# The Information Content of Options Trading for the CEO-Employee Pay Ratio

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## Abstract

This research examines how option trading activity improves the precision of information and reduces information asymmetry. Our findings demonstrate that companies with more options trading activity have a higher CEO-employee pay ratio. There is also an overall positive relation between both CEO's and ordinary employee's awareness of firm value and CEO's and ordinary employee's pay for performance. Employees' understanding of their relevant payment based on the precise firm value, on the other hand, declines in firms with increased physical capital intensity, industrial uniformity, and profitability. Lastly, when the employee has more bargaining power or the CEO's risk incentive is stronger, the positive relation between options' information contents and CEO-employee pay ratio weakens.

**Keywords**: Price informativeness; CEO-employee pay ratio; Options volumes; Employee's bargaining power.

**JEL Classification**: G14.

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## 1. Introduction

The higher pay inequality/relative wage difference between a chief executive officer (CEO) and rank-and-file employees has seen growing concern from both academia and practice. Regulators and stock market investors have debated about whether high pay inequality results in poor firm performance due to the high pay disparities inside a company, which can hurt employee morale and productivity. Based on this argument, the U.S. Securities and Exchange Commission (SEC) in August 2015 followed new legislation passed by the U.S. Congress, the Dodd-Frank Act, requiring all firms to release their CEO-employee pay ratio. However, related studies have not fully supported these debates.[1]

There are two theories with different perspectives (tournament and equity fairness) that express the opposing effect of pay disparity on firm performance. According to the tournament theory, pay disparity improves firm performance, because of the increase in managers' incentives. Goel and Thakor (2008) indicate that the CEO as a player in the tournament will increase her/his performance to win the promotion prize, which will result in more risk-taking behavior by the CEO, as Kini and Williams (2012) point out the positive relation between pay disparity and firm risk. In contrast to the tournament model, the equity fairness theory documents a negative relation between pay disparity and firm performance such as product quality (Cowherd and Levine, 1992) and employee turnover (Wade, O'Reilly and Pollock, 2006).

Using a proprietary dataset in which employee pay is observed at the firm-job title-year level, Mueller, Ouimet and Simintzi (2017) indicate that the difference in pay inequity within firms reflects differences in managerial talent. They further show that

[1] Cowherd and Levine (1992) indicate that lower pay inequality denotes higher product quality, which means a lower CEO-employee pay ratio leads to employees working harder. Crawford, Nelson, and Rountree (2014) use compensation data from the bank industry and find a concave relation between the pay ratio and future operating performance. Cheng, Ranasinghe and Zhao (2017) challenge the notion that high CEO pay ratios are on average harmful to firms, because their results show them to be positively related to both firm value and performance.

the pay inequality is positively associated with firms' operating performance and valuation assessed by the managerial rent extraction story. To distinguish the incentive provision from managerial talent, they find that some firm characteristics such as firms with large capitalization belonging to more competitive industries and having better governance exhibit more significance of this phenomenon. Mueller et al. (2017) provide determinants of pay inequality regarding the managerial-level perspective, while Faleye, Reis and Venkateswaran (2013) investigate the determinants of the pay ratio in regards to both managerial and rank-and-file employee levels. They similarly find that pay inequity positively influences the top managerial level. Faleye et al. (2013) find that pay inequity also has a positive effect on the ordinary employee level, because workers perceive an opportunity via a higher pay ratio that incentivizes them to "fight for the prize".

No matter what viewpoint related studies take, there is a common question over whether both top management and ordinary employees should have accurate price information that guides them to realize firm performance and valuation. We study this question in line with the information content of a firm's stock options trading, which offers extended answers to those two competing theories. Based on the tournament theory, accurate price information helps top management to realize whether corporate decisions are appropriate or not (Khanna, Slezak and Bradley, 1994; Dow and Gorton, 1997; Subrahmanyam and Titman, 1999; Chen, Goldstein and Jiang, 2007; Foucault and Gehrig, 2008) or the bargaining power of compensation (Gorton, Huang and Kang, 2016; Kang and Liu, 2008).

Based on equity fairness, as Faleye et al. (2013) mention, productivity improves when ordinary employees are well-informed about the pay ratio, but seem to perceive an opportunity for a higher pay ratio according to firm performance and value. Therefore, we expect that a firm with more price efficiency provides less asymmetric

information on all aspects of employees, and that ordinary employees have more bargaining power for their compensation regarding their firm's valuation.

Prior research indicates that options contain private information conveyed by prices no matter for theoretical or empirical studies (e.g., Cao, 1999; Pan and Poteshman, 2006; Roll, Schwartz and Subrahmanyam, 2009). Enhanced informational options may even push higher market valuations, meaning that if prices release more information, then corporate resources can be allocated more efficiently, leading to higher firm values (Khanna et al. 1994; Subrahmanyam and Titman, 1999). Cao (1999) provides additional evidence that informed options trading reveals more information, leads to reduced investment risk in the underlying asset, and hence tends to increase the asset's price.

Earlier studies suggest that the information quality available to investors rises when an option is listed (Skinner, 1990; Ho, Hassell, and Swidler, 1995). These studies imply that options can reduce information asymmetry and improve information quality, thus leading to lower expected returns by stock investors.[2] Roll et al. (2009) indicate that option activity reveals more information and thus influences firm value. Naiker, Navissi, and Truong (2013) note that options trading enhances informational efficiency and results in a lower cost of equity. Blanco and Wehrheim (2017) find that options trading can positively affect a firm's innovation (patent), because better informational efficiency from options trading leads to an improved allocation of corporate resources. Based on prior studies, we know that the existing literature suggests that firms with more options trading should be valued higher.

The survey papers of Murphy (1999) and Core, Guay, and Larcker (2003), mainly

[2] Lambert, Leuz, and Verrecchia (2012) present that the information risk effect on share prices is not due to information asymmetry and information precision. However, their framework still finds that options trading is negatively associated with the cost of equity capital.

based on U.S. studies, show that the most widely accepted evidence is positive and is driven by CEO equity-based incentives (Hall and Liebman, 1998).[3] Bergstresser and Philippon (2006) also indicate that high pay-performance sensitivity leads managers to exhibit higher levels of earnings management. Based on prior studies as mentioned above, we therefore consider the effect of options on prices and further discuss how they influence firms' incentives toward the CEO-employee pay ratio. This study looks to link the relation between options trading and price information efficiency to the CEO-employee pay ratio.

The first stage of the empirical results provides evidence that options volume positively correlates with the CEO-employee pay ratio, as calculated by Roll et al. (2009) and Faleye et al. (2013), respectively. The results are consistent with prior studies' arguments (Roll et al., 2009; Blanco and Wehrheim, 2017; Gorton, Huang and Kang, 2016; Kang and Liu, 2008).

The second stage of the empirical investigation provides further evidence for how physical capital intensity, industrial homogeneity, and labor unionization affect the relation between options trading activities and CEO-employee pay ratio. We use these three measures to proxy for an employee's bargaining power (Parrino, 1997; Hillary, 2006; Faleye et al., 2013). Faleye et al. (2013) argue that an employee's bargaining power can directly impact the CEO-employee pay ratio. Following this line of thought, we find that an employee's higher bargaining power mitigates the effect of options trading on the CEO-employee pay ratio.

We finally consider how a firm's profitability and the CEO incentive impact such a relation. Blanco and Wehrheim (2017) find that the effects of options trading exhibit

[3] Very few studies do not find a positive relationship or even find opposite results. In the literature, most prior studies support the positive association between CEO compensation and firm performance.

more positive sensitivity for firms with lower profitability, because options trading can mitigate managers' greater risk of being fired when their firm has lower performance in the short term. In this case, managers are willing to invest in R&D when information is more efficient (more options trading). Our results also support this argument that options trading significantly affects the CEO-employee pay ratio when firms have lower performance. In addition, most studies argue that a CEO holding more options may present higher risk-taking incentives. Following Coles, Daniel and Naveen (2006), we consider the CEO option holdings vega as a primary characteristic of compensation[4] and find that if managers have higher risk-taking incentives, then higher options activities lead to a reduced effect of options trading. This is consistent with the argument of Shen and Zhang (2013), who find that a higher vega might lead managers to invest in more inefficient R&D investments and destroy firm performance.

The paper continues as follows. Section 2 develops the hypotheses. Section 3 discusses the data and summary statistics. Section 4 describes the empirical methodology. Section 5 presents the empirical results. The last section offers concluding remarks.

## 2. Hypotheses' development

Prior studies indicate that the options market is a more effective channel for investors to release their private information and thus enhance market efficiency (Roll et al., 2009; Naiker et al., 2013; Blanco and Wehrheim, 2017). Roll et al. (2009) suggest that higher options trading implies higher firm value, because options reveal more information and allows corporates to allocate resources more efficiently. Naiker et al. (2013) find a lower implied cost of equity capital when firms list options. Blanco and

[4] Vega is defined as the dollar change in a CEO's option holdings from a 1% change in stock return volatility.

Wehrheim (2017) indicate that options can improve the allocation of corporate resources and informational efficiency, leading companies to have higher patents and citations. We know that most studies support that options activities are good for firms. If options let price information be more efficient, then a CEO can make better decisions and obtain better firm performance (Chen et al., 2007; Foucault and Gehrig, 2008). Based on the positive CEO pay-performance relationship (Murphy, 1999; Core et al., 2003), we therefore conjecture that options activities may affect CEO pay and state our first hypothesis.

**Hypothesis 1**: *Options trading positively affects the CEO-employee pay ratio.*

Earlier studies point out that managers have an incentive to lower their firm's perceived ability to project a negative picture when they face a labor union's wage demand, including a cut in dividends (DeAngelo and DeAngelo, 1991), managing earnings downward (DeAngelo and DeAngelo, 1991), strategically choosing accounting methods (D'Souza, Jacob, and Ramesh, 2000; Cullinan and Bline, 2003), holding less cash (Klasa, Maxwell, and Ortiz-Molina, 2009), and missing analysts' forecasts (Bova, 2013). Faleye et al. (2013) find that employee bargaining power negatively affects the CEO-employee pay ratio. Workers cannot be easily replaced when the workforce is highly skilled or unionized. In this case, ordinary employees have higher bargaining power and can negotiate with management. Hillary (2006) and Chung et al. (2016) find a positive relationship between labor union strength and information asymmetry. These studies argue that firm management does not change information asymmetry over outsiders when companies face organized labor. In addition, firms have an incentive to adjust earnings management when they have higher labor bargaining power.

One advantage of options is the increase in price information efficiency, but prior

studies indicate that a stronger labor union leads to imprecise information. We therefore conjecture that employee bargaining power negatively affects the relationship between options activities and the CEO-employee pay ratio and build the second hypothesis.

**Hypothesis 2**: *The positive relation between options trading and CEO-employee pay ratio is weaker for firms with higher employee bargaining power.*

Blanco and Wehrheim (2017) argue that options trading activities can shield managers who face the risk of being fired due to short-term market pressures, especially for firms with a decline in profitability. Smith and Watts (1992) find that information asymmetry is more severe for firms with significant growth opportunities. Under a similar argument, if firms have a higher profitability to reduce information efficiency and hence lead to imprecise information, then we formulate the next hypothesis as follows.

**Hypothesis 3**: *The positive relation between options trading and the CEO-employee pay ratio is weaker for firms with higher firm performance.*

Shen and Zhang (2013) present that firms with higher CEO vega induce managers to invest in more inefficient R&D projects that destroy firm performance. Kini and Williams (2012) indicate that pay disparity positively relates to firm risk. If higher vega induces lower firm performance, then we expect that CEOs may have lower pay based on a positive CEO pay-performance nexus. We therefore suggest that the effect of options trading on the CEO-employee pay ratio turns weaker when firms have a higher vega. However, Blanco and Wehrheim (2017) find that a higher vega denotes more innovative outputs (patents). Shen and Zhang (2018) present that the CEO pay gap can enhance innovative efficiency, because higher tournament incentives lead managers to

invest in more efficient R&D projects. A higher vega also leads to greater CEO compensation when she/he holds more stock options. We therefore develop two alternative hypotheses as follows.

**Hypothesis 4a**: *The positive relation between options trading and the CEO-employee pay ratio is weaker for firms with a higher CEO vega.*

**Hypothesis 4b**: *The positive relation between options trading and the CEO-employee pay ratio is stronger for firms with a higher CEO vega.*

## 3. Data and descriptive statistics

The primary dataset we use includes stock option quotes and volumes, and we also measure the CEO-employee pay ratio. The sample period runs from January 1996 to December 2015. The stock options data are from the OptionMetrics database, including daily closing call and put option volumes.[5] Following Roll et al. (2009), we utilize the options' total annual dollar volume classified by all maturity and moneyness, multiply this by each option's total traded amount by the end-of-day quote's midpoint for that option, and then annually aggregate this number across all trading days. The CEO-employee pay variable is defined as total CEO compensation (Execucomp data item TDC1) divided by ordinary employee pay.[6] Total CEO pay compensation includes a CEO's salary, bonus, other annul pay, total value of restricted stock in the granted year, long-term incentive payouts, and all other compensation. Ordinary employee pay is the ratio of average labor expenses minus total top executive compensation to the number of employees. The employees' pay compensation and the number of employees are obtained from the Compustat database and ExecuComp database, respectively.

[5] All of the stock options are American style.
[6] For a given year, we obtain the compensation data from the Execucomp database.

We also consider several control variables in our study and compute the following firm characteristic variables and their data from the Compustat database: Sale is a firm's annual sales; Capex/Asset (CAPX_A) is the ratio of capital expenditure to total assets; Leverage is the ratio of total debt to total assets; CEO Tenure is the number of years that the current CEO has worked as a CEO in the firm, which is collected from the Execucomp database; and CEO Age is the CEO's age in a specific year.

<TABLE 1 ABOUT HERE>

Table 1 exhibits summary statistics for both the dependent and independent variables used in this study, including the 10%, 50%, and 90% percentiles, means, and standard deviations.

**4. Model specification**

This study focuses on how options trading affects the CEO-employee pay ratio. We therefore use the following model to examine our issue:

$$Ln(CEO-employee\ pay)_{i,t} or\ Ln(NEO-employee\ pay)_{i,t} = a_{0,t} + \beta_{1,t}Ln(OPTVOL) + \beta_{2,t}Ln(Sale) + \beta_{3,t}Leverage + \beta_{4,t}CAPX\_A + \beta_{5,t}Ln(CEO\ Age) + \beta_{6,t}CEO\ Tenure + Year\ dummy + Industry\ dummy + \varepsilon_{i,t}, \quad (1)$$

where Ln(CEO-employee pay) is the logarithm of total CEO compensation over ordinary employee pay; Ln(NEO-employee pay) is the logarithm of total top executive compensation (excluding CEO) over ordinary employee pay; Ln(OPTVOL) is the natural logarithm of the annual options volume; and Ln(Sale) is the natural logarithm of a firm's sales. Leverage is defined as the ratio of total debt to total assets. CAPX_A is the ratio of capital expenditure to total assets. CEO Tenure is the number of years

that the current CEO has worked as a CEO in the firm. Ln(CEO Age) is the logarithm of the CEO's age in a specific year. We also control the two-digit industry dummy and year dummy.

We re-run the regression model to consider the effect of employee bargaining power, which tests Hypothesis 2. Following Faleye et al. (2013), we use physical capital intensity, industry homogeneity, and labor unionization as proxies for employee bargaining power. The model is:

$$Ln(CEO - employee\ pay)_{i,t} or Ln(NEO - employee\ pay) = a_{0,t} + \beta_{1,t}Ln(OPTVOL) + \beta_{2,t}EBP_m + \beta_{3,t}Ln(OPTVOL) \times EBP_m + \beta_{4,t}Ln(Sale) + \beta_{5,t}Leverage + \beta_{6,t}CAPX_A + \beta_{7,t}Ln(CEO\ Age) + \beta_{8,t}CEO\ Tenure + Year\ dummy + Industry\ dummy + \varepsilon_{i,t,} \quad (2)$$

where $EBP_m$ denotes the employee bargaining power measures; and m presents physical capital intensity, industry homogeneity, or labor unionization.

We follow Blanco and Wehrheim (2017) and Shen and Zhang (2018) to consider the effect of firm profitability and CEO vega, respectively. Next, we replace EBP with change in industry-adjusted stock return, industry-adjusted ROE, and CEO vega in Eq. (2) of the regression model to test Hypotheses 3, 4a, and 4b.

## 5. Empirical results

This section examines how options trading affects the CEO-employee pay ratio. Section 5.1 presents our baseline results and considers the regression model with/without CEO pay. To strengthen our findings, Section 5.2 discusses the endogeneity issue to robust our preliminary results. We then explore the potential channels driving our findings. Section 5.3 considers employee bargaining power.

Section 5.4 and Section 5.5 analyze how a firm's profitability and CEO vega affect the relationship between options trading and CEO-employee pay ratio, respectively.

### 5.1 Preliminary results

Table 2 presents the results of the baseline model Eq. (1). Columns 1 through 4 report regression results with the dependent variable based on different types of CEO compensation and top executives' compensation (NEO) relative to employee pay. All columns in Table 2 have positively significant coefficient estimates on Ln(Optvol) except for CEO cash pay.

We first show the main results in column 1 and consider the effect of options trading on Ln( CEO total pay) with controls for Ln(Sales), Leverage, CAPX_A, Ln(CEO Age), CEO Tenure, two-digit industry dummies, and year dummies. We find that a positive and significant association exists between CEO total pay relative to employee pay and options volume, which is consistent with our expectation. Columns 2 and 3 consider CEO cash pay relative to employee pay and CEO long-term pay relative to employee pay, respectively.[7] We also find a positive relation, but the significance weakens. In column 4 the dependent variable is top executives' compensation (NEO) relative to employee pay. We find that options trading volumes also positively influence NEO total pay at the 1% level.

In sum, no matter which type of CEO compensation we use, we find that options trading volumes positively impact the CEO-employee pay (NEO-employee pay) ratio, thus supporting Hypothesis 1. Our findings are also consistent with the arguments of Roll et al. (2009), who point out that options volumes enhance information efficiency and hence lead to a more efficient allocation of firms' resources. Roll et al. (2009)

[7] CEO long-term pay includes long-term incentive payouts, restricted options grants, and stock grants. CEO cash pay includes bonus, salary, and other annual payments.

support that higher options volumes induce higher firm value. Blanco and Wehrheim (2017) also indicate that options volumes help managers make efficient decisions. Therefore, our results not only confirm previous studies' findings, but also provide new evidence on the CEO-employee pay ratio.

<TABLE 2 ABOUT HERE>

### 5.2 The endogeneity issue for option volume

In order to solve endogeneity concerns between option volumes and CEO-employee pay (Abernethy, Bouwens, and Van Lent, 2004; Aboody, Barth, and Kasznik, 2004), we re-run our analysis for the impact of option volumes on CEO-employee pay using a two-stage least squares regression model (2SLS). As Roll et al. (2009) point out that open interest is an exogenous variable to the relationship between CEO-employee pay (NEO-employee pay) and options volume,[8] we therefore use it as an instrumental variable to mitigate endogeneity concerns in this study.

In the first-stage regression, we regress average open interest on the instrumental variable, option volumes, and all other control variables in the second-stage regression. Columns 1 and 2 in Table 3 show the results of first-stage regression and find that the coefficient of the instrument for average open interest is significantly positive, which is consistent with our expectation. Columns 3 and 4 in Table 3 report the second-stage regressions results. The coefficients of the instrumented option volumes in Columns 3 and 4 are all positively significant, meaning that the positive relation between option volumes and CEO-employee pay (NEO-employee pay) is robust when we further control for the potential endogeneity problem.

<TABLE 3 ABOUT HERE>

[8] We focus our analysis on total open interest. An untabulated table shows similar results when we use moneyness as an alternative instrumental variable (Roll et al., 2009).

### 5.3 Interaction between physical capital intensity, industry homogeneity, and labor unionization

We next consider what the impact is for employee productivity or employee bargaining power on the relation between options trading and the CEO-employee pay ratio. We consider three measures to examine this effect (Faleye et al., 2013). First, we use physical capital intensity as a measure to capture the efficiency of employee productivity. Second, we construct an industry homogeneity measure following Parrino (1997), who examines the level of the relation between firms in an industry and competition. Higher levels imply that firms in an industry have greater competition. Third, we use labor unionization to capture employees' bargaining power (Freeman and Medoff, 1984), because unions can help facilitate better communication between management and employees and thus improve efficiency.[9] If options trading activity indeed can enhance CEO-employee pay, then this pay ratio should decrease when we improve employees' working efficiency and their bargaining power. We then expect a negative effect on the relation between options trading and the CEO-employee pay ratio.

<TABLE 4 ABOUT HERE>

Column 1 of Table 4 shows a negatively significant coefficient estimate of the interaction between options volume and physical capital intensity (significant at the 5% level), while the major effect of options trading remains positively significant at the 1% level. The results are similar when we consider the NEO-employee pay ratio in the second column of Table 4.

<TABLE 5 ABOUT HERE>

Table 5 exhibits results of regressions using the industry homogeneity measure. In column 1, we find that higher industry homogeneity has a negative effect on the relation

[9] Baldwin (1983) mentions that unions may use their bargaining power to facilitate self-interested pursuits.

between options trading and the CEO-employee pay ratio, but the effect is not significant when we consider the NEO-employee pay ratio in column 2. One possible explanation is that higher industry homogeneity leads to management finding it easier to replace workers. In this case, employees put forth greater effort to keep their competitive jobs and hence exhibit better productivity (Faleye et al., 2013). Our results support the finding of Faleye et al. (2013), who show that higher industry homogeneity denotes greater revenue per employee.

<TABLE 6 ABOUT HERE>

Table 6 reports the results associated with the interaction between options volume and labor unionization. To measure labor unionization, we use the unionization rate multiplied by labor intensity (Hillary, 2006).[10] The interaction term between options volume and labor unionization is negatively significant at the 5% level.[11] This implies that options trading indeed enhances the CEO-employee pay ratio, but if we consider employee bargaining power, then this relation decreases.

In sum, our results support that employee bargaining power does mitigate the positively relationship between options trading and the CEO-employee pay ratio. This result supports Hypothesis 2.

### 5.4 Interaction with firm profitability

We further analyze how firms' profitability impacts the relation between options volumes and the CEO-employee pay ratio. Kothari (2001) indicates that financial reporting reveals information of firm performance to outsiders and further influences

[10] Labor unionization data are from the Union Membership and Coverage Database, which is constructed and maintained by Barry Hirsch and David Macpherson (http://unionstats.gsu.edu/). The unionization rate is defined as the percentage of employed laborers who are members of a union, and labor intensity is the number of employees scaled by a firm's total assets.

[11] We also use the percentage of employed laborers who are members of a union (unionization rate) to examine our analysis. The untabulated table finds similar results when we use the unionization rate multiplied by labor intensity.

stock prices and market expectations. Thus, managers are concerned about their firms' performance in the short-term period, because poor performance will lead to a greater risk of being fired (Jenter and Lewellen, 2014). We therefore expect that if options trading activity can reduce managers' risk of being fired and short-term market pressures, then there should be a positive effect on options trading when firms show a decline in profitability.

There is a negatively significant coefficient on this interaction no matter if the firms' profitability measure is lagged change in industry-adjusted stock return or industry-adjusted ROE (Correa and Lel, 2016; Banker, Darrough, Huang, and Plehn-Dujowich, 2012). It suggests that options trading more strongly affects the CEO-employee pay ratio when firms have lower profitability growth, thus supporting Hypothesis 3.

<TABLE 7 ABOUT HERE>

### 5.5 Interaction with CEO vega

Based on the findings of Blanco and Wehrheim (2017), options trading activity can reduce managers' short-run pressures and help them and their firm turn out more patents and patent citations per dollar invested in research and development (R&D). However, a CEO may have higher risk-taking incentives when she/he holds more options.[12] In this case, a higher vega might lead to managers overinvesting in inefficient R&D projects (Shen and Zhang, 2013). Furthermore, Kini and Williams (2012) find that pay disparity positively relates to firm risk. We therefore expect that if options trading activity can reduce managers' risk of being fired, then there should be a positive effect on options trading when firms have a lower CEO vega. The coefficient of the interaction term is negatively significant at the 5% level, suggesting that the effect of options

[12] CEO vega data are obtained from the Lalitha Naveen website (http://sites.temple.edu/lnaveen/data/).

trading on the CEO-employee pay ratio is more pronounced when firms' CEO vega is lower. We find that the results support Hypothesis 4a rather than Hypothesis 4b.

<TABLE 8 ABOUT HERE>

## 6. Conclusions

How do financial derivatives impact the CEO-employee pay ratio? This research answers this question by studying the relationship between options markets and the CEO-employee pay ratio and showing that this ratio is greater under higher options trading activity. These findings suggest that options trading can enhance information efficiency and help managers to decide on investment projects or for boards of directors to monitor CEO performance and hence influence CEO pay. Our findings support the arguments of Roll et al. (2009), who find that options trading reveals more information and induces higher firm valuations. Our results support their claims, provide direct evidence to link options trading activity and CEO-employee pay ratio, and suggest that firms with larger options volumes correlate to higher efficient information and improve the allocation of their resources, thus translating into higher CEO pay.

This research provides several possible channels to confirm our arguments. First, we present that higher employee productivity or higher employee bargaining power reduces the influence of options trading on the CEO-employee pay ratio. Second, we provide evidence that options trading positively affects the CEO-employee pay ratio when firms have lower profitability. Finally, we show that if the CEO holds more options (higher risk-taking incentives), then this may lead to inefficient investments and hence mitigate the effects of options activities on the CEO-employee pay ratio.

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## Table 1 Summary statistics

This table reports summary statistics for variables constructed based on the sample of U.S. publicly-traded firms from 1996 to 2015. CEO total pay is defined as total CEO compensation. NEO is non-CEO top executive compensation. CEO long-term pay includes long-term incentive payouts, restricted stock grants, and options grants. CEO cash pay includes salary, bonus, and other annual payments. Ordinary employee pay is the ratio of average labor expenses minus total top executive compensation to the number of employees. Relative pay variables are constructed by the different types of CEO compensation and divided by ordinary employee pay. Option volume is the total annual dollar volume of options. Sale is a firm's annual sales. CAPX_A is the ratio of capital expenditure to total assets. Leverage is the ratio of total debt to total assets. CEO Tenure is the number of years that the current CEO has worked as a CEO in the firm. CEO Age is CEO's age in a specific year.

| Variable | P10 | P50 | P90 | Mean | SD |
|---|---|---|---|---|---|
| CEO-employee relative pay (total) | 11.763 | 39.084 | 163.914 | 73.508 | 119.854 |
| CEO-employee relative pay (cash) | 4.913 | 12.146 | 44.747 | 19.767 | 24.229 |
| CEO-employee relative pay (L-T) | 0.000 | 0.405 | 15.103 | 6.123 | 20.912 |
| NEO-employee relative pay (total) | 29.752 | 86.750 | 373.892 | 169.681 | 290.628 |
| NEO-employee relative pay (cash) | 14.641 | 32.960 | 125.095 | 56.324 | 68.424 |
| NEO-employee relative pay (L-T) | 0.000 | 1.095 | 36.035 | 15.952 | 57.781 |
| Ordinary employee total pay | 36.578 | 68.948 | 174.883 | 90.194 | 75.317 |
| Option volume (in million $) | 0.001 | 0.041 | 2.871 | 1.962 | 8.938 |
| Sale | 322.129 | 1427.764 | 15820.000 | 6355.318 | 14827.012 |
| Leverage | 0.002 | 0.091 | 0.335 | 0.136 | 0.148 |
| CAPX_A | 0.001 | 0.011 | 0.118 | 0.040 | 0.060 |
| CEO Tenure | 2.000 | 8.000 | 22.000 | 10.241 | 8.215 |
| CEO Age | 51.000 | 61.000 | 72.000 | 61.279 | 7.788 |

## Table 2 Options volume and CEO-employee pay ratio

This table presents four regressions of options trading volume on different types of CEO compensation relative to employee pay. CEO total pay is defined as total CEO compensation. NEO is non-CEO top executive compensation. CEO long-term pay includes long-term incentive payouts, restricted stock grants, and options grants. CEO cash pay includes salary, bonus, and other annual payments. Ordinary employee pay is the ratio of average labor expenses minus total top executive compensation to the number of employees. Ln(OPTVOL) is the natural logarithm of the total annual dollar volume of options. Ln(Sale) is the natural logarithm of a firm's annual sales. Leverage is total debt divided by total assets. CAPX_A is the ratio of capital expenditure to total assets. CEO Tenure is the number of years that the current CEO has worked as a CEO in the firm. Ln(CEO Age) is the logarithm of the CEO's age in a specific year. The full sample period is January 1996 to December 2015. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. All t-statistics are two-way clustered standard errors, clustered by firm.

| | Dependent variable = | | | |
|---|---|---|---|---|
| | Ln(CEO total pay) | Ln(CEO cash pay) | Ln(CEO LT pay) | Ln(NEO total pay) |
| | (1) | (2) | (3) | (4) |
| Ln(OPTVOL) | 0.0460 | 0.0069 | 0.0700 | 0.0456 |
| | (3.10)*** | (0.57) | (1.85)* | (3.66)*** |
| Ln(sale) | 0.2583 | 0.1012 | 0.1366 | 0.3092 |
| | (7.89)*** | (3.65)*** | (1.76)* | (11.16)*** |
| Leverage | 0.7130 | 0.2179 | 0.8228 | 0.5830 |
| | (3.51)*** | (1.02) | (2.43)** | (3.25)*** |
| CAPX_A | -0.3251 | -0.2280 | -4.0035 | 0.2993 |
| | (-0.54) | (-0.45) | (-2.68)*** | (0.54) |
| Ln(CEO Age) | 1.0620 | 1.0901 | 2.0137 | 0.2500 |
| | (2.98)*** | (4.12)*** | (2.93)*** | (0.97) |
| CEO Tenure | 0.0110 | 0.0146 | 0.0109 | -0.0097 |
| | (2.57)** | (3.93)*** | (1.39) | (-3.38)*** |
| Constant | -1.2628 | -0.5941 | -6.8906 | 3.1940 |
| | (-0.89) | (-0.56) | (-2.49)** | (3.14)*** |
| Year fixed effect | YES | YES | YES | YES |
| Industry fixed effect | YES | YES | YES | YES |
| Observations | 4,845 | 4,845 | 4,845 | 4,845 |
| Adjusted $R^2$ | 0.5272 | 0.4840 | 0.3877 | 0.6307 |

Table 3 Results by the two-stage least-square regression for option volumes

This table shows regression results of 2SLS for options volume (OPTVOL) on firms' CEO-employee pay ratio, and other control variables are the same as those in Table 2 with the natural logarithm of the average open interest as an instrumental variable. All regressions include year dummies and two-digit SIC code industry dummies. The full sample period is January 1996 to December 2015. T-statistics are based on two-way clustered standard errors, clustered by firm. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

| | OLS (first stage) | | 2SLS (two stage) | |
|---|---|---|---|---|
| Dependent variable | Ln(OPTVOL) | | Ln(CEO total pay) | Ln(NEO total pay) |
| | (1) | (2) | (3) | (4) |
| Ln(OPTVOL) | | | 0.0604 | 0.1150 |
| (Instrumented) | | | (2.49)** | (4.19)*** |
| Ln(sale) | 0.8307 | 0.8023 | 0.2372 | 0.2137 |
| | (15.33)*** | (13.05)*** | (5.57)*** | (4.73)*** |
| Leverage | 0.0544 | -0.4326 | 0.7555 | 0.3884 |
| | -0.1500 | (-1.07) | (3.71)*** | (1.78)* |
| CAPX_A | 2.5754 | 2.9409 | -0.3934 | -0.5878 |
| | (2.18)** | (2.87)*** | (-0.66) | (-0.98) |
| Ln(CEO Age) | 0.1140 | -0.3616 | 1.0447 | -0.2105 |
| | -0.2000 | (-0.55) | (2.93)*** | (-0.61) |
| CEO Tenure | 0.0032 | -0.0005 | 0.0110 | -0.0055 |
| | -0.4200 | (-0.05) | (2.55)** | (-1.46) |
| Ln(Open interest) | 1.1087 | 1.0522 | | |
| | (20.11)*** | (14.62)*** | | |
| Constant | -0.6574 | 1.8761 | -1.1918 | 5.0504 |
| | (-0.29) | (0.72) | (-0.84) | (3.65)*** |
| Year fixed effect | YES | YES | YES | YES |
| Industry fixed effect | YES | YES | YES | YES |
| Observations | 4,845 | 4,845 | 4,845 | 4,845 |
| Adjusted $R^2$ | 0.8230 | 0.8250 | 0.5310 | 0.5960 |

## Table 4 Interaction with physical capital intensity

This table presents two regressions of CEO-employee pay ratio and NEO-employee pay ratio on options trading volume and the interaction term. Physical capital intensity is net property, plant, and equipment per employee in millions of dollars. Ln(OPTVOL) is the natural logarithm of the total annual dollar volume of options. Ln(Sale) is the natural logarithm of a firm's annual sales. Leverage is total debt divided by total assets. CAPX_A is the ratio of capital expenditure to total assets. CEO Tenure is the number of years that the current CEO has worked as a CEO in the firm. Ln(CEO Age) is the logarithm of CEO's age in a specific year. The full sample period is January 1996 to December 2015. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. All t-statistics are two-way clustered standard errors, clustered by firm.

| Dependent variable | Ln(CEO total pay) | Ln(NEO total pay) |
|---|---|---|
| | (1) | (2) |
| Ln(OPTVOL) | 0.0517 | 0.0472 |
| | (3.35)*** | (3.63)*** |
| Physical capital intensity | 0.6399 | 0.6811 |
| | (2.19)** | (2.10)** |
| Ln(OPTVOL)* | -0.0590 | -0.0559 |
| Physical capital intensity | (-2.31)** | (-1.97)** |
| Ln(sale) | 0.2571 | 0.3148 |
| | (7.73)*** | (11.29)*** |
| Leverage | 0.6910 | 0.5837 |
| | (3.36)*** | (3.19)*** |
| CAPX_A | -0.1510 | 0.2962 |
| | (-0.24) | (0.56) |
| Ln(CEO Age) | 1.0020 | 0.1900 |
| | (2.80)*** | (0.73) |
| CEO Tenure | 0.0113 | -0.0094 |
| | (2.59)** | (-3.25)*** |
| Constant | -0.9385 | 3.4789 |
| | (-0.66) | (3.37)*** |
| Year fixed effect | YES | YES |
| Industry fixed effect | YES | YES |
| Observations | 4,845 | 4,845 |
| Adjusted $R^2$ | 0.5295 | 0.6316 |

## Table 5 Interaction with industry homogeneity

This table presents two regressions of CEO-employee pay ratio and NEO-employee pay ratio on options trading volume and the interaction term. Industry homogeneity is the mean partial correlation between a firm's returns and an equally-weighted industry index, for all firms in the same industry, holding market returns constant. Ln(OPTVOL) is the natural logarithm of the total annual dollar volume of options. Ln(Sale) is the natural logarithm of a firm's annual sales. Leverage is total debt divided by total assets. CAPX_A is the ratio of capital expenditure to total assets. CEO Tenure is the number of years that the current CEO has worked as a CEO in the firm. Ln(CEO Age) is the logarithm of CEO's age in a specific year. The full sample period is January 1996 to December 2015. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. All t-statistics are two-way clustered standard errors, clustered by firm.

| Dependent variable | Ln(CEO total pay) | Ln(NEO total pay) |
|---|---|---|
| | (1) | (2) |
| Ln(OPTVOL) | 0.0473 | 0.0452 |
| | (5.52)*** | (5.55)*** |
| Industry homogeneity | 0.1451 | 0.0352 |
| | (3.02)*** | (0.94) |
| Ln(OPTVOL)* | -0.0051 | 0.0023 |
| Industry homogeneity | (-2.01)** | (0.87) |
| Ln(sale) | 0.2566 | 0.3096 |
| | (14.92)*** | (17.27)*** |
| Leverage | 0.7070 | 0.5900 |
| | (6.21)*** | (6.52)*** |
| CAPX_A | -0.3300 | 0.3038 |
| | (-0.90) | (0.89) |
| Ln(CEO Age) | 1.0585 | 0.2461 |
| | (6.43)*** | (2.21)** |
| CEO Tenure | 0.0112 | -0.0097 |
| | (6.87)*** | (-6.35)*** |
| Constant | -1.2439 | 3.2159 |
| | (-1.86)* | (7.42)*** |
| Year fixed effect | YES | YES |
| Industry fixed effect | YES | YES |
| Observations | 4,845 | 4,845 |
| Adjusted $R^2$ | 0.5277 | 0.6309 |

## Table 6 Interaction with labor unionization

This table presents two regressions of CEO-employee pay ratio and NEO-employee pay ratio on options trading volume and the interaction term. Labor unionization is the unionization rate multiplied by labor intensity. Ln(OPTVOL) is the natural logarithm of the total annual dollar volume of options. Ln(Sale) is the natural logarithm of a firm's annual sales. Leverage is total debt divided by total assets. CAPX_A is the ratio of capital expenditure to total assets. CEO Tenure is the number of years that the current CEO has worked as a CEO in the firm. Ln(CEO Age) is the logarithm of CEO's age in a specific year. The full sample period is January 1996 to December 2015. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. All t-statistics are two-way clustered standard errors, clustered by firm.

| Dependent variable | Ln(CEO total pay) | Ln(NEO total pay) |
|---|---|---|
| | (1) | (2) |
| Ln(OPTVOL) | 0.0468 | 0.0453 |
| | (5.46)*** | (5.54)*** |
| Labor unionization | 0.0755 | 0.0642 |
| | (2.40)** | (2.86)*** |
| Ln(OPTVOL)* | -0.0066 | -0.0050 |
| Labor unionization | (-2.20)** | (-2.37)** |
| Ln(sale) | 0.2613 | 0.3134 |
| | (15.44)*** | (17.61)*** |
| Leverage | 0.7294 | 0.6056 |
| | (6.37)*** | (6.69)*** |
| CAPX_A | -0.3518 | 0.2967 |
| | (-0.97) | (0.87) |
| Ln(CEO Age) | 1.0815 | 0.2686 |
| | (6.45)*** | (2.41)** |
| CEO Tenure | 0.0107 | -0.0103 |
| | (6.34)*** | (-6.51)*** |
| Constant | -1.3801 | 3.0786 |
| | (-2.01)** | (7.09)*** |
| Year fixed effect | YES | YES |
| Industry fixed effect | YES | YES |
| Observations | 4,845 | 4,845 |
| Adjusted $R^2$ | 0.5284 | 0.6325 |

## Table 7 Interaction with firm profitability

This table presents two regressions of CEO-employee pay ratio and NEO-employee pay ratio on options trading volume and the interaction term. Here, $\Delta$Industry-adjusted Ret $_{t-1}$ and $\Delta$Industry-adjusted ROE $_{t-1}$ are lagged change in industry-adjusted stock return and industry-adjusted ROE, respectively. Ln(OPTVOL) is the natural logarithm of the total annual dollar volume of options. Ln(Sale) is the natural logarithm of a firm's annual sales. Leverage is total debt divided by total assets. CAPX_A is the ratio of capital expenditure to total assets. Ln(CEO Age) is the logarithm of CEO's age in a specific year. CEO Tenure is the number of years that the current CEO has worked as a CEO in the firm. The full sample period is January 1996 to December 2015. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. All t-statistics are two-way clustered standard errors, clustered by firm.

| Dependent variable | Ln(CEO total pay) | | Ln(NEO total pay) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Ln(OPTVOL) | 0.0528 | 0.0527 | 0.0560 | 0.0570 |
| | (1.99)** | (1.98)** | (2.21)** | (2.25)** |
| $\Delta$Industry-adjusted Ret $_{t-1}$ | 0.0001 | | 0.0000 | |
| | (1.55) | | (0.40) | |
| Ln(OPTVOL)* | 0.0000 | | 0.0000 | |
| $\Delta$Industry-adjusted Ret$_{t-1}$ | (-2.86)*** | | (-1.70)* | |
| $\Delta$Industry-adjusted ROE $_{t-1}$ | | 0.0686 | | 0.0488 |
| | | (1.87)* | | (2.09)** |
| Ln(OPTVOL) )* | | -0.0085 | | -0.0060 |
| $\Delta$Industry-adjusted ROE $_{t-1}$ | | (-1.95)* | | (-2.17)** |
| Ln(sale) | 0.2029 | 0.2050 | 0.2437 | 0.2434 |
| | (3.29)*** | (3.32)*** | (4.71)*** | (4.74)*** |
| Leverage | 0.5990 | 0.5931 | 0.7174 | 0.7076 |
| | (2.46)** | (2.43)** | (2.97)*** | (2.95)*** |
| CAPX_A | -0.3774 | -0.4003 | 0.4179 | 0.3859 |
| | (-0.61) | (-0.65) | (0.71) | (0.66) |
| Ln(CEO Age) | 1.4718 | 1.4922 | 0.0530 | 0.0643 |
| | (2.21)** | (2.24)** | (0.12) | (0.15) |
| CEO Tenure | 0.1754 | 0.1749 | -0.0084 | -0.0083 |
| | (2.76)*** | (2.75)*** | (-1.85)* | (-1.83)* |
| Constant | -1.9724 | -2.0562 | 4.7021 | 4.6583 |
| | (-0.74) | (-0.77) | (2.76)*** | (2.73)*** |
| Year fixed effect | YES | YES | YES | YES |
| Industry fixed effect | YES | YES | YES | YES |
| Observations | 4,845 | 4,845 | 4,845 | 4,845 |
| Adjusted $R^2$ | 0.5437 | 0.5406 | 0.6189 | 0.6170 |

## Table 8 Interaction with CEO vega

This table presents two regressions of CEO-employee pay ratio and NEO-employee pay ratio on options trading volume and the interaction term. Vega is the dollar change in a CEO's options holdings from a 1% change in stock return volatility. Ln(OPTVOL) is the natural logarithm of the total annual dollar volume of options. Ln(Sale) is the natural logarithm of a firm's annual sales. Leverage is total debt divided by total assets. CAPX_A is the ratio of capital expenditure to total assets. CEO Tenure is the number of years that the current CEO has worked as a CEO in the firm. Ln(CEO Age) is the logarithm of CEO's age in a specific year. The full sample period is January 1996 to December 2015. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. All t-statistics are two-way clustered standard errors, clustered by firm.

| Dependent variable | Ln(CEO total pay) | Ln(NEO total pay) |
|---|---|---|
| | (1) | (2) |
| Ln(OPTVOL) | 0.0501 | 0.0523 |
| | (3.23)*** | (4.17)*** |
| Vega | 0.0045 | 0.0043 |
| | (2.97)*** | (3.27)*** |
| Ln(OPTVOL)*Vega | -0.0003 | -0.0002 |
| | (-2.47)** | (-2.66)*** |
| Ln(sale) | 0.2247 | 0.2662 |
| | (5.90)*** | (8.80)*** |
| Leverage | 0.5819 | 0.4997 |
| | (2.79)*** | (2.60)*** |
| CAPX_A | -0.3854 | 0.0275 |
| | (-0.67) | (0.05) |
| Ln(CEO Age) | 1.0843 | 0.2305 |
| | (3.00)*** | (0.91) |
| CEO Tenure | 0.0126 | -0.0097 |
| | (2.85)*** | (-3.43)*** |
| Constant | -1.1254 | 3.5672 |
| | (-0.78) | (3.55)*** |
| Year fixed effect | YES | YES |
| Industry fixed effect | YES | YES |
| Observations | 4,845 | 4,845 |
| Adjusted $R^2$ | 0.5403 | 0.6434 |