complexity, firm performance, firm risk, and CEO–chair duality.

In contrast, we expect the bargaining power and compensation of non-management workers to increase with their skill level because highly skilled employees are generally more difficult to replace. Similarly, outside employment opportunities increase employees' bargaining power through increased competition for labor among employers and by giving credibility to employees' voluntary turnover threats. In the same way, labor unions can increase the bargaining strength and compensation of lower-level workers by aggregating employee clout and maintaining a (near) monopoly of labor supply. Consequently, we hypothesize a negative relation between pay ratio and each of employee skill, outside opportunities, and unionization.

2.2. Relative pay and employee productivity

The principal argument underlying oppositions to large CEO–employee pay ratios stems from notions of fairness and inter-class pay equity. Adams (1965) is among the first to formalize these concepts, arguing that individuals in a social exchange expect rewards to be distributed commensurate with the contributions of each participant. Thus, individuals evaluate their exchange relationships with their firms by comparing the balance between the inputs they contribute (e.g., work effort and skills) and the outcomes they receive (e.g., pay) to the input–outcome balances of a reference group. As shown by Kulik and Ambrose (1992), individuals are not restricted in their choice of referents to others of a similar stature, and indeed use a variety of referents including employees at different levels in their organization's hierarchy and individuals outside their firms. Regardless of the reference group, individuals feel a sense of inequity if they perceive that the ratio of their inputs to outcomes is unfavorable relative to the referents. Thus, a large CEO–worker pay ratio can result in a perception of inequity among lower-level employees.

Adams (1965) argues further that this perception of inequity generates tension, which provokes the individual to find some means of resolving the inequity. Cowherd and Levine (1992) show that individuals can accomplish this in several ways. For instance, employees can alter their perceptions of either their own or their reference group's inputs and/or outcomes. They also can modify their actual inputs (e.g., through decreased effort and/or absenteeism) or end perceived inequitable relationships, for example, by leaving the firm. Thus, perceived inequity arising from high CEO–employee pay ratios can result in costly behaviors that reduce employee productivity.

Similarly, relative deprivation theory (Martin, 1981; Crosby, 1984) argues that individuals experience deprivation when they believe that they have received less than they deserved relative to others in the same organization. Fehr and Schmidt (1999) provide consistent experimental evidence, showing that agents suffer a disutility as the distribution of compensation in their firm departs from an egalitarian one. Bolton and Ockenfels (2000) develop this idea further and argue that employee incentives are affected by own relative payoff (i.e., a measure of how much a person's own pecuniary payoff compares with those of others). These studies imply that employees compare their pay with those of others and are dissatisfied if they perceive such comparisons to be unfavorable. The implication once again is that large pay ratios can generate lower employee effort and productivity. These arguments lead to the following hypothesis:

H_1. Productivity is negatively associated with CEO–employee relative pay.

In contrast to the preceding arguments, sequential rank order tournament theory (e.g., Lazear and Rosen, 1981) models levels in an organization's hierarchy as successive stages of a multi-stage, winner-take-all tournament in which the ultimate winner becomes the CEO. Thus, the pay differential between two successive levels represents the magnitude of the potential prize on promotion for the best relative performer at the lower level and the pay differential with the CEO represents the ultimate prize. Consequently, higher pay differentials can motivate employees at the lower levels to exert increased effort since only the best relative performers are promoted. Thus, higher productivity can result from greater pay ratios as lower-level employees strive to win the promotion tournament. Thus, our second hypothesis states as follows:

H_2. Productivity is positively associated with CEO–employee relative pay.

Hypotheses H_1 and H_2 both presuppose that rank-and-file employees are informed on executive compensation and sufficiently empowered and/or motivated to act in response to differences between top management pay and the remuneration of ordinary workers. Of course, this need not be the case. First, rank-and-file workers may be uninformed on the relative pay for their specific firm because executive compensation data are typically disclosed in regulatory filings that most employees likely disregard or find inaccessible. Moreover, even if cognizant of this information, the ability and/or incentive of lower-level employees to act on it is potentially limited. For instance, it is arguably quite easy for firms to benchmark the productivity of lower-level employees and terminate or otherwise punish those who are less productive, making it costly for employees to impose lower productivity on the firm. Equally, rank-and-file employees may not be motivated by tournament incentives because of the relatively low probability of success given the large number of potential winners at each level and the large number of levels between rank-and-file employees and top executive positions. Finally, employees can interpret higher executive compensation as a rational response by directors and therefore perceive no inequity in spite of higher pay ratios. For example, employees may believe that the relative contribution of top management to firm performance justifies its relative pay. Employees could also believe that higher pay compensates executives for the increased size and complexity of organizations (e.g., Gabaix and Landier, 2008) and the greater compensation risk of top executives deriving from, among others, enhanced board vigilance (see, e.g., Hermalin (2005)) and higher pay–performance sensitivity (Holmstrom and Kaplan, 2003). Thus, pay ratios would have no impact on employee incentives and behavior. This leads to our final hypothesis:

H_3. Productivity is unrelated with CEO–employee relative pay.

3. Sample selection and data

Our primary variable of interest is the compensation of the CEO and other executives relative to average rank-and-file employee pay. Constructing this variable requires data on executive as well as ordinary employee compensation. We obtain executive compensation data from Standard and Poor's (S&P) ExecuComp, which provides detailed data for firms in the S&P 1500 indexes (S&P 500, S&P Mid-Cap 400, and S&P Small-Cap 600). We define a CEO as the person identified as the chief executive officer of the firm in ExecuComp (CEOANN = CEO), and classify all other executives whose remunerations are disclosed as named executive officers (NEOs). The sample covers 1993–2006.

Companies are not required to disclose non-executive employee compensation data in publicly available sources.[4] Thus, our sample is limited to those companies covered in ExecuComp that voluntarily disclose employee compensation data in Compustat. Consequently, we lose a significant proportion of the observations obtained from ExecuComp, resulting in a final sample of 3121 firm-years for 450 unique firms. This introduces potential self-selection issues, which we examine by comparing our sample with the population of firms covered by ExecuComp. As Table 1 shows, the industry distribution of our sample firms is reasonably similar to that of the ExecuComp universe, with two main exceptions: The financial services industry is overrepresented in our sample (47% compared to 14% in ExecuComp), while the manufacturing industry is underrepresented (6% vs. 27% in ExecuComp). Our sample firms also are larger on average, with median sales of $1.8 billion compared to $1.1 billion for ExecuComp firms. Nevertheless, revenue per employee is comparable. The median revenue per employee for the sample is $226,500 compared with $219,300 for ExecuComp firms. Overall, we believe that the sample is reasonably representative of the ExecuComp population although we caution that our results should be interpreted subject to the obvious caveat that the sample consists of firms that made voluntary disclosures of employee compensation data. In Section 4, we also perform separate analyses for financial and non-financial firms to assuage concerns that our results are driven by firms operating in the financial industry.

We define average ordinary employee pay as total labor expenses reported in Compustat less total executive compensation from ExecuComp, divided by the number of employees. We then compute our relative pay measures by dividing executive compensation variables by average ordinary employee pay. Our primary measure is the natural log of total CEO pay to average employee pay. For robustness purposes, we also construct similar variables using CEO cash and long-term pay as well as the average total, cash, and long-term pay of NEOs. Here, cash compensation consists of salary and cash bonus, while long-term pay consists of stock and option grants and other long-term incentive payouts.

Our main outcome variable is employee productivity. We focus on productivity for two major reasons. First, our primary objective is to examine the effects of pay ratios on workers' incentives and behavior. Employee productivity provides the best opportunity and greatest power to do so because employee actions most plausibly have first order effects on productivity. Second, employee productivity is an often overlooked facet of performance. Thus, focusing on productivity provides an insight into a different aspect of corporate outcome. Nevertheless, we examine ROA and Tobin's q as additional measures of firm performance in Section 4.4.

We follow Cronqvist et al. (2009) and construct our primary measure of employee productivity as (the natural log of) revenue per employee, calculated as the ratio of revenue to the number of employees, both as reported in Compustat. This captures productivity at the most basic level. We also define an additional measure for robustness purposes, namely, total factor productivity. This measure recognizes that employee productivity also depends on the firm's production technology. To construct this variable, we follow Faleye et al. (2006) and assume that the firm's output is generated by a Cobb–Douglas production function of the form,

$$Y_{it} = AL_{it}^{\beta}K_{it}^{\alpha} \quad (1)$$

Here, Y_{it} is net sales for firm i in period t, L_{it} is the number of employees, K_{it}, is net property, plant, and equipment, and A, a, and β are parameters. We employ residuals from our estimation of the natural log transformation of (1) over all Compustat firms as a measure of firm-level total factor productivity, controlling for industry factors by estimating a separate equation for each two-digit Standard Industrial Classification code (SIC) industry group.

Table 2 presents summary statistics for these variables. Mean (median) total CEO pay is $4.6 ($2.4) million, while the corresponding value for the average worker is $59,870. Thus, mean (median) CEO–employee pay ratio is 95.5 (52.2), that is, the average CEO in our sample earns about 95 times the average worker's pay.[5] The mean (median) ratio of average total NEO compensation to average employee pay is considerably lower at 37.1 (23.1). This is to be expected, since other named executives typically earn significantly less than the CEO.

Table 1
Industry distribution of sample firms vs. ExecuComp firms.

SIC code	% Of observations		Revenue ($ mil)		Revenue per employee ($ 000s)	
	Sample	ExecuComp	Sample	ExecuComp	Sample	ExecuComp
1	1.5	5.1	4185	811	494.4	414.6
2	10.0	17.2	3700	1420	254.1	230.2
3	6.2	26.8	8949	814	192.3	198.0
4	18.1	11.6	1964	1898	193.1	341.3
5	7.3	11.7	954	1812	37.9	134.9
6	47.3	13.8	1532	1361	277.4	356.8
7	4.6	10.2	967	573	116.5	174.4
8	4.9	3.1	1445	714	85.6	108.8
9	0.2	0.4	769	2573	363.2	213.6
All	100	100	1856	1116	226.5	219.3

The table compares the distribution of our sample firms with all firms in the ExecuComp database over 1993–2006. Revenue and revenue per employee are industry medians in thousands of dollars. Industry breakout is by one-digit SIC code, where 1 is mining and construction, 2 is consumer manufacturing, 3 is electrical and industrial manufacturing, 4 is transportation and utilities, 5 is trade, 6 is financial, 7 is commercial services, 8 is private price services and 9 is public administration.

4. Empirical analysis

4.1. Explaining CEO–employee relative pay

We begin our tests with an analysis of the determinants of the relative compensation of top executives and ordinary employees. As discussed in Section 2.1, we expect CEO–employee pay ratio to increase with firm size, growth opportunities, operating complexity, firm performance, firm risk, and CEO–chair duality. We

[4] H.R. 4173 requires disclosure of the ratio of CEO compensation to median compensation of all employees excluding the CEO beginning in 2011. However, this requirement is yet to be implemented by the SEC. As of June 2012, no firm has disclosed this information in regulatory filings.

[5] This figure is lower than numbers typically reported in the popular press. This discrepancy arises most likely because our measure of employee pay (total labor expenses) includes items not typically accounted for in popular discussions of CEO–ordinary worker pay differentials, mostly employee benefits. In addition, due to data aggregation limitations, our definition of ordinary employee compensation necessarily includes the compensation of non-named top executives typically excluded in popular discourses.

Table 2
Summary statistics for main variables.

	N	1st Quartile	Mean	Median	3rd Quartile
Panel A: Compensation variables					
CEO total pay	3121	1185.67	4630.19	2407.82	5261.07
CEO cash pay	3121	700.00	1757.56	1137.30	2041.67
CEO long-term pay	3121	236.98	2830.10	1059.66	3161.98
NEO total pay	3121	525.70	1764.37	981.72	1959.84
NEO cash pay	3121	340.12	826.68	515.01	914.88
NEO long-term pay	3121	144.81	932.01	387.13	1020.24
Ordinary employee total pay	3121	39.56	59.87	51.95	67.45
Panel B: Relative pay variables					
CEO–employee relative pay (total)	3121	25.04	95.47	52.22	107.86
CEO–employee relative pay (cash)	3121	14.55	36.65	25.04	43.12
CEO–employee relative pay (L–T)	3121	5.33	57.70	22.81	65.28
NEO–employee relative pay (total)	3121	12.14	37.10	23.05	44.79
NEO–employee relative pay (cash)	3121	6.98	15.65	11.12	18.34
NEO–employee relative pay (L–T)	3121	2.84	17.18	8.06	21.16
Panel C: Employee productivity variables					
Revenue per employee	3121	146.16	272.15	226.54	326.65
Total factor productivity	3121	−0.198	0.033	0.018	0.253
Tobin's *q*	3121	0.32	0.98	0.71	1.30
Return on assets	3121	1.14	3.57	2.15	6.05

CEO total pay is total CEO compensation (TDC1 in ExecuComp). CEO cash pay is the sum of salary, bonus, and other annual payments. CEO long-term pay is the sum of restricted stock grants, options grants, and long-term incentive payouts. NEOs are non-CEO top executives whose compensation is disclosed in ExecuComp. Compensation variables for other executives are defined in the same way as for the CEO but averaged at the firm-year level. Ordinary employee pay is average labor expenses less total top executive compensation divided by the number of employees. Relative pay variables are constructed by dividing the respective compensation amount for executives by ordinary employee pay. Revenue per employee is total revenue divided by the number of employees. Total factor productivity is the residual of industry-specific Cobb–Douglas production functions estimated for each two-digit SIC industry group using all Compustat firms. Tobin's *q* is the market value of common equity plus the book value of debt plus the redemption value of preferred equity, divided by the book value of assets. Return on assets is the ratio of operating income after depreciation to total assets at the end of the preceding year. Compensation amounts and revenue per employee are in thousands of dollars. All variables are winsorized at the first and 99th percentiles.

also expect the ratio to decline with employee skill, outside opportunities, and unionization.

Similar to Core et al. (1999), we use the natural log of sales revenue as a proxy for firm size and operating complexity, and book/market ratio (calculated as the ratio of the book value of equity to the market value of equity) as a proxy for growth opportunities. We measure firm performance using industry-adjusted annual stock returns and ROA (ratio of operating income after depreciation to prior year total assets). We employ the standard deviation of monthly stock returns over the preceding 5 years as a proxy for firm risk. Our measure of CEO–chair duality equals one when the CEO also serves as board chair, zero otherwise.

We use three proxies for employee skill, each intended to capture a potentially different dimension of task-relevant dexterity. The first is R&D expenditures (normalized by total assets), based on the argument that firms investing in R&D require highly skilled employees both to execute R&D projects and also to increase the likelihood of successful innovation. The second is the percentage of full-time employees who hold at least a bachelor's degree, calculated each year at the two-digit SIC industry level using data from the U.S. Bureau of Census. This is based on arguments similar to those in studies that use education level as a measure of the level of human capital in different nations (e.g., Barro and Lee, 1993; Barro, 2001). The variable is constructed at the industry level because of data limitations. The final proxy is the ratio of physical capital to the number of employees, which is based on the intuition that capital intensive operations generally require higher employee skills relative to labor intensive ones.[6]

Our measures of employee outside opportunities are industry homogeneity and industry concentration. Industry homogeneity captures the similarity among firms in the same industry after isolating market effects. Thus, it reflects the extent to which employee skills are easily transferable among firms in an industry. We construct this variable following the methodology of Parrino (1997). In contrast, industry concentration (revenue-based Herfindahl index) measures the extent to which the industry is dominated by a few firms, which potentially diminishes employees' outside options and their relative bargaining power. Finally, we measure employee unionization using the percentage of unionized employees in the industry in each year. The data for this variable come from the Current Population Surveys (CPSs) of the Bureau of Labor Statistics.[7] It is constructed at the industry level due to data limitations.

Table 3 presents summary statistics for each control variable described above while Table 4 presents pairwise correlation coefficients. As Table 4 shows, none of the variables are highly correlated, with the largest correlation coefficient (in absolute value) being 0.498 between physical capital intensity and workforce unionization.

Next, we estimate regressions of the natural log of the ratio of executive pay to ordinary employee remuneration on the above variables. Each regression also includes year and two-digit SIC industry fixed effects.[8] We correct standard errors for clustering at the firm level and winsorize all continuous variables at the first

[6] As described above, R&D and physical capital intensity are defined at the firm level and not adjusted for cross-industry differences. Since R&D spending and PP&E investments may cluster by industry, we also construct industry-adjusted R&D and PP&E intensity variables by subtracting from each variable its industry median during the same year. Our results are not sensitive to this adjustment.

[7] We obtain union data from an Internet database that provides private and public sector union membership, coverage, and density estimates compiled from the Current Population Survey (CPS) (Hirsch and Macpherson, 2003). The database can be accessed at http://www.unionstats.com/.

[8] Several of our explanatory variables are constructed at the industry level, which raises the question of whether industry fixed effects are appropriate in these models. Note, however, that the industry-level variables are measured annually, i.e., even though every firm in the same industry has the same value on these variables during each year, the value changes from one year to the next. Thus, the variables are not subsumed by the industry fixed effects. Nevertheless, we estimate additional regressions where we exclude industry fixed effects. Results are similar to those obtained with industry fixed effects. The main exception is that industry homogeneity is positive and significant when we include industry fixed effects but negative and significant when we exclude them.

Table 3
Summary statistics for control variables.

	Observations	Lower quartile	Mean	Median	Upper quartile
Workforce education	3121	0.208	0.288	0.305	0.325
Physical capital intensity	3118	0.028	0.117	0.045	0.085
Industry concentration	3121	0.026	0.058	0.040	0.070
Industry homogeneity	3121	0.211	0.277	0.266	0.348
Workforce unionization	3121	0.014	0.108	0.020	0.178
CEO tenure	3025	3.000	9.007	7.000	13.000
CEO alignment	3121	0.27	2.730	0.789	2.427
CEO–chair duality	3121	0.000	0.742	1.000	1.000
Firm size	3121	7.311	8.717	8.716	9.983
Leverage	3121	0.053	0.170	0.139	0.266
Book/market ratio	3121	0.300	0.453	0.451	0.622
Market performance	3121	−10.299	2.082	0.000	11.056
Return on assets	3097	1.135	3.565	2.145	6.052
Firm risk	3121	0.067	0.093	0.086	0.110

Workforce education is the percentage of industry employees with at least a bachelor's degree. Physical capital intensity is net property, plant, and equipment per employee in millions of dollars. Industry concentration is the sales-based Herfindahl index computed over all Compustat firms in the same industry. Industry homogeneity is the mean partial correlation between firm's returns and an equally weighted industry index, for all firms in the same industry, holding market return constant. Workforce unionization is the percentage of unionized industry workers. CEO tenure is in years. CEO alignment is the change in the CEO's firm-specific wealth for each $100 change in the firm's market value. CEO–chair duality equals one when the CEO also serves as board chair, zero otherwise. Firm size is the natural log of revenue. Leverage is long-term debt divided by total assets. Book/market ratio is book value of equity divided by market value of equity. Market performance is 1-year industry (median) adjusted stock return. Return on assets is the ratio of operating income after depreciation to prior year total assets. Firm risk is the standard deviation of monthly stock returns over the preceding 60 months. Industries are defined at the two-digit SIC group level. All continuous variables are winsorized at the first and 99th percentiles.

Table 4
Correlation coefficients.

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
CEO–employee relative pay	[1]	1.000											
Firm size	[2]	0.344	1.000										
Book/market	[3]	−0.134	0.047	1.000									
Market performance	[4]	0.062	−0.043	−0.084	1.000								
Return on assets	[5]	0.083	−0.299	−0.032	0.137	1.000							
Firm risk	[6]	0.056	−0.337	−0.140	0.082	−0.092	1.000						
CEO–chair duality	[7]	0.130	0.171	0.055	−0.014	0.011	−0.086	1.000					
Industry concentration	[8]	−0.032	−0.274	−0.062	0.003	0.157	0.230	−0.011	1.000				
Industry homogeneity	[9]	−0.114	0.248	0.078	0.002	−0.238	−0.146	−0.040	−0.063	1.000			
Workforce unionization	[10]	−0.177	−0.133	0.062	−0.021	0.084	−0.086	0.020	0.201	0.196	1.000		
R&D intensity	[11]	0.078	0.007	−0.117	0.020	0.153	−0.041	0.057	−0.081	−0.355	0.041	1.000	
PPE intensity	[12]	−0.273	0.047	0.123	−0.040	−0.026	−0.287	−0.041	−0.102	0.314	0.498	−0.053	1.000
Workforce education	[13]	−0.068	0.287	−0.002	0.010	−0.117	0.118	0.025	−0.166	−0.063	−0.402	0.025	−0.165

CEO–employee relative pay is the natural log of the ratio of the CEO's total pay to average employee pay. Firm size is the natural log of sales revenue. Book/market ratio is book value of equity divided by market value of equity. Market performance is 1-year industry (median) adjusted stock return. Return on assets is the ratio of operating income after depreciation to prior year total assets. Firm risk is the standard deviation of monthly stock returns over the preceding 60 months. CEO–chair duality equals one when the CEO also serves as board chair, zero otherwise. Industry concentration is the sales-based Herfindahl index computed over all Compustat firms in the same industry. Industry homogeneity is the mean partial correlation between firm's returns and an equally weighted industry index, for all firms in the same industry, holding market return constant. Workforce unionization is the percentage of unionized industry workers. R&D intensity is the ratio of R&D expenditures to total assets, assumed equal to zero when R&D is missing in Compustat. PPE intensity is net property, plant, and equipment per employee in millions of dollars. Workforce education is the percentage of industry employees with at least a bachelor's degree. Average employee pay is average compensation (including benefits) earned by all employees excluding the most highly compensated executives disclosed in corporate filings. Workforce education is the percentage of industry employees with at least a bachelor's degree.

and 99th percentiles to minimize the effects of any potential outliers. Results are presented in Table 5.

The dependent variable in the first column is the natural log of the ratio of total CEO pay to average employee compensation. Results of this regression are consistent with the bargaining power hypothesis in that variables associated with greater CEO bargaining power are positively related with pay ratio while those associated with greater employee bargaining power generally have a negative effect. Specifically, relative pay increases with firm size, operating and market performance, firm risk, and CEO–chair duality but decreases with employee unionization and physical capital intensity. The coefficients imply that an increase of one standard deviation in each of firm size, market-adjusted stock return, operating performance, and firm risk is associated with increases of 106%, 5%, 18%, and 12% in CEO–employee pay ratio, while the same change in employee unionization and physical capital intensity is associated with decreases of 53% and 24%, respectively. Surprisingly, we find that relative pay increases with employee outside options as measured by industry homogeneity. While we expected a negative effect, this result suggests that the similarity of firms in homogenous industries enhances management's ability to replace workers more than it increases employee bargaining clout through greater outside employment opportunities.

Results are similar when we focus on cash and long-term compensation in the second and third columns of Table 5. The regression in the fourth column uses the natural log of the ratio of average total compensation of NEOs to average employee pay as the dependent variable. As the table shows, results are comparable to those in the first column for the CEO. In further tests (not tabulated), we include firm-level governance variables such as board size, classified board, and percentage of independent directors. None of these variables is significant, which suggests that board structure does not influence relative pay in any meaningful manner.

These results suggest that observed pay ratios between top executives and ordinary employees arise mainly from the relative ability of workers and executives to negotiate higher compensation with the relevant counterparty. Executives earn more and pay ra-

Table 5
Determinants of relative compensation of top executives to ordinary employees.

	CEO (total pay)	CEO (cash pay)	CEO (LT pay)	NEO (total pay)
Firm size	0.391***	0.262***	0.593***	0.401***
	(0.000)	(0.000)	(0.000)	(0.000)
Book/market ratio	−0.074	−0.077	−0.090	−0.108*
	(0.308)	(0.127)	(0.488)	(0.066)
Market performance	0.002***	0.003***	−0.000	0.001**
	(0.002)	(0.000)	(0.879)	(0.024)
Operating performance	0.032***	0.027***	0.041***	0.032***
	(0.000)	(0.000)	(0.000)	(0.000)
Firm risk	3.028***	1.177	5.002**	3.071***
	(0.006)	(0.178)	(0.010)	(0.000)
CEO–chair duality	0.129**	0.137***	0.108	0.060
	(0.013)	(0.001)	(0.311)	(0.140)
Industry concentration	0.283	−0.914	1.714	0.847
	(0.732)	(0.291)	(0.458)	(0.283)
Industry homogeneity	1.116**	0.947***	1.277	1.001***
	(0.016)	(0.008)	(0.143)	(0.005)
Workforce unionization	−5.024***	−4.733***	−5.546*	−3.643***
	(0.001)	(0.000)	(0.060)	(0.007)
R&D intensity	1.553	−0.091	2.618	2.688
	(0.661)	(0.981)	(0.522)	(0.430)
Physical capital intensity	−1.343***	−1.185***	−1.622***	−1.127***
	(0.000)	(0.000)	(0.000)	(0.000)
Workforce education	−0.039	−0.800	2.208	−0.157
	(0.947)	(0.108)	(0.160)	(0.720)
Constant	0.419	1.515***	−2.915***	−0.375
	(0.161)	(0.000)	(0.000)	(0.135)
Adjusted R^2	0.543	0.537	0.370	0.644
Observations	3094	3088	3013	3094
Unique firms	447	447	443	447

The dependent variable in the first three columns is the natural log of the respective ratios of the CEO's total, cash, and long-term pay to average employee compensation. The dependent variable in the fourth column is the total compensation ratio defined for other named top executives. Cash compensation is the sum of salary, bonus, and other annual payments. Long-term compensation is the sum of restricted stock grants, options grants, and long-term incentive payouts. Firm size is the natural log of sales revenue. Book/market ratio is book value of equity divided by market value of equity. Market performance is 1-year industry (median) adjusted stock return. Operating performance is the ratio of operating income after depreciation to prior year total assets. Firm risk is the standard deviation of monthly stock returns over the preceding 60 months. CEO–chair duality equals one when the CEO also serves as board chair, zero otherwise. Industry concentration is the sales-based Herfindahl index computed over all Compustat firms in the same industry. Industry homogeneity is the mean partial correlation between firm's returns and an equally weighted industry index, for all firms in the same industry, holding market return constant. Workforce unionization is the percentage of unionized industry workers. CEO tenure is in years. R&D intensity is the ratio of R&D expenditures to total assets, assumed equal to zero when R&D is missing in Compustat. Physical capital intensity is net property, plant, and equipment per employee in millions of dollars. Workforce education is the percentage of industry employees with at least a bachelor's degree. Each regression includes industry and year fixed effects. Industries are defined at the two-digit SIC group level. All continuous variables are winsorized at the first and 99th percentiles. Numbers in parentheses are *p*-values based on robust standard errors corrected for firm-level clustering.

* Levels of significance at 10%.

** Levels of significance at 5%.

*** Levels of significance at 1%.

tios are higher when top management is in a strong bargaining position relative to the board, such as when the company outperforms its peers and/or its operations are large, risky, or complex. In contrast, workers earn more and pay ratios are lower when ordinary employees enjoy relative strength in negotiating with management, for example, when the workforce is highly skilled or unionized and employees are not easily replaceable. In the next section, we turn to the question of how the productivity of employees is affected by the relative pay of ordinary workers and top executives.

4.2. The effect of relative pay on productivity

While our primary objective is to test the three hypotheses developed in Section 2.2, we recognize that other variables besides relative pay potentially affect employee productivity. Perhaps the most important among these is the actual level of employee pay. More productive employees would generally be paid more, resulting in lower pay ratios and a mechanical negative association between productivity and relative pay. Thus, we include the natural log of average employee pay in all specifications.

Furthermore, it is plausible to expect higher productivity when employees are highly skilled. Therefore, we control for skill level using the percentage of full-time industry employees who hold a bachelors' degree or higher in each year. We also control for capital intensity because investments in physical assets can facilitate employee productivity through, for example, automation and improved work and process flow. Our measure of capital intensity is net dollar invested in property, plant, and equipment per employee.

Companies operating in competitive industries are subject to continuous pressures that can affect employee productivity significantly. For example, competition can aid productivity by encouraging innovation and efficiencies. To account for these effects, we create two industry-level variables designed to capture industry competition dynamics. The first is the revenue-based Herfindahl index for each two-digit SIC code industry. Higher scores on this variable imply more concentration and less industry competition. The second is a measure of industry homogeneity, which we construct following Parrino (1997) as described earlier. This variable measures the similarity among firms in an industry after isolating market effects. Higher scores imply greater similarity between firms in an industry and in turn higher competition.

Freeman and Medoff (1984) introduce the phrase "the two faces of unionism" to describe the potential effects of labor unions on firm performance. On the one hand, unions can improve efficiency and therefore productivity by facilitating better communication

Table 6
Relative pay and employee productivity.

	A: Full sample		B: Financial firms		C: Non-financial firms	
	SLE	TFP	SLE	TFP	SLE	TFP
CEO–employee relative pay	0.010	0.011	0.013	0.016	0.009	0.006
	(0.525)	(0.489)	(0.658)	(0.583)	(0.480)	(0.611)
Average employee pay	0.680***	0.602***	0.635***	0.639***	0.696***	0.556***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Workforce education	0.297	0.092	0.914	0.535	−0.224	−0.329*
	(0.202)	(0.684)	(0.314)	(0.608)	(0.216)	(0.064)
Physical capital intensity	0.936***	−0.513***	1.028***	−0.848***	0.984***	−0.375***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Industry concentration	−0.249	−0.748	0.601	1.793	−0.250	−0.767
	(0.679)	(0.197)	(0.803)	(0.460)	(0.688)	(0.194)
Industry homogeneity	0.515***	0.685***	0.403	1.203	0.000	0.102
	(0.001)	(0.000)	(0.598)	(0.107)	(1.000)	(0.670)
Workforce unionization	−0.446	−1.039*	−16.015***	−13.981***	−0.864	−0.866
	(0.477)	(0.076)	(0.002)	(0.010)	(0.185)	(0.133)
CEO tenure	0.001	−0.001	−0.000	−0.000	0.001	−0.003
	(0.686)	(0.772)	(0.905)	(0.919)	(0.731)	(0.134)
CEO incentive alignment	0.003	0.002	0.000	−0.000	0.001	0.000
	(0.447)	(0.614)	(0.939)	(0.940)	(0.789)	(0.980)
Firm size	0.003	−0.019	0.025	−0.017	−0.028*	−0.026**
	(0.803)	(0.165)	(0.242)	(0.439)	(0.098)	(0.046)
Leverage	0.232*	0.217*	1.251***	1.332***	−0.116	−0.206**
	(0.074)	(0.096)	(0.000)	(0.000)	(0.245)	(0.040)
Constant	2.689***	−1.456***	2.230***	−3.747***	2.798***	−1.104***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Adjusted R^2	0.850	0.510	0.590	0.511	0.902	0.565
Observations	3022	3022	1375	1375	1647	1647
Unique firms	442	442	187	187	255	255

SLE is the natural log of revenue per employee. TFP is the residual of industry-specific Cobb–Douglas production functions estimated using all Compustat firms. CEO–employee relative pay is the natural log of the ratio of the CEO's total pay to average employee pay. Average employee pay is average compensation (including benefits) earned by all employees excluding the most highly compensated executives disclosed in corporate filings. Workforce education is the percentage of industry employees with at least a bachelor's degree. Physical capital intensity is net property, plant, and equipment per employee in millions of dollars. Industry concentration is the sales-based Herfindahl index computed over all Compustat firms in the same industry. Industry homogeneity is the mean partial correlation between firm's returns and an equally weighted industry index, for all firms in the same industry, holding market return constant. Workforce unionization is the percentage of unionized industry workers. CEO tenure is in years. CEO incentive alignment is the change in the CEO's firm-specific wealth for each $100 change in the firm's market value. Firm size is the natural log of sales revenue. Leverage is long-term debt divided by total assets. Each regression includes industry and year fixed effects. Industries are defined at the two-digit SIC group level. All continuous variables are winsorized at the first and 99th percentiles. Numbers in parentheses are *p*-values based on robust standard errors corrected for firm-level clustering.
* Levels of significance at 10%.
** Levels of significance at 5%.
*** Levels of significance at 1%.

between management and employees, helping balance employee and employer interests, and "putting pressure on management to tighten job production standards and accountability in order to preserve profits in the face of higher wages" (p. 15). Yet unions can gain labor market monopoly, which can facilitate self-interested pursuits that depress productivity. For example, unions can use their bargaining power to extract greater leisure or otherwise hold up the employer (see also Baldwin, 1983). Accordingly, we use the percentage of unionized employees in each two-digit SIC industry in each year to control for the potential effects of labor unions on productivity.

We also control for CEO tenure and incentive alignment to account for the potential effects of top management experience and incentives. We measure CEO tenure as the number of years for which the CEO has served as such with the current firm. Following the literature (e.g., Aggarwal and Samwick, 2003; Kale et al., 2009), we define the CEO's incentive alignment as the change in the CEO's firm-specific wealth for a $100 change in shareholder wealth, calculated as[9]:

$$\textit{Alignment} = ((\text{Shares owned} + \text{option delta} \times \text{options held})/\text{shares outstanding}) \times 100 \quad (2)$$

Finally, we control for firm size and leverage. We define firm size as the natural log of sales revenue and leverage as the ratio of long-term debt to total assets. Table 3 presents summary statistics for all control variables.

Next, we estimate regressions of employee productivity on relative pay, controlling for these variables. The regressions are estimated with year and industry fixed effects and standard errors corrected for clustering at the firm level.[10] As before, we winsorize all continuous variables at the first and 99th percentiles. Results are presented in Table 6.

The dependent variable in the first column of Panel A is the natural log of revenue per employee. The relative pay variable in this regression is the natural log of the ratio of total CEO compensation to average employee pay. As the table shows, it is not significant at conventional levels, with a *p*-value of 0.525. The dependent variable in the second column is total factor productivity. Again, CEO–employee relative pay is not statistically significant. Next, we repeat these tests for financial and non-financial firms, since financial firms account for almost half of our sample. Panels B and C of Table 6 show that no significant relation exists between employee productivity and relative pay in either subsample. We

[9] We use stock ownership at the beginning of the year to obtain the stock-based sensitivity of an executive's equity portfolio. For option holdings, we follow Core and Guay (2002) and determine an average exercise price for all previously granted options based on their year-end intrinsic value. We treat all previously granted options as a single grant with a 5-year time to maturity and obtain the risk-free rate from the 5-year Treasury bills constant maturity series. We compute the average delta of prior option grants using the modified Black–Scholes formula.

[10] Results are similar without industry fixed effects.

also estimate additional regressions (not tabulated) using alternative measures of relative pay (CEO cash compensation to employee pay, CEO equity-based compensation to employee pay, NEO total, cash, and equity-based compensation to employee pay). In each case, we find no significant relation between productivity and relative pay. Furthermore, we verify that this result is not attributable to overly conservative standard errors by estimating basic ordinary least squares (OLS) regressions without corrections for firm-level clustering or heteroskedasticity. We obtain similar results in these tests. Thus, it appears that the ratio of top executive compensation relative to employee pay does not affect firm productivity in any significant manner.

Nevertheless, it is possible that the relevant measure of relative pay is not the raw CEO–employee pay ratio itself; rather, employees may react more to pay ratios that are considered above and beyond some "reasonable" rates. We investigate this by defining two sets of excess pay ratio measures. The first set is based on residuals from our model explaining observed CEO–employee pay ratios in the first column of Table 5. These measures are the residual itself; an indicator variable that equals one if the residual is greater than the sample median, zero otherwise; and an indicator variable that equals one if the residual equals or exceeds the sample third quartile and zero if the residual equals or falls below the sample first quartile. The second set consists of a continuous variable that equals the difference between each firm's pay ratio and its industry median pay ratio during the same year; an indicator variable that equals one if the continuous variable exceeds the median, zero otherwise; and an indicator variable that equals one if the continuous variable equals or exceeds the sample third quartile and zero if it equals or falls below the sample first quartile. We then repeat our productivity regressions using these measures. Results are very similar to those obtained using raw pay ratios, i.e., we find no relation between our measures of productivity and each of the different measures of excess pay ratio. We do not tabulate these results to conserve space but they are available upon request.[11]

Other results in Table 6 are generally consistent with expectations. In contrast to the relative pay results, we find that average employee pay is significantly positively related with productivity in all regressions, with *p*-values that are consistently lower than 0.001. While we recognize that this does not necessarily imply that higher employee pay causes increased productivity (which is a question beyond the scope of this study), the fact that we find no effect for relative pay suggests that employees care more about their absolute pay rather than their pay relative to top management.

Table 6 also shows that productivity is higher in industries with greater similarity among firms as reflected by the statistically positive coefficients on industry homogeneity. A possible explanation is that employees invest more in their skills in homogeneous industries because it is easier for them to transfer skills across firms since there are more outside employment opportunities. Alternatively, greater industry homogeneity increases the ease with which management can replace workers. This potentially motivates employees to exert greater effort in order to remain competitive and keep their jobs, leading to higher productivity. Finally, the negative union coefficients suggests that unions are associated with lower productivity, especially among financial firms. We do not find any strong and consistent relation between other variables and productivity.

[11] We thank an anonymous referee for suggesting these tests.

4.3. Why does relative pay have no effect on productivity at the average firm?

In Section 4.2 above, we discussed and tested hypotheses on the relation between CEO–employee relative pay and employee productivity. Our results indicate that the ratio of executive compensation to ordinary employee pay has no significant effect on employee productivity on average. In this section, we examine potential explanations for this finding to provide additional insights into these issues.

As discussed under hypothesis H_3, a plausible explanation is that employees are not knowledgeable about the pay ratio for their specific firms because they are uninformed on the level of executive pay. We test this conjecture by examining a subset of firms where employees are more likely to be informed on executive compensation issues. These are firms whose CEOs were mentioned by name in a news item or popular press article discussing executive pay. For each year, we search executive compensation news in *Factiva* for each CEO's name together with that of his employer. This identifies 28.5% of our sample. We presume that employees of these firms are more likely to be informed on top management compensation since their firms and CEOs were featured in popular press discussions of executive pay. We then estimate regressions similar to those in Table 6 for these firms, expecting pay ratio to be significant if the lack of significance in the full sample is attributable to a lack of employee awareness. Due to space considerations, we only present results for revenue per employee but total factor productivity results are qualitatively similar and are available upon request. As the first column of Table 7 shows, we do not find a significant relation between productivity and relative pay even in this subsample. Thus, it appears that the full sample results are not driven by a lack of employee awareness of top executive pay.

Next, we evaluate the hypothesis that productivity is unaffected by relative pay because employees on average perceive their pay differential relative to top executives as equitable. This would be the case, for instance, if employees believe that top management's relative contribution to firm performance and value justifies higher relative pay. To test this hypothesis, we focus on two subsets of firms where this is less likely to be true because the average employee is highly skilled. The first are firms operating in industries where the fraction of employees with at least an undergraduate degree is higher than the sample third quartile (32.5%), based on the intuition that highly educated employees are more likely to attribute a greater proportion of firm value and performance to their individual skills rather than top management's ability and effort. The second subset consists of firms with positive R&D investments, based on a similar reasoning but focusing on firm-specific skills. We expect a negative relation between relative pay and productivity in each subsample if the hypothesis that the full sample results are explained by rank-and-file employee perception of pay equity is correct. As the second and third columns of Table 7 reveal, this is not the case. Rather, pay ratio does not have a significant effect on employee productivity in either subsample. Thus, it does not appear that our full sample results are attributable to employee perception of equitable pay differentials relative to top management.

Another potential explanation is that employees are cognizant of their pay relative to top executives, perceive high pay ratios as inequitable, but are powerless to impose costs on the firm because they fear managerial retribution. We focus on firms in highly unionized industries to test this hypothesis. Here, we define highly unionized industries as those where the percentage of unionized workers is at or above the full sample third quartile, which is 17.8%. Since unionized employees enjoy substantial entrenchment, we expect to find a negative and significant effect for pay ratio on

Table 7
Relative pay and productivity where equity considerations likely matter more.

	Informed employees	Highly educated	High R&D	Highly unionized	Informed highly unionized	Domestic firms	Multinationals
CEO–employee relative pay	0.029	0.001	0.019	0.022	0.020	0.031	−0.013
	(0.260)	(0.969)	(0.459)	(0.186)	(0.428)	(0.102)	(0.496)
Average employee pay	0.713***	0.820***	0.615***	0.461***	0.435***	0.641***	0.791***
	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)
Workforce education	0.377	1.258	0.005	0.510*	0.333	0.492*	−0.243
	(0.277)	(0.105)	(0.988)	(0.062)	(0.535)	(0.081)	(0.333)
Physical capital intensity	1.108***	1.134***	2.415***	0.584***	1.186***	0.541***	1.309***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry concentration	−0.176	0.010	−1.520	−0.463	−1.138	−0.910	0.821
	(0.787)	(0.994)	(0.125)	(0.515)	(0.262)	(0.158)	(0.338)
Industry homogeneity	0.404	0.527	0.593*	0.869**	1.860*	0.367**	−0.159
	(0.304)	(0.283)	(0.094)	(0.020)	(0.067)	(0.046)	(0.622)
Workforce unionization	−3.992***	−0.903	−0.118	−1.104	−5.250***	0.265	−1.274*
	(0.007)	(0.663)	(0.855)	(0.116)	(0.003)	(0.745)	(0.083)
CEO tenure	−0.002	−0.005	0.007*	−0.000	0.001	0.002	−0.004
	(0.662)	(0.154)	(0.093)	(0.959)	(0.830)	(0.457)	(0.187)
CEO incentive alignment	0.004	0.003	0.014*	0.004	−0.000	0.004	0.004
	(0.597)	(0.620)	(0.058)	(0.508)	(0.999)	(0.303)	(0.485)
Firm size	−0.001	0.029	0.019	−0.027	−0.030	−0.025	0.031*
	(0.978)	(0.188)	(0.519)	(0.325)	(0.259)	(0.123)	(0.052)
Leverage	0.408**	−0.030	−0.097	0.124	0.306*	0.363**	0.246*
	(0.036)	(0.882)	(0.700)	(0.428)	(0.057)	(0.035)	(0.095)
Constant	2.615***	1.581***	1.656**	3.113***	4.371***	3.539***	1.665***
	(0.000)	(0.002)	(0.027)	(0.000)	(0.000)	(0.000)	(0.000)
Adjusted R^2	0.881	0.820	0.906	0.815	0.909	0.842	0.933
Observations	849	737	439	770	176	2218	804
Unique firms	197	220	70	136	37	353	132

The dependent variable in each regression is the natural log of revenue per employee. The regression in the first column is estimated over firms whose CEOs were mentioned in popular press discussions of executive pay. The second column is estimated over firms in industries where the percentage of unionized employees is greater than the sample third quartile (17.8%). The third column is estimated over firms in the intersection of the samples for the first and second columns. The fourth column is estimated over firms in industries where the proportion of employees with at least a bachelor's degree is greater than the sample third quartile (32.5%). The fifth column is estimated over firms with positive R&D investments. The sixth column is estimated over firms with no significant international operations based on segment data from Compustat. The seventh column is estimated over firms with significant international operations. CEO–employee relative pay is the natural log of the ratio of the CEO's total compensation to average employee compensation. Average employee pay is average compensation (including benefits) earned by all employees outside the group of the most highly compensated executives disclosed in corporate filings with the SEC. Workforce education is the percentage of industry employees with at least a bachelor's degree. Physical capital intensity is net property, plant, and equipment per employee in millions of dollars. Industry concentration is the sales-based Herfindahl index computed over all Compustat firms in the same industry. Industry homogeneity is the mean partial correlation between firm's returns and an equally weighted industry index, for all firms in the same industry, holding market return constant. Workforce unionization is the percentage of unionized industry workers. CEO tenure is in years. CEO incentive alignment is the change in the CEO's firm-specific wealth for each $100 change in the firm's market value. Firm size is the natural log of sales revenue. Leverage is long-term debt divided by total assets. Each regression includes industry and year fixed effects. Industries are defined at the two-digit SIC group level. All continuous variables are winsorized at the first and 99th percentiles. Numbers in parentheses are *p*-values based on robust standard errors corrected for firm-level clustering.

* Levels of significance at 10%.

** Levels of significance at 5%.

*** Levels of significance at 1%.

productivity among these firms if the full sample results are driven by employee career concerns. The fourth column of Table 7 presents results of this test. As before, we find no significant relation between pay ratio and productivity. In fact, the coefficient is positive. We also estimate another regression over highly unionized firms whose CEOs were mentioned in news items discussing executive pay. Again, we find no significant effect for pay ratio (fifth column of Table 7). Thus, productivity does not suffer in response to high pay ratios even when employees are protected by unions and are reasonably well-informed on executive pay issues.

Besides the foregoing, given that our sample firms are generally larger firms, it is likely that many have substantial foreign operations. Since international employees are less likely to be knowledgeable about the compensation of U.S.-based top executives, a significant number of such employees can weaken any link between relative pay and productivity. We evaluate this conjecture by estimating separate regressions for multinational firms (MNCs) and those with domestic-only operations. We define MNCs as firms with reportable non-domestic geographic segments, identified using the Compustat segment files. This classifies 27.2% of our sample as MNCs. The sixth and seventh columns of Table 7 show results of regressions estimated for domestic firms and MNCs, respectively. As seen in the table, we find a positive and marginally significant relation between productivity and relative pay among firms with no international operations (*p*-value = 0.102) but find no relation among multinational firms. Thus, it appears that a large number of international employees partially explains the lack of significance in full sample results.

Other than the pay awareness and international operations tests, the preceding analyses can essentially be construed as a further examination of the inequity aversion hypothesis since they mainly search for negative effects in instances where perceptions of pay inequity are likely to be stronger. Overall, these tests suggest that the incentives of rank-and-file employees are not distorted by pay equity considerations. In fact, the contrasting results for MNCs and domestic firms suggest it is likely that higher pay ratios incentivize employees. Relative to international workers, U.S.-based employees are more likely to be knowledgeable about the compensation of U.S.-based CEOs and are also more likely to perceive opportunities for promotion to higher-level positions. That we find a (marginally) positive productivity effect among domestic firms and no relation among MNCs suggests that tournament incentives

Table 8
Relative pay and productivity where tournament incentives likely matter more.

	Fewer employees	More employees	Fewer employees, informed	Fewer employees, uninformed	Fewer employees, low union	Fewer employees, high union
CEO–employee relative pay	0.071**	0.018	0.162***	0.050	0.091**	0.008
	(0.043)	(0.252)	(0.005)	(0.231)	(0.041)	(0.851)
Average employee pay	0.481***	0.716***	0.462***	0.470***	0.518***	−0.027
	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.933)
Workforce education	0.868	−0.205	4.848*	−0.104	2.482	−0.630
	(0.297)	(0.527)	(0.051)	(0.914)	(0.385)	(0.522)
Physical capital intensity	0.524*	0.892***	−0.101	0.532*	1.274***	0.354
	(0.058)	(0.004)	(0.932)	(0.060)	(0.000)	(0.243)
Industry concentration	0.338	−0.332	1.153	0.264	0.267	−0.056
	(0.838)	(0.614)	(0.893)	(0.874)	(0.970)	(0.970)
Industry homogeneity	0.630	0.176	2.365	0.886**	1.041	0.808
	(0.149)	(0.459)	(0.352)	(0.050)	(0.760)	(0.355)
Workforce unionization	3.172*	−1.367*	−14.520	2.663	−8.035	−0.282
	(0.056)	(0.089)	(0.511)	(0.118)	(0.829)	(0.849)
CEO tenure	−0.004	−0.001	−0.003	−0.005	−0.002	−0.019**
	(0.206)	(0.747)	(0.725)	(0.125)	(0.542)	(0.028)
CEO incentive alignment	−0.003	−0.011	−0.004	−0.003	−0.006	0.003
	(0.432)	(0.405)	(0.832)	(0.546)	(0.151)	(0.764)
Firm size	0.068	0.105***	0.051	0.056	0.073	−0.040
	(0.184)	(0.000)	(0.472)	(0.295)	(0.220)	(0.599)
Leverage	0.650*	0.017	1.135**	0.603	0.946**	−0.118
	(0.090)	(0.913)	(0.021)	(0.171)	(0.020)	(0.807)
Constant	2.023***	1.507***	0.152	2.447***	0.833	6.764***
	(0.002)	(0.000)	(0.935)	(0.001)	(0.704)	(0.000)
Adjusted R^2	0.709	0.955	0.758	0.691	0.703	0.800
Observations	763	750	141	622	242	161
Unique firms	162	105	48	152	83	46

The dependent variable in each regression is the natural log of revenue per employee. Firms with fewer (more) employees are those whose employees are fewer (more) than the sample first (third) quartile of 3250 (27,650). Informed employees are those whose CEOs were mentioned in popular press discussions of executive pay. Low (high) union firms are those in industries where the percentage of unionized employees is lower (greater) than the sample first (third) quartile of 1.4% (17.8%). CEO–employee relative pay is the natural log of the ratio of the CEO's total compensation to average employee compensation. Average employee pay is average compensation (including benefits) earned by all employees outside the group of the most highly compensated executives disclosed in corporate filings with the SEC. Workforce education is the percentage of industry employees with at least a bachelor's degree. Physical capital intensity is net property, plant, and equipment per employee in millions of dollars. Industry concentration is the sales-based Herfindahl index computed over all Compustat firms in the same industry. Industry homogeneity is the mean partial correlation between firm's returns and an equally weighted industry index, for all firms in the same industry, holding market return constant. Workforce unionization is the percentage of unionized industry workers. CEO tenure is in years. CEO incentive alignment is the change in the CEO's firm-specific wealth for each $100 change in the firm's market value. Firm size is the natural log of sales revenue. Leverage is long-term debt divided by total assets. Each regression includes industry and year fixed effects. Industries are defined at the two-digit SIC group level. All continuous variables are winsorized at the first and 99th percentiles. Numbers in parentheses are *p*-values based on robust standard errors corrected for firm-level clustering.

* Levels of significance at 10%.
** Levels of significance at 5%.
*** Levels of significance at 1%.

may well be the dominant effect of higher relative pay. Therefore, we perform additional tests to examine whether the pay differential relative to top executives provide tournament incentives to rank-and-file employees by analyzing instances where such incentives are plausibly stronger.

One such instance is where the firm has fewer employees. If higher relative pay provides tournament incentives to employees, then we should find that such incentives are more meaningful among firms with fewer employees because the probability of winning sequential promotion tournaments is greater at such firms. Thus, we repeat our regressions for firms where the number of employees is fewer than the first quartile, which is 3250 employees. Mean and median number of employees for this sample are 1745 and 1730, respectively. As the first column of Table 8 shows, relative pay is significantly positively related with productivity among these firms, with a *p*-value of 0.043. Its coefficient of 0.071 implies that an increase of 1% in relative pay is associated with an increase of 0.07% in revenue per employee. Since the standard deviation of relative pay for this sample amounts to 150% of its mean, this implies that an increase of one standard deviation in relative pay is associated with an increase of 10.5% in revenue per employee, which is economically non-trivial. For comparison purposes, we also estimate a separate regression for firms where the number of employees is greater than the sample third quartile of 27,650. For this subsample, mean and median number of employees are 85,600 and 57,200, respectively. As the second column of Table 8 shows, relative pay is insignificant in this regression, suggesting that the large number of potential winners nullifies any tournament incentives associated with pay differentials.

Earlier, we argued that the effect of relative pay is moderated by the degree to which employees are informed on executive compensation issues. However, we do not find a significant relation between relative pay and productivity in the subsample of firms whose employees are more informed on CEO pay. Yet the coefficient is positive and the lack of significance is likely attributable to the large number of employees at these firms, with average employees of 46,720. This suggests an additional analysis to further test if pay differentials provide tournament incentives to rank-and-file employees as results in the preceding paragraph suggest. Specifically, relative pay should have a more positive effect among firms with fewer employees when those employees are informed about executive pay compared to when they are uninformed since informed employees would be more cognizant of the potential prize. We test this conjecture by estimating separate regressions for the two subsamples, where in-

formed employees are defined as those at firms whose CEOs were mentioned in news items on executive compensation. As the third column of Table 8 shows, relative pay is positive and significant at the 1% level in the regression estimated over smaller firms whose employees are informed on top management pay. Its coefficient implies that an increase of one standard deviation in relative pay among these firms is associated with an increase of 22.6% in revenue per employee. In contrast, the fourth column of Table 8 shows that relative pay is insignificant in the regression estimated over smaller firms with employees who are less informed on executive pay.

Finally, we examine the moderating role of workforce unionization to provide additional evidence on whether pay differentials offer tournament incentives to rank-and-file employees. In general, unionization increases the importance of non-merit factors such as seniority in employee promotion decisions. Thus, employee unionization should diminish tournament incentives. Consequently, we expect a more positive relation between productivity and relative pay in non-unionized firms with fewer employees if tournament incentives are important. We present results of regressions estimated for non-unionized and unionized smaller firms in the fifth and sixth columns of Table 8, respectively. Here, unionized firms are defined as those operating in industries where the proportion of unionized workers is greater than the sample third quartile (17.8%) while non-unionized firms are defined as those operating in industries where the percentage of unionized employees is lower than the sample first quartile (1.4%). Smaller firms are defined as earlier, that is, those whose employees are fewer than the sample first quartile. Once again, we obtain results that are consistent with tournament incentives. Among non-unionized smaller firms, relative pay is significantly positively related with productivity, with a p-value of 0.041. Its coefficient implies that an increase of one standard deviation in relative pay among these firms is associated with an increase of 13.4% in sales per employee. In contrast, relative pay is not significantly associated with productivity among unionized smaller firms.

Overall, these results suggest that rank-and-file employees do not perceive higher pay ratios as an inequitable outcome to be redressed via costly behaviors (such as shirking) that lower productivity. Even in scenarios where employees are well-informed about executive pay and are reasonably protected by unions against retaliatory managerial actions, we do not observe lower productivity as pay ratio increases. Rather, our results suggest that ordinary employees perceive an opportunity in higher relative executive pay. However, the extent to which such perceived opportunity incentivizes them depends on the likelihood of success in a promotion tournament. Productivity increases with relative pay when the firm has fewer employees who are well-informed on executive pay, and when non-merit factors are less likely to influence promotion decisions. In contrast, relative pay has no effect on employee productivity when there are many employees or when employees are less likely to perceive that promotion decisions are entirely merit-based such as in unionized firms.

4.4. Relative pay and other measures of firm performance

Thus far, we have focused on employee productivity as we examine the effects of the pay differential between rank-and-file employees and top executives. As argued earlier, this choice is predicated on the intuition that employee productivity provides the cleanest test of the effect of relative pay on employee incentives and behavior. Nevertheless, we recognize that other measures of firm performance are more commonly used in the literature in other contexts. Therefore, this section extends our analysis to two other performance measures, that is, Tobin's q and ROA. As in several prior studies, we define Tobin's q as the sum of the market value of common equity, the book value of debt, and the redemption value of preferred equity, divided by the book value of assets. As stated earlier, we define ROA as the ratio of operating income after depreciation to total assets at the end of the preceding year.

Table 9 presents results of regressions using these measures and controlling for standard covariates of firm financial performance. Each regression also includes year and industry (or firm) fixed effects, and standard errors are corrected for firm-level clustering. In the first column, we find a positive and significant relation between relative pay and Tobin's q. This suggests that firm value increases with the ratio of CEO compensation to ordinary employee pay, which is consistent with our earlier finding that ordinary employees do not perceive inter-class inequity in higher pay ratios. The coefficient of relative pay implies that an increase of one standard deviation in CEO–employee pay ratio is associated with an increase of 5.3% in firm value.

Nevertheless, we recognize that a positive association does not imply causation. Therefore, we perform additional tests to provide further evidence on the nature of the relation. In the second column of Table 9, we report results of the regression of Tobin's q on the first lag of relative pay, controlling for the same set of covariates as in the first column. As the table shows, (lagged) relative pay is significantly positively related with firm value. We obtain similar results in untabulated regressions where we employ the second and third lags of relative pay, with p-values of 0.031 and 0.061, respectively. Next, we estimate a regression of the change in Tobin's q on the change in relative pay as reported in the third column. Again, we find that the change in relative pay is positively associated with the change in Tobin's q. We also estimate a regression with firm fixed effects to control for unobservable time-invariant firm characteristics that potentially affect firm value and/or relative pay. The fourth column shows that relative pay remains significantly positively related with firm value in this regression.

Finally, we implement dynamic panel methods by using generalized method of moments (GMM) to estimate a system of equations that express firm value as a function of the covariates in both levels and first differences (Arellano and Bond, 1991; Arellano and Bover, 1995).[12] The levels equation includes the first lag of firm value as an additional regressor, which assuages concerns about reverse causality by allowing past realizations of firm value to affect its current level, essentially conditioning on the history of all explanatory variables. The levels equation also uses lagged first differences of the other regressors as instruments. In contrast, the first differences equation uses the second lagged values of regressors as instruments. By estimating the two equations as a system, system GMM improves the efficiency of estimates while controlling for unobserved heterogeneity, simultaneity, and dynamic endogeneity. As the fifth column of Table 9 shows, we continue to find that relative pay is significantly positively associated with firm value.[13] Together with the other results in the second through fourth columns of Table 9 discussed above, these findings strongly suggest that the positive relation between firm value and relative pay is substantive rather than spurious.

Table 10 reports results of a similar analysis for ROA. In the first column, relative pay is significantly positively related with ROA at less than the 1% level. The second column shows similar

[12] See Wintoki et al. (2012) for an accessible discussion of system GMM estimation.

[13] As noted in Table 9, the Hansen test of over-identification does not reject the null hypothesis that all instruments are valid (p-value = 0.857) while the differences-in-Hansen tests of instrument exogeneity does not reject the null hypothesis that instruments used in the levels equations are exogenous (p-value = 0.992). Furthermore, the Arellano–Bond test for autocorrelation does not reject the null of no second order serial correlation in first-differenced residuals (p-value = 0.340).

Table 9
Relative pay and firm value.

	Full panel	Lagged pay ratio	ΔTobin's *q*	FFE	System GMM
CEO–employee relative pay	0.048**	–	–	0.079***	0.090**
	(0.025)			(0.000)	(0.046)
Lagged relative pay	–	0.050**	–	–	–
		(0.025)			
Change in relative pay	–	–	0.026**	–	–
			(0.034)		
Lagged Tobin's *q*	–	–	–	–	0.745***
					(0.000)
Average employee pay	−0.071	−0.073	0.067**	0.105	0.160
	(0.302)	(0.305)	(0.011)	(0.237)	(0.259)
Workforce education	−0.048	−0.216	−0.236	−0.623	−0.980
	(0.923)	(0.629)	(0.426)	(0.171)	(0.152)
Physical capital intensity	0.330***	0.328***	−0.013	−0.136	0.086
	(0.002)	(0.004)	(0.755)	(0.437)	(0.565)
Industry concentration	−0.761	−0.675	−0.616	0.940	0.895
	(0.344)	(0.481)	(0.117)	(0.203)	(0.258)
Industry homogeneity	−0.732**	−0.806**	0.085	−0.372	−0.095
	(0.014)	(0.011)	(0.672)	(0.230)	(0.793)
Workforce unionization	1.307	1.079	0.689	1.314	−0.817
	(0.221)	(0.421)	(0.324)	(0.181)	(0.632)
CEO tenure	0.001	0.002	0.001	0.003	0.001
	(0.705)	(0.611)	(0.212)	(0.189)	(0.849)
CEO incentive alignment	0.002	−0.002	−0.003*	0.007	−0.013
	(0.658)	(0.658)	(0.058)	(0.185)	(0.255)
Firm size	−0.085***	−0.082***	−0.002	−0.205***	−0.084**
	(0.000)	(0.000)	(0.785)	(0.000)	(0.025)
Leverage	0.280	0.142	−0.028	0.106	−0.290
	(0.212)	(0.537)	(0.706)	(0.607)	(0.414)
Return on assets	0.088***	0.084***	0.003*	0.040***	−0.003
	(0.000)	(0.000)	(0.068)	(0.000)	(0.740)
R&D	17.880***	19.634***	1.296	7.822	6.467
	(0.000)	(0.000)	(0.376)	(0.223)	(0.474)
Constant	1.126*	1.815***	−0.144	1.741***	0.575
	(0.068)	(0.000)	(0.642)	(0.001)	(0.450)
Adjusted R^2	0.714	0.714	0.066	0.869	n.a.
Observations	3022	2584	2555	3022	2555
Unique firms	442	440	439	442	439
Arellano–Bond test for *AR*(1) (*p*-value)					(0.000)
Arellano–Bond test for *AR*(2) (*p*-value)					(0.340)
Hansen test of over-identification (*p*-value)					(0.857)
Difference-in-Hansen tests of exogeneity (*p*-value)					(0.992)

The dependent variable in all but the third column is Tobin's *q*, defined as the market value of common equity plus the book value of debt plus the redemption value of preferred equity, divided by the book value of assets. The dependent variable in the third column is the annual change in Tobin's *q*. CEO–employee relative pay is the natural log of the ratio of the CEO's total compensation to average employee compensation. Average employee pay is average compensation (including benefits) earned by all employees outside the group of the most highly compensated executives disclosed in corporate filings. Workforce education is the percentage of industry employees with at least a bachelor's degree. Physical capital intensity is net property, plant, and equipment per employee in millions of dollars. Industry concentration is the sales-based Herfindahl index computed over all Compustat firms in the same industry. Industry homogeneity is the mean partial correlation between firm's returns and an equally weighted industry index, for all firms in the same industry, holding market return constant. Workforce unionization is the percentage of unionized industry workers. CEO tenure is in years. CEO incentive alignment is the change in the CEO's firm-specific wealth for each $100 change in the firm's market value. Firm size is the natural log of sales revenue. Leverage is long-term debt divided by total assets. Return on assets is the ratio of operating income after depreciation to total assets at the end of the preceding year. R&D is the ratio of research and development expenditures to total assets. The regressions in all but the fourth column include industry and year fixed effects. Industries are defined at the two-digit SIC group level. The regression in the fourth column includes firm and year fixed effects. In the system GMM estimation results, *AR*(1) and *AR*(2) are tests for first-order and second-order auto correlation in the first-differenced residuals, under the null of no auto correlation. Hansen test of over-identification is under the null that all instruments are valid. Difference-in-Hansen tests of exogeneity is under the null that instruments used for the equations in levels are exogenous. All continuous variables are winsorized at the first and 99th percentiles. Numbers in parentheses are *p*-values based on robust standard errors corrected for firm-level clustering.

* Levels of significance at 10%.

** Levels of significance at 5%.

*** Levels of significance at 1%.

results when we use the first lag of relative pay instead of its contemporaneous values. Likewise, the third and fourth columns show that relative pay remains significantly positively related with ROA when we regress the change in ROA on the change in relative pay and when we include firm fixed effects, respectively. Finally, the fifth column shows that the result continues to hold when we employ dynamic panel methods using system GMM.

We also perform additional tests to examine whether the impact of relative pay on firm value and ROA is greater in subsamples where tournament incentives are likely to be stronger. Consistent with this, we find that relative pay is significantly positively related with Tobin's *q* among firms with domestic-only operations (coefficient of 0.060, *p*-value = 0.011) but negative and insignificant among MNCs (coefficient of −0.031, *p*-value = 0.466). Other results are inconclusive, although they are generally in the expected direction. For example, while the coefficient of relative pay in the Tobin's *q* regression estimated over firms with fewer employees who are well-informed on executive compensation is much larger than the one in the regression for firms with fewer but relatively uninformed employees (0.083 vs. 0.022), neither is significant at conventional levels. Coefficients in analogous ROA regressions follow a similar pattern in terms of relative magnitude (1.045 vs. 0.434) and statistical significance.

Table 10
Relative pay and operating performance.

	Full panel	Lagged pay ratio	ΔROA	FFE	System GMM
CEO–employee relative pay	0.933***	–	–	1.209***	1.798***
	(0.000)			(0.000)	(0.001)
Lagged relative pay	–	0.649***	–	–	–
		(0.001)			
Change in relative pay	–	–	0.241**	–	–
			(0.047)		
Lagged ROA					0.570***
					(0.000)
Average employee pay	−0.692	−1.267**	−1.536**	1.006	1.336
	(0.226)	(0.034)	(0.010)	(0.183)	(0.420)
Workforce education	−0.834	−1.985	−1.581	−0.563	−3.028
	(0.830)	(0.626)	(0.697)	(0.877)	(0.608)
Physical capital intensity	1.674*	1.990**	1.352	−0.623	−0.863
	(0.076)	(0.045)	(0.165)	(0.662)	(0.798)
Industry concentration	−14.799***	−15.585**	−15.704**	−15.357**	−6.808
	(0.008)	(0.013)	(0.014)	(0.016)	(0.473)
Industry homogeneity	−3.167	−3.469	−2.938	−1.977	0.894
	(0.210)	(0.225)	(0.300)	(0.465)	(0.842)
Workforce unionization	8.267	9.867	8.397	−7.363	3.194
	(0.348)	(0.381)	(0.459)	(0.361)	(0.892)
CEO tenure	0.025	0.027	0.028	0.033*	0.028
	(0.193)	(0.191)	(0.157)	(0.071)	(0.481)
CEO incentive alignment	0.025	0.010	0.015	0.020	−0.166
	(0.520)	(0.799)	(0.693)	(0.586)	(0.106)
Firm size	−0.631***	−0.468**	−0.216	−0.899**	−1.073***
	(0.002)	(0.029)	(0.219)	(0.047)	(0.009)
Leverage	−9.945***	−10.215***	−10.230***	−5.579*	−4.390
	(0.000)	(0.000)	(0.000)	(0.059)	(0.279)
Constant	11.590**	12.570***	13.894***	5.719	−0.183
	(0.011)	(0.000)	(0.000)	(0.225)	(0.985)
Adjusted R^2	0.321	0.303	0.296	0.609	n.a.
Observations	3022	2584	2555	3022	2555
Unique firms	442	440	439	442	439
Arellano–Bond test for $AR(1)$ (p-value)					(0.000)
Arellano–Bond test for $AR(2)$ (p-value)					(0.797)
Hansen test of over-identification (p-value)					(0.851)
Difference-in-Hansen tests of exogeneity (p-value)					(0.999)

The dependent variable in all but the third column is ROA, defined as the ratio of operating income after depreciation to total assets at the end of the preceding year. The dependent variable in the third column is the annual change in ROA. CEO–employee relative pay is the natural log of the ratio of the CEO's total compensation to average employee compensation. Average employee pay is average compensation (including benefits) earned by all employees outside the group of the most highly compensated executives disclosed in corporate filings. Workforce education is the percentage of industry employees with at least a bachelor's degree. Physical capital intensity is net property, plant, and equipment per employee in millions of dollars. Industry concentration is the sales-based Herfindahl index computed over all Compustat firms in the same industry. Industry homogeneity is the mean partial correlation between firm's returns and an equally weighted industry index, for all firms in the same industry, holding market return constant. Workforce unionization is the percentage of unionized industry workers. CEO tenure is in years. CEO incentive alignment is the change in the CEO's firm-specific wealth for each $100 change in the firm's market value. Firm size is the natural log of sales revenue. Leverage is long-term debt divided by total assets. The regressions in all but the fourth column include industry and year fixed effects. Industries are defined at the two-digit SIC group level. The regression in the fourth column includes firm and year fixed effects. In the system GMM estimation results, $AR(1)$ and $AR(2)$ are tests for first-order and second-order auto correlation in the first-differenced residuals, under the null of no auto correlation. Hansen test of over-identification is under the null that all instruments are valid. Difference-in-Hansen tests of exogeneity is under the null that instruments used for the equations in levels are exogenous. All continuous variables are winsorized at the first and 99th percentiles. Numbers in parentheses are p-values based on robust standard errors corrected for firm-level clustering.

* Levels of significance at 10%.
** Levels of significance at 5%.
*** Levels of significance at 1%.

Overall, results in this section bolster the earlier results for employee productivity. At a minimum, they are inconsistent with the argument that higher ratios of relative CEO-to-employee compensation create perceptions of inequity that distort incentives for rank-and-file workers. Rather, the results suggest that higher pay ratios incentivizes employees toward greater productivity, better operating performance, and improved value creation in certain settings.

4.5. Other tests

Results presented thus far are based on CEO compensation relative to ordinary employee pay. We focus on this variable because much of the discussion on relative employee compensation in the popular press is centered on CEO pay in comparison with rank-and-file worker remuneration. As a robustness check, we re-examine our results using the ratio of average total compensation of NEOs to average employee pay. Results are similar to those obtained with our main variable and are not tabulated due to space considerations.

5. Summary and conclusion

The relative compensation of top executives and lower-level employees has been the subject of intense debate and commentaries in recent times. While the popular press and social activists fixate on the apparent unfairness of CEO compensation that is several times rank-and-file employee pay, economic theory suggests that such differential can either improve, stifle, or be unrelated to employee incentives and performance, depending on whether internal promotion incentives or pay equity and fairness concerns dominate employee actions, or whether workers are informed about and are able or willing to act on information about their CEO's

pay. Our objective is to provide evidence on these issues by analyzing two related topics: the antecedents of CEO–employee pay differential and its effect on employee incentives and performance.

Our results suggest that the pay differential between top executives and ordinary employees is largely determined by the relative bargaining power of workers and executives to negotiate higher pay with the relevant counterparty. The differential is greater when executives enjoy strong bargaining powers vis-à-vis the board and lower when employees are unionized or highly skilled. More importantly, we do not find that a higher pay differential is associated with perverse incentives that manifest in reduced employee productivity and firm performance. Rather, we find a positive productivity effect in settings where tournament incentives are plausibly stronger, such as when the firm has fewer employees who are informed on executive pay or are not unionized.

The recent financial crisis has ignited a fierce and very public debate on corporate compensation structures, with some critics and politicians going as far as calling for legislation to limit CEO–employee pay ratios. We believe such propositions are well-intentioned. Yet our findings suggest that they are likely to impose unintended costs on some classes of firms while not benefiting others. We hope that these results will stimulate additional research into these issues with a view to providing comprehensive evidence that informs sound public policy.

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