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The relation between CEO equity incentives and the quality of accounting disclosures: New evidence

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ABSTRACT

This paper provides new evidence on the negative relation between CEO equity incentives and accounting disclosure quality. We analyze a comprehensive set of disclosure quality variables, including discretionary accruals quality, the quantity and quality of voluntary disclosures, fineness of reported financial statement information, and the narrative quality of regulatory filings, and use them to create information disclosure quality indices. We address the potential endogeneity of CEO equity incentives by conducting two-stage least squares/IV models and natural experiments created by situations in which there is an exogenous shock to the use or value of CEO stock options. Our results are robust to subsample analyses and to alternative measures of the incentives created by CEO options.

1. Introduction

Studies of the relation between management incentives and accounting disclosure quality typically examine whether equity-based incentives, specifically stock and stock options, have a positive or negative impact on the quality of a firm's disclosures. While much work has been done, empirical findings to date are mixed. Thus, there remains debate on this important topic. As explained below, this paper addresses the debate in three innovative ways.

First, we analyze the relation between CEO equity incentives and accounting disclosure quality utilizing a comprehensive set of disclosure quality variables; to date extant studies tend to focus on a single or small number of numeric measures. In contrast, we utilize five well-established quantitative measures of disclosure quality that are conceptually different and, in addition, five linguistic measures. We analyze all ten measures individually to see if they yield consistent findings and also use them to form comprehensive disclosure quality indices that summarize the information they contain.

Second, we carefully analyze the effect of both CEO vega and CEO delta on disclosure quality. With some notable exceptions (e.g., Armstrong et al. (2013); Kim et al. (2015)), the extant literature focuses on CEO delta, the change in the risk-neutral (Black-Scholes) value of a CEO's stock and option portfolio in response to a 1% change in stock price. It is used to capture the sensitivity of CEO wealth to changes in stock price. CEO vega is defined as the change in the risk-neutral (Black-Scholes) value of a CEO's option portfolio in

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response to a 1% change in the standard deviation of the firm's stock returns. It is used to capture the sensitivity of CEO wealth to changes in equity risk. We also assess whether our results are robust to alternative measures of CEO vega, including measures that take CEO risk aversion and under-diversification into account.

Third, it is possible that omitted variables or hidden factors jointly determine equity-based CEO compensation and accounting disclosure quality. We tackle the challenges posed by this concern by conducting multiple analyses. Prior studies have not taken a multi-faceted approach to addressing this issue. Specifically, we conduct two-stage least squares (2SLS) with valid instruments (IVs), and perform three separate natural experiments created by situations in which there is an exogenous shock to the use or value of CEO stock options.[1]

All of our findings support the hypothesis that CEO vega has a deleterious effect on the quality of future accounting disclosures. In some analyses, CEO delta does as well. Further, our results are robust to subsample analysis that isolates situations in which the impact of equity incentives on disclosure quality is likely to be the strongest versus the weakest. In addition, our results are robust to alternative measures of CEO vega.

The rest of the paper is organized as follows. In Section 2, we develop hypotheses and provide a brief review of the literature. In Section 3, our data sources, variable construction and descriptive statistics are presented. Section 4 presents our primary analyses. Section 5 presents subsample analyses and robustness tests. Section 6 concludes.

2. Hypothesis development and brief literature review

2.1. Hypothesis development

Our primary hypothesis is that option-based CEO compensation is negatively related to the quality of future accounting disclosures.[2] Because CEOs are risk-averse, increases in equity risk generate both a reward (or wealth) effect and a risk (or risk aversion) effect (Guay (1999); Armstrong et al. (2013)). The reward effect captures the increase in CEO wealth associated with risk increases when a CEO is compensated with options which have a convex payoff function whose value increases with stock risk. The risk effect captures the decline in utility for a risk-averse CEO associated with risk increases when elements of his or her compensation package are exposed to that risk. If less informative, less transparent disclosure polices and misreporting increase both stock price and risk then, all else constant, CEOs with greater vega are more likely to reduce transparency and misreport. In other words, CEO vega makes managers less averse to any increased risk that accompanies such disclosure practices. Laux (2014) shows theoretically that convex compensation packages (e.g. option-based contracts) increase CEO incentives to manipulate information. Bolton et al. (2005) and Peng and Röell (2008, 2014) show that CEOs with option-based compensation have incentives to drive up market expectations through earnings manipulations, and that a firm's stock price can deviate from its long-run fundamental value for an extended period of time.

While theoretical predictions regarding the effect of stock risk (vega) on managers' incentives with respect to information disclosure quality are clear, theoretical predictions regarding the effect of stock price (delta) on managers' incentives with respect to information disclosure quality are unclear or ambiguous. On the one hand, CEO delta provides incentives to reduce transparency and to misreport if this increases stock price. On the other hand, CEO delta discourages such disclosure practices if they expose a risk-averse CEO to increased equity risk. Thus, we make no specific prediction regarding the relation between CEO delta and the quality of future accounting disclosures.

As a confirmatory check, we also examine the relation between the portion of CEO non-performance-based compensation (salary-to-total compensation), where possible. A higher proportion of non-performance-based pay provides managers with weaker incentives to increase stock price and potentially with incentives to reduce risk. Thus, we expect that a higher proportion of CEO non-performance-based pay will be positively related to the quality of future accounting disclosures.

2.2. Literature review and our contribution

As noted earlier, the dominant focus in the extant literature is on the relation between CEO portfolio delta and information disclosure quality. To the best of our knowledge, Armstrong et al. (2013) are the first to document the empirical finding that it is vega, rather than delta, that provides managers with stronger incentives to engage in misreporting. Kim et al. (2015) find a positive relation between CEO vega and audit fees, suggesting that options motivate earnings management activities that auditors take into account when setting their fees. In contrast, Chava and Purnanandam (2010) find that CEO vega has no effect on the earnings management decision.

To date, the empirical evidence on the relation between CEO portfolio delta and accounting disclosure quality is mixed. One set of studies provides evidence that CEO portfolio delta is associated with lower quality disclosures. For example, Burns and Kedia (2006), Bergstresser and Philippon (2006), Cornett et al. (2008), and Feng et al. (2011) find that CEO portfolio delta is positively associated with the propensity to misreport earnings. Relatedly, Agarwal et al. (2011) show that high-delta hedge fund managers tend to inflate

[1] We are grateful to an anonymous referee for suggestions regarding our quasi-natural experiments.

[2] The literature addressing the incentive effects of stock and options on management decision-making and risk-taking is voluminous. Notable contributions include, but certainly are not limited to Haugen and Senbet (1981), Smith and René (1985), Lambert et al. (1991), Guay (1999), Core and Guay (1999), Carpenter (2000), Ross (2004), Coles et al. (2006), Lewellen (2006), Low (2009), Armstrong and Vashishtha (2012), Armstrong et al. (2013), Hayes et al. (2012), Bakke et al. (2016), and Shue and Townsend (2017b).

reported returns.

Another set of studies provides evidence that CEO portfolio delta either is positively associated with accounting disclosure quality or is unrelated to it. For example, Nagar et al. (2003) argue that equity-based incentives make managers less reluctant to publicly disseminate information that reduces their private control benefits. Consistent with this, they find that voluntary disclosures are positively related to the value of CEO equity holdings and the portion of CEO compensation affected by stock price. Their study does not examine whether its findings pertaining to increases in equity risk are driven by the reward effect, the risk effect or a combination of both. Erickson et al. (2006) find no consistent evidence of an association between delta for the top five executives and accounting fraud. Jiang et al. (2010) find that CEO delta plays a weaker role than that of CFO delta in earnings management. Using a propensity-score matched-pair research design, Armstrong et al. (2010) find evidence that accounting irregularities occur less frequently for firms with higher CEO delta.[3]

There are at least three potential explanations for the mixed empirical results in the existing literature. First, the existing literature addressing this topic tends to focus on a single or small number of numeric-based attributes of accounting earnings measures. Second, studies have not consistently analyzed both CEO vega and CEO delta which, as explained above, have different and potentially off-setting incentive effects. Further, CEO vega is typically estimated based on the Black-Scholes model which assumes risk-neutrality. Thus, this measure has an inherent problem when examining the risk-taking behavior of a risk-averse CEO.[4] Third, the existing literature may not have adequately addressed the potential for endogeneity in the determination of CEO equity incentives (this is pointed out by Hayes et al. (2012), Bakke et al. (2016), Shue and Townsend (2017b), among others).

Our paper contributes to the literature by addressing all three of the above-mentioned potential explanations for mixed findings. Below, we provide more detail regarding our analyses.

2.2.1. Broadened set of disclosure quality measures and formation of disclosure quality indices

First, our tests employ ten disclosure quality measures which fall into two categories of five measures each: i) more traditional, widely used numerical measures and ii) measures of accounting report readability and sentiment.

The five more traditional, numeric measures are discretionary accruals quality (Francis et al. (2005)), the number of voluntary 8-K filings (Boone and White (2015)), earnings response coefficients (Kothari and Sloan (1992)), management earnings forecast precision (Boone and White (2015)), and the disaggregation quality of financial statement information (Chen et al. (2015)).

The five measures of report readability and sentiment are included because firms convey value-relevant information, not only through the numbers they report, but through large volumes of textual information. In 1998, the SEC published its *Plain English Handbook* (See, SEC (1998)), which was developed as a guide to help firms to make their disclosure documents easier to read. Recent advances in textual analysis, combined with the SEC's emphasis on the readability of disclosure documents, have led to a surge in research in this area.[5]

Not surprisingly, there are significant positive correlations among many of the ten measures of disclosure quality, particularly the readability measures. These significant correlations provide a basis for employing principal components analysis (PCA) to create two composite disclosure quality indices.

2.2.2. CEO vega, CEO delta, and alternative measures of CEO vega

Second, all of our analyses use both CEO vega and CEO delta to capture equity-based CEO incentives. In addition, we test whether our results hold when alternative measures of CEO vega are used. Using Ingersoll's (2006) model for the subjective value of options, we estimate the subjective value of a CEO's stock options, which takes into account the fact that equity-based compensation is worth less to a risk-averse, under-diversified CEO than to an optimally diversified outside investor. Further, to test whether our findings are driven by current versus past option awards, we decompose CEO vega into current and prior option grants. Finally, to test whether our findings are driven by recent stock performance, we decompose CEO vega into the component that is correlated with recent stock return and the component that is not.

2.2.3. Addressing potential endogeneity concerns

Third, we employ a battery of tests to address the endogeneity of equity-based compensation. First, we conduct two-stage least squares (2SLS) analysis using instruments that are valid and satisfy the exclusion restriction, which requires that the instruments only relate to disclosure quality measures through their effect on CEO equity-based compensation.

[3] Armstrong et al.'s (2013) Table 1 and Armstrong et al.'s (2010) Table 1 provide a summary of the literature on equity incentives and mis-reporting and accounting irregularities. They measure misreporting by way of discretionary accruals, accounting restatements, and SEC enforcement actions and accounting irregularities by way of financial restatements related to accounting manipulation, accusation of accounting manipulation in a class action lawsuit, and SEC enforcement actions.

[4] The more risk-averse the manager is, the smaller is the subjective value of his or her stock options. Therefore, an increase in stock volatility is likely to have a negative impact on the subjective value of stock options unless the risk is largely systematic in nature. A relatively high risk-averse CEO holding an option is not necessarily inclined to increase risk.

[5] See https://www.sec.gov/pdf/handbook.pdf. Prior studies show that firms with less readable reports are associated with higher stock return volatility, greater equity analysts' earnings forecast dispersion, negative excess returns, poor earnings, lower earnings persistence, and higher earnings management (Li (2008), Lehavy et al. (2011), Larcker and Zakolyukina (2012), Loughran and McDonald (2013), Bonsall et al. (2017), and Lo et al. (2017)).

Table 1
Summary statistics.

	Mean	Median	Std	Obs.
CEO Compensation and other CEO variables				
CEO vega ($000 s)	97.413	34.631	207.049	19,339
CEO delta ($000 s)	827.977	207.850	1271.671	19,339
CEO salarycomp (%)	31.6%	24.3%	24.1%	19,339
CEO tenure (years)	8.643	6.083	8.037	19,339
CEO age (years)	55.924	56.000	7.530	19,339
CEO duality (0,1)	0.610	1.000	0.488	19,339
Founder CEO (0,1)	0.162	0.000	0.368	19,339
CEO ability	0.012	−0.019	0.136	19,339
Control variables				
Sales ($millions)	4869.136	1150.902	15,801.702	19,339
Firm age (years)	28.505	24.016	19.416	19,339
Leverage	0.195	0.148	0.169	19,339
ROA	0.032	0.077	0.167	19,339
Stock return	0.189	0.126	0.610	19,339
Market-to-book	1.946	1.483	1.547	19,339
PP&E/Assets	0.264	0.199	0.231	19,339
Growth in sales	0.126	0.078	0.370	19,339
Intangibles	0.062	0.013	0.177	19,339
ILLIQ	0.528	0.170	0.901	19,339
σCF	0.065	0.027	0.058	19,339
σSales	0.227	0.168	0.200	19,339
Top5_Instown (%)	42.0%	39.5%	12.8%	19,339
Measures of information disclosure quality				
Discretionary accruals quality (DAQ)$_{t+1,t+3}$	0.006	−0.013	0.227	17,444
Voluntary disclosure frequency$_{t+1,t+3}$	17.055	10.000	24.665	18,968
Earnings response coefficient (ERC)$_{t+1,t+3}$	0.246	0.067	0.389	18,319
Forecast precision$_{t+1,t+3}$	2.135	2.000	0.523	18,968
DQ_BS (%)$_{t+1,t+3}$	67.7%	72.6%	16.5%	19,326
DQ_IS (%)$_{t+1,t+3}$	46.5%	42.9%	14.5%	19,339
DQ (%)$_{t+1,t+3}$	57.1%	56.4%	15.5%	19,339
Complex words$_{t+1,t+3}$	3405.9	2754.7	2940.9	18,964
Loughran-McDonald (L-M) uncertainty words$_{t+1,t+3}$	176.3	136.1	164.0	18,964
Flesch-Kincaid (F-K) readability index$_{t+1,t+3}$	15.5	15.5	1.3	18,964
Gunning-Fog (G-F) readability index$_{t+1,t+3}$	19.5	19.5	1.4	18,964
Loughran-McDonald (L-M) modal weak words$_{t+1,t+3}$	60.8	39.3	69.2	18,964

The unit of observation is a firm-year. The sample period is 1992 to 2018. Data for vega, delta, salarycomp, and continuous control variables are winsorized at the 1st and 99th percentiles. Detailed variable definitions are in Appendix A.

To further address endogeneity concerns, we take advantage of a natural experiment created by the adoption of Financial Accounting Standard (FAS) 123R which requires firms to expense executive stock options. FAS 123R represents an exogenous shock that reduced many firms' use of CEO options (Hayes et al. (2012); Bakke et al. (2016)). Another follows Shue and Townsend (2017b). Specifically, we employ two instruments motivated by two natural experiments that take advantage of exogenous variation in CEO vega by way of the institutional features of multi-year fixed-number and fixed-value option grant plans.

3. Sample construction, variable definitions, and descriptive statistics

Our sample consists of firm-year panel data from 1992 to 2018. To be included in the analysis, a firm-year observation must have data on disclosure quality variables, CEO compensation and characteristics, firm-level control variables and instrumental variables, where relevant. Following prior research, we exclude financial firms (standard industrial classification (SIC) codes between 6000 and 6999) and utilities (SIC codes between 4900 and 4999). Data for some disclosure quality variables are obtained from Wharton's *WRDS SEC Analytics Suite* and *I/B/E/S Guidance* Database. CEO compensation and characteristics, accounting data and stock data are obtained from *ExecuComp*, *Compustat* and the *Center for Research in Security Prices* (*CRSP*), respectively. CEO founder status is obtained from *Equilar Consultants*. CEO duality data are obtained from *RiskMetrics*. Data on institutional ownership are obtained from *Thomson*

Reuters Institutional Holdings (13F). Compensation consultant identity is obtained from Institutional Shareholder Services' (ISS) *Incentive Lab* Database. For observations with missing data on CEO characteristics and compensation consultant from the above sources, we hand-collect data from SEC filings when available.[6] Detailed definitions for all variables used in the analysis are presented in Appendix A.

3.1. Equity-based CEO compensation and other CEO and firm-level control variables

Following Core and Guay (2002) and Hayes et al. (2012), we estimate CEO vega and CEO delta using *ExecuComp* data on option terms and the annual standard deviation of stock return and average annual dividend for the preceding 36 months. To isolate the effect of equity-based CEO compensation on disclosure quality, we control for other elements of CEO compensation and CEO characteristics. CEO control variables are the ratio of salary-to-total compensation (CEO salarycomp),[7] CEO tenure, CEO age, CEO duality (equals one if the current CEO also chairs the board), Founder CEO (equals one if the current CEO founded the firm), and CEO ability (based on the managerial ability score constructed by Demerjian et al. (2012), estimated by including year fixed effects but not industry fixed effects).

Table 1 presents sample summary statistics. To reduce the influence of outliers, data for CEO vega, CEO delta, and continuous control variables are winsorized at the 1st and 99th percentiles. As shown in Table 1, the mean (median) CEO vega indicates that a 1% increase in the standard deviation of a firm's stock return adds $97,413 ($34,631) to CEO wealth. Mean (median) CEO delta shows that CEO wealth increases by $827,977 ($207,850) when stock price increases by 1%. Consistent with prior studies, CEO vega and CEO delta are positively skewed, thus we use the natural log of one plus CEO vega and CEO delta in our analysis. Mean (median) CEO salarycomp is 31.6% (24.3%) of total compensation. Our CEO variables are similar to those from prior studies using *ExecuComp* data (e.g., Armstrong and Vashishtha (2012); Custodio et al. (2013)).[8]

To control for firm characteristics, we look to the relevant literature on disclosure quality, especially Armstrong et al. (2013) and Boone and White (2015). More specifically, firm-level control variables are the natural log of sales, the natural log of firm age, Leverage, ROA, and stock return. In addition, there are four measures of growth opportunities (Market-to-book, PP&E/assets, Growth in sales, and Intangibles ((R&D plus advertising)/sales)) and two measures of the volatility of the firm's operating performance (cash flow volatility (σCF) and sales volatility (σSales)). Stock illiquidity and stock ownership by the top five institutions are also included as control variables.[9] Stock illiquidity (ILLIQ) is the average of the square root of Amihud's (2002) daily illiquidity measure (See Gopalan et al. (2012) for details of the calculation). Top five institutional ownership (Top5_Instown) is holdings by the top 5 institutional investors as a percentage of total institutional holdings. As shown in Table 1, the univariate statistics for firm-level control variables are comparable to those from prior studies.

3.2. Disclosure quality measures

Our analysis utilizes multiple measures of accounting disclosure quality, all of which are measured over the three-years from t + 1 to t + 3. All disclosure quality variables are constructed such that a higher value indicates higher disclosure quality/greater transparency.

As stated earlier, our traditional measures of the quality and quantity of disclosure are discretionary accruals quality (DAQ),[10] the number of voluntary 8-K filings (total SEC Form 8-K filings of Other Events (Item 5 or 8.01) or Regulation Fair Disclosures (Item 9 or 7.01)),[11] earnings response coefficients (ERC),[12] management's earnings forecast precision (a scaled index based on the earnings forecast types: qualitative = 0, open-ended = 1, range = 2, and point = 3, more precise forecasts are associated with a higher scaled

[6] For firm-years with missing data on the identity of compensation consultant from *Incentive Lab*, we retrieve missing data from proxy statements and other SEC filings when possible. In most cases, the primary consultant is clearly identified in the text of proxy statements and other SEC filings. For instances in which multiple consultants are listed, we select the consultant used to provide advice regarding CEO compensation.

[7] To capture the non-performance-based component of CEO compensation, we focus on the salary component of cash compensation and exclude cash bonus. This is because the typical CEO cash bonus contract has option-like features (Shaw and Zhang (2010)).

[8] For example, in Custodio et al.'s (2013) 1993–2007 sample, the mean (median) CEO has a tenure of 7.97 (6.00) years and is 55.55 (56) years old; 62.2% of the CEOs in their sample also hold the title of Chairman of the Board.

[9] See Boone and White (2015) regarding the effect of institutional ownership on firm transparency and information production, Cronqvist and Fahlenbrach (2009) regarding the effect of institutional ownership on equity incentives, and O'Hara's (2003) presidential address regarding the effect of stock illiquidity on firm disclosure policy.

[10] See Francis et al. (2005) regarding the construction of Discretionary accruals quality (DAQ). Accruals quality is the standard deviation of each firm's residuals from the Dechow and Dichev's (2002) regression model, calculated over years t-4 through t. Discretionary accruals quality is the estimated residual from annual regressions with accruals quality as dependent variable and a set of explanatory variables including log of total assets, standard deviation of cash flow from operations, standard deviation of sales revenues, natural logarithm of operating cycle, and incidence of negative earnings realizations over the prior 10 years (see equation (8) of Francis et al. (2005)).

[11] See Boone and White (2015). Regulation Fair Disclosure, Reg. FD, did not begin until late year 2000. Our use of year fixed effects should help minimize the effect of an exogenous regulatory shock on this disclosure measure.

[12] See Kothari and Sloan (1992) for details of the construction of earnings response coefficient (ERC). We follow closely equation (2) of Kothari and Sloan (1992) with ERC defined as the estimated coefficient from firm-level regressions of annual returns on earnings (scaled by stock price at the beginning of the year) over years t-9 through t with at least 6 annual observations.

Table 2
Equity-based CEO compensation and future disclosure quality using traditional measures.

Dependent variables measured from t+1 to t+3	**Traditional measures of disclosure quality**				
	DAQ	ln(1+Voluntary disclosure frequency)	ERC	Forecast precision	DQ (%)
CEO ln(1+vega)$_t$	−0.1268***	−0.0429***	−0.0270***	−0.1689***	−0.1063**
	(−2.94)	(−12.51)	(−6.08)	(−12.70)	(−2.03)
CEO ln(1+delta)$_t$	−0.2895***	−0.0074	−0.0061	−0.0624***	−0.1929***
	(−4.18)	(−1.60)	(−1.06)	(−3.50)	(−5.22)
CEO salarycomp$_t$	0.7216**	0.0548**	0.0808***	0.1793**	0.5232**
	(2.42)	(2.45)	(2.92)	(2.07)	(2.56)
ln (1+CEO tenure)$_t$	0.1125	0.0452***	0.0180*	0.0767**	−0.1519*
	(1.02)	(5.49)	(1.91)	(2.44)	(−1.80)
ln(CEO age)$_t$	0.1721	0.0604	0.1003*	0.1419	0.3994
	(0.33)	(1.23)	(1.76)	(0.76)	(0.82)
CEO duality$_t$ (0,1)	−0.0709	−0.0247**	−0.0097	0.0130	−0.0185
	(−0.58)	(−2.02)	(−0.64)	(0.27)	(−0.14)
Founder CEO$_t$ (0,1)	−0.3244	−0.0598***	−0.0913***	0.2119**	−0.2714
	(−1.39)	(−2.75)	(−3.40)	(2.49)	(−1.22)
CEO ability$_t$	2.0847***	0.1040**	0.0520	0.9186***	1.1250**
	(3.23)	(2.54)	(1.05)	(5.70)	(2.47)
ln(Sales)$_t$	−0.8590***	−0.1100***	−0.0269*	−0.4274***	0.6823***
	(−7.12)	(−9.76)	(−1.93)	(−10.15)	(5.85)
ln(Firm age)$_t$	−0.5161**	−0.3021***	−0.3835***	−0.5940***	−0.3193
	(−2.10)	(−16.69)	(−13.72)	(−8.63)	(−1.54)
Leverage$_t$	−0.8693*	−0.2095***	−0.1030**	−0.6349***	4.2123***
	(−1.77)	(−5.07)	(−2.09)	(−5.50)	(9.68)
ROA$_t$	1.4614**	0.4819***	0.2190***	0.5002**	0.9199
	(2.23)	(6.67)	(2.81)	(2.54)	(1.41)
Stock return$_t$	−0.0514	−0.0040*	0.0147***	−0.0016	0.0153
	(−1.26)	(−1.78)	(3.94)	(−0.15)	(0.50)
Market-to-book$_t$	−0.0723**	−0.0215***	−0.0120*	−0.0295**	−0.2291***
	(−2.04)	(−6.31)	(−1.88)	(−2.12)	(−6.08)
PP&E/assets$_t$	2.3105***	0.1734***	0.5161***	2.0231***	3.6843***
	(3.11)	(2.99)	(7.09)	(18.37)	(4.06)
Growth in sales$_t$	−0.0096	−0.0002	−0.0023**	−0.0044**	−0.0513***
	(−1.46)	(−0.12)	(−2.45)	(−2.27)	(−2.95)
Intangibles$_t$	−0.9495***	−0.041	−0.1424***	−0.2404***	−1.5867***
	(−2.79)	(−1.58)	(−4.22)	(−2.84)	(−4.52)
ILLIQ$_t$	−0.6286*	−0.0552	−0.0657	−0.4505***	−0.2963
	(−1.73)	(−1.21)	(−1.22)	(−3.12)	(−0.65)
σCF$_t$	−0.5918	−0.1543*	−0.0591	−1.4721***	−4.5248***
	(−0.46)	(−1.81)	(−0.53)	(−4.25)	(−5.01)
σSales$_t$	−0.0794	−0.0052	−0.0198	−0.2372***	−0.3922***
	(−0.65)	(−0.51)	(−1.22)	(−7.73)	(−3.60)
Top5_Instown$_t$	−1.4879**	−0.2331***	−0.3191***	−0.3808**	0.9670**
	(−2.44)	(−5.01)	(−5.38)	(−2.16)	(2.51)
Constant	−5.7108***	0.1411	3.4623***	0.5494	51.6110***
	(−2.70)	(0.78)	(14.61)	(0.76)	(26.52)
Adj R-squared	0.6097	0.6133	0.5808	0.5957	0.7723
Observations	17,444	18,968	18,319	18,968	19,339

Dependent variables are five traditional measures of disclosure quality: discretionary accruals quality (DAQ), ln(1+Voluntary disclosure frequency), earnings response coefficient (ERC), earnings forecast precision, and disaggregation quality (DQ) of accounting data. All dependent variables are defined such that a higher number represents higher quality disclosure. t-values are based on robust standard errors clustered by firm and by year (two-way) and are reported in parentheses. Firm and year fixed effects are included in all models. The sample period is 1992–2018. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Detailed variable definitions are in Appendix A.

index) and disaggregation quality (DQ_BS, DQ_IS and DQ, based on the level of disaggregation of financial data items in a firm's annual reports. DQ_BS (DQ_IS) is the value-weighted (equally-weighted) disclosure quality score of balance sheet (income statement) items and DQ is an equally-weighted average of DQ_BS and DQ_IS).[13]

As shown in Table 1, over the three-year period from t + 1 to t + 3, mean DAQ is close to zero at 0.006, as is the median (−0.013).[14] Sample firms file 17 voluntary 8-K filings on average (10 at the median) over the three-year period. The mean (median) ERC is 0.246 (0.067), while the mean (median) management earnings forecast precision is 2.135 (2.000). The mean (median) of disaggregation

[13] See Chen et al. (2015). We construct DQ_BS (DQ_IS) using the linking table for the balance sheet items (income statement items) provided by Internet appendix A(B) of Chen et al. (2015).

[14] For purposes of comparison, Francis et al. (2005) report a zero mean (−0.003 median) value for discretionary accruals quality using 1970–2001 data.

quality (DQ%) is 57.1% (56.4%), with the percentage of items disclosed on the balance sheet being higher than the percentage disclosed on the income statement.[15]

Our five measures of narrative quality are based on a count of complex words, a count of Loughran-McDonald uncertainty words (Loughran and McDonald (2016)), the Flesch-Kincaid readability index (Hwang and Kim (2017)), the Gunning-Fog readability index (Li (2008); Lehavy et al. (2011); Lo et al. (2017)), and a count of Loughran-McDonald modal weak words (Loughran and McDonald (2016)). We interpret the use of more complex words, more uncertainty words, lower readability and more modal weak words as reflective of less transparent, lower quality disclosures. More specifically, they are defined as follows:

- -ln (1+ Complex words): the natural log of the annual average of the number of words that contain three or more syllables in a firm's quarterly reports plus 1 multiplied by −1 so that a higher number indicates less complex language.
- -ln (1+ Loughran-McDonald (L-M) uncertainty words): the natural log of the average annual number of L-M financial uncertainty words in a firm's quarterly reports plus 1 multiplied by −1 so that a higher number indicates less uncertain linguistic tone.[16]
- −1 * Flesch-Kincaid (F-K) readability index: 0.39(# words/# sentences) + 11.8(# syllables/# words) − 15.59. Maps to U.S. reading levels (e.g., a score of 9 indicates a 9th grade reading level) multiplied by −1 so that a higher number indicates greater ease of readability.
- −1 * Gunning-Fog (G-F) readability index: 0.4 ((# words/# sentences) + 100(# complex words/# words)). Maps to U.S. reading levels multiplied by −1 so that a higher number indicates greater ease of readability.
- -ln (1+ L-M modal weak words): the natural log of the average annual number of L-M financial-modal-weak words in a firm's quarterly reports plus 1 multiplied by −1 so that a higher number indicates less weak linguistic tone.[17]

As shown in Table 1, the yearly mean (median) number of complex words for years t + 1 to t + 3 is 3406 (2755), while the mean (median) number of L-M uncertainty words is 176 (136) and the mean (median) L-M financial-modal-weak word count is 60.8 (39.3). The mean (median) Flesch-Kincaid (F-K) readability index is 15.5 (15.5) and the mean (median) Gunning-Fog (G-F) readability index is 19.5 (19.5).

4. Empirical results

4.1. Analysis using individual measures of disclosure quality

We begin our analysis of whether or not the CEO equity-based incentives, in particular CEO vega, have a deleterious effect on accounting disclosure quality by examining how each individual disclosure quality measure in years t + 1 to t + 3 is affected by the equity-based CEO compensation in year t. The model specification is:

$$\text{Disclosure quality measure}_{i,t+1\text{ to }t+3} = \beta_0 + \beta_1\,\text{CEO}\,ln(1+\text{vega})_{i,t} + \beta_2\,\text{CEO}\,ln(1+\text{delta})_{i,t} + \sum_k \beta_k\,\text{Control}_{i,k,t} + \text{Fixed effects} + \varepsilon_{i,t+1\text{ to }t+3}. \quad (1)$$

Empirically, our hypothesis predicts a negative coefficient on CEO ln(1+ vega) in Eq. (1) (i.e., $\beta_1 < 0$) for each measure of accouting disclosure quality. Recall that because stock price varies over time, the payoff to a CEO's incentive contracts is uncertain, imposing risk on him or her. CEO vega, which captures convexity in pay, counteracts the CEO's risk aversion. Therefore, CEO vega provides a risk-averse CEO with incentives to pursue less informative disclosure polices if they increase both stock price and risk. If our prediction is correct, this will manifest itself in relatively poor discretionary accruals quality, a lower volume of voluntary 8-K filings, less credible earnings reports that have a lower effect on investors' valuation of the firm (i.e., low ERC), low earnings forecast precision, coarser information reported to investors (i.e., low DQ%), and low readability in financial reports. Recall that the effect of CEO delta on CEO incentives in this context is ambiguous, thus we do not make an empirical prediction regarding the sign of β_2 in Eq. (1).

Table 2 presents models estimated using our five traditional disclosure measures as dependent variables. Because the scale of variables is different, we rescale them such that each has a mean of one, with a higher value indicating higher disclosure quality. This facilitates the comparison of coefficients across models. All explanatory variables are measured in year t. To account for unobservable, time-invariant heterogeneity in disclosure practices across firms and for any time-trends in disclosure practices, all specifications contain firm and year fixed effects and robust standard errors clustered at the firm and year level (two-way). Adjusted R-squareds range from 0.58 to 0.77 across models.

Results show that CEO ln(1+ vega) is significantly negatively associated with future measures of disclosure quality in all models. This is consistent with our hypothesis. Forecast precision, DAQ and DQ% have the largest coefficients in absolute value (−0.169, −0.127 and − 0.106, respectively). CEO ln(1+ delta) is also negatively associated with disclosure quality in three of five models (DAQ, Forecast precision, and DQ%). In contrast, CEO salarycomp is positively associated with all five measures of disclosure quality. In unreported robustness tests, we use first order differences for dependent and explanatory variables to estimate the effect of changes in

[15] For purposes of comparison, using 1973 to 2011 data, Chen et al. (2015) report a mean (median) DQ of 58.3% (57.0%). Similarly, mean (median) DQ_BS is 71.6% (71.8%) and is higher than the mean (median) DQ_IS of 45.0% (41.8%).

[16] Uncertainty words are words such as "approximately", "unpredictably", "depend(s)", "likelihood", "possibly", "riskier" etc.

[17] Weak modal words are words such as "could", "might", "perhaps", "somewhat", "conceivable", etc.

Table 3
Equity-based CEO compensation and future disclosure quality using linguistic measures.

Dependent variables measured from t+1 to t+3	**Linguistic measures of disclosure quality**				
	−Ln(1+Complex words)	−F-K Readability index	−G-F Readability index	−ln(1+L-M Uncertainty words)	-ln(1+L-M Modal weak words)
CEO ln(1+vega)$_t$	−0.0051***	−0.0037***	−0.0028***	−0.0162***	−0.0159***
	(−12.90)	(−8.66)	(−7.97)	(−18.55)	(−13.08)
CEO ln(1+delta)$_t$	−0.0052***	−0.0016***	−0.0012***	−0.0100***	−0.0143***
	(−10.22)	(−3.11)	(−2.84)	(−8.85)	(−8.81)
CEO salarycomp$_t$	0.0216***	0.0133***	0.0092***	0.0359***	0.0440***
	(11.86)	(6.04)	(5.04)	(8.94)	(7.56)
ln(1+CEO tenure)$_t$	0.0090***	0.0038***	0.0031***	0.0230***	0.0284***
	(10.05)	(3.68)	(3.60)	(11.82)	(10.09)
ln(CEO age)$_t$	0.0155***	0.0112*	0.0099*	0.0419***	0.0432**
	(2.91)	(1.83)	(1.95)	(3.57)	(2.49)
CEO duality$_t$ (0,1)	−0.0020*	−0.0015	−0.0016	−0.0095***	−0.0085**
	(−1.71)	(−1.02)	(−1.32)	(−3.24)	(−2.03)
Founder CEO$_t$ (0,1)	−0.0006	−0.0042*	−0.0050**	−0.0138***	−0.0097
	(−0.25)	(−1.92)	(−2.29)	(−2.64)	(−1.23)
CEO ability$_t$	0.0333***	0.0242***	0.0189***	0.0826***	0.0812***
	(7.22)	(4.90)	(4.55)	(8.19)	(5.69)
ln(Sales)$_t$	−0.0456***	−0.0248***	−0.0180***	−0.0952***	−0.1308***
	(−36.57)	(−16.13)	(−14.11)	(−34.67)	(−33.22)
ln(Firm age)$_t$	−0.0764***	−0.0404***	−0.0273***	−0.1469***	−0.1956***
	(−37.82)	(−13.87)	(−11.42)	(−33.65)	(−30.01)
Leverage$_t$	−0.0255***	−0.0006	0.0010	−0.0609***	−0.0728***
	(−6.03)	(−0.14)	(0.24)	(−6.50)	(−5.18)
ROA$_t$	0.1416***	0.0639***	0.0465***	0.2739***	0.3892***
	(14.24)	(7.33)	(6.58)	(13.30)	(13.34)
Stock return$_t$	−0.0002	−0.0001	0.0000	−0.0002	−0.0005
	(−0.70)	(−0.25)	(0.00)	(−0.70)	(−0.62)
Market-to-book$_t$	−0.0023***	−0.0001	−0.0002	−0.0056***	−0.0070***
	(−4.80)	(−0.14)	(−0.55)	(−5.39)	(−4.64)
PP&E/assets$_t$	0.1604***	0.0759***	0.0582***	0.3280***	0.3985***
	(23.24)	(10.11)	(9.23)	(21.92)	(19.40)
Growth in sales$_t$	−0.0002**	−0.0003***	−0.0003***	−0.0006**	−0.0008**
	(−2.16)	(−4.13)	(−3.79)	(−2.31)	(−2.49)
Intangibles$_t$	−0.0128***	−0.0105***	−0.0102***	−0.0250***	−0.0368***
	(−4.32)	(−3.40)	(−3.50)	(−4.18)	(−4.67)
ILLIQ$_t$	−0.0172***	0.0027	0.0037	−0.0356***	−0.0269
	(−2.78)	(0.53)	(0.88)	(−2.59)	(−1.46)
σCF$_t$	−0.0506***	−0.0162*	−0.0062	−0.1338***	−0.1599***
	(−5.93)	(−1.82)	(−0.85)	(−7.11)	(−5.56)
σSales$_t$	−0.0041***	−0.0061***	−0.0053***	−0.0081***	−0.0123***
	(−3.38)	(−5.75)	(−5.51)	(−3.62)	(−3.30)
Top5_Instown$_t$	−0.0397***	−0.0186***	−0.0171***	−0.0952***	−0.1088***
	(−7.42)	(−3.16)	(−3.47)	(−7.89)	(−6.42)
Constant	1.1191***	1.0918***	1.0624***	1.2300***	1.4443***
	(75.51)	(50.10)	(57.65)	(39.75)	(27.11)
Adj R-squared	0.9029	0.6818	0.6715	0.9083	0.8832
Observations	18,964	18,964	18,964	18,964	18,964

Dependent variables are linguistic measures of disclosure quality: −Ln(1+Complex words), −Flesch-Kincaid (F-K) Readability index, −Gunning-Fog (G-F) Readability index, −ln(1+Loughran-McDonald (L-M) Uncertainty words) and −ln(1+Loughran-McDonald (L-M) Modal weak words). All dependent variables are defined such that a higher number represents a higher readability. t-values are based on robust standard errors clustered by firm and by year (two-way) and are reported in parentheses. Firm and year fixed effects are included in all models. The sample period is 1992–2018. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Detailed variable definitions are in Appendix A.

CEO equity-based compensation on changes in future disclosure quality. First-differenced specifications remove potentially confounding firm-specific fixed effects. We also replace firm fixed effects with industry fixed effects for all models. In both instances our Table 2 findings are confirmed.

Among other CEO variables, CEO tenure is significantly positively associated with disclosure quality in three of the five models (ln (1 + Voluntary disclosure frequency), ERC, and Forecast precision). Founder CEO is negatively associated with disclosure quality in two of five models (ln(1 + Voluntary disclosure frequency) and ERC). CEO ability is positively associated with disclosure quality in four of five models (except ERC). Other CEO variables are not consistently significant. Regarding firm-level control variables, Market-to-Book is consistently significantly negatively associated with disclosure quality variables, while PP&E/assets is consistently significantly positively associated with disclosure quality.

Table 3 presents models estimated using our five linguistic measures of the narrative quality of financial reports which capture the readability, complexity, and uncertainty reflected in disclosure documents as dependent variables. Again, we rescale each measure

Table 4
Pearson Correlations between CEO compensation variables and disclosure quality and quantity variables.

	CEO compensation variables		Disclosure quality variables											
	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CEO compensation variables														
1. CEO ln(1+vega)$_t$	0.420***	−0.425***	−0.243***	−0.205***	−0.219***	−0.205***	−0.088***	−0.194***	−0.154***	−0.260***	−0.175***	−0.135***	−0.259***	−0.232***
2. CEO ln(1+delta)$_t$		−0.377***	−0.292***	−0.101***	−0.119***	−0.142***	−0.079***	−0.118***	−0.106***	−0.196***	−0.119***	−0.098***	−0.187***	−0.167***
3. CEO salarycomp$_t$			0.197***	0.220***	0.191***	0.158***	0.092***	0.211***	0.166***	0.300***	0.184***	0.147***	0.287***	0.263***
Disclosure quality variables														
4. DAQ$_{t+1,t+3}$				0.167***	0.144***	0.068***	0.171***	0.178***	0.172***	0.187***	0.117***	0.098***	0.183***	0.179***
5. ln(1+Voluntary disclosure frequency)$_{t+1,t+3}$					0.244***	0.183***	0.048***	0.351***	0.291***	0.520***	0.298***	0.270***	0.498***	0.444***
6. ERC$_{t+1,t+3}$						0.130***	0.135***	0.222***	0.188***	0.277***	0.174***	0.157***	0.257***	0.253***
7. Forecast precision$_{t+1,t+3}$							0.231***	0.281***	0.271***	0.178***	0.158***	0.125***	0.209***	0.201***
8. DQ_BS (%)$_{t+1,t+3}$								0.544***	0.905***	0.031***	0.092***	0.058***	0.066***	0.087***
9. DQ_IS (%)$_{t+1,t+3}$									0.855***	0.470***	0.312***	0.246***	0.462***	0.432***
10. DQ (%)$_{t+1,t+3}$										0.241***	0.216***	0.151***	0.268***	0.271***
11. −ln(1+Complex words)$_{t+1,t+3}$											0.642***	0.603***	0.955***	0.904***
12. −F-K readability $_{t+1,t+3}$												0.981***	0.623***	0.608***
13. −G-F readability $_{t+1,t+3}$													0.574***	0.559***
14. −ln(1+L-M Uncertainty words)$_{t+1,t+3}$														0.952***
15. −ln(1+L-M Modal weak words)$_{t+1,t+3}$														

The unit of observation is a firm-year. The sample period is 1992 to 2018. Data for vega, delta, and salarycomp are winsorized at the 1st and 99th percentiles. Detailed variable definitions are in Appendix A.

Table 5
Equity-based CEO compensation and future information disclosure quality indices.

Dependent variables measured from t+1 to t+3	Report quality index	Readability index	Dependent variables are changes from t to t+3	Change-on-Change Report quality index	Change-on-Change Readability index
CEO ln(1+vega)$_t$	−0.0160***	−0.1013***	△CEO ln(1+vega)$_{t-1,t}$	−0.0603***	−0.0341***
	(−7.90)	(−14.74)		(−7.90)	(−4.53)
CEO ln(1+delta)$_t$	−0.0121***	−0.0740***	△CEO ln(1+delta)$_{t-1,t}$	0.0102*	0.0058
	(−2.65)	(−8.35)		(1.67)	(1.16)
CEO salarycomp$_t$	0.0559**	0.3091***	△CEO salarycomp$_{t-1,t}$	0.0182*	0.0017
	(2.49)	(9.49)		(1.73)	(0.05)
ln (1+CEO tenure)$_t$	0.0328***	0.1525***	–	–	–
	(2.74)	(9.51)		–	–
ln(CEO age)$_t$	0.0675	0.2906***	–	–	–
	(0.94)	(3.00)		–	–
CEO duality$_t$ (0,1)	−0.0137	−0.0517**	–	–	–
	(−0.75)	(−2.18)		–	–
Founder CEO$_t$ (0,1)	−0.0874**	−0.0775*	–	–	–
	(−2.05)	(−1.83)		–	–
CEO ability$_t$	0.1014***	0.5824***	△CEO ability$_{t-1,t}$	0.0232	0.0896
	(3.37)	(7.24)		(1.23)	(1.58)
ln(Sales)$_t$	−0.1575***	−0.7330***	△ln(Sales)$_{t-1,t}$	−0.1456***	−0.3537***
	(−9.23)	(−32.46)		(−4.89)	(−10.53)
ln(Firm age)$_t$	−0.1069***	−1.1529***	△ln(Firm age)$_{t-1,t}$	–	–
	(−8.43)	(−30.47)		–	–
Leverage$_t$	−0.1984***	−0.3437***	△Leverage$_{t-1,t}$	−0.0639	0.3034***
	(−2.68)	(−4.52)		(−1.39)	(4.05)
ROA$_t$	0.4304***	2.1307***	△ROA$_{t-1,t}$	0.0574	0.3621***
	(3.09)	(12.52)		(0.56)	(3.86)
Stock return$_t$	0.0081*	−0.0006	△Stock return$_{t-1,t}$	0.0199***	0.0014
	(1.77)	(−0.16)		(3.76)	(0.29)
Market-to-book$_t$	−0.0068***	−0.0328***	△Market-to-book$_{t-1,t}$	−0.0094*	−0.0075
	(−2.57)	(−4.09)		(−1.76)	(−1.50)
PP&E/assets$_t$	0.6079***	2.4224***	△PP&E/assets$_{t-1,t}$	0.2182*	0.1410
	(6.48)	(20.27)		(1.74)	(1.11)
Growth in sales$_t$	−0.0006**	−0.0056***	△Growth in sales$_{t-1,t}$	−0.0058**	−0.0021
	(−2.00)	(−3.49)		(−2.38)	(−0.90)
Intangibles$_t$	−0.0808***	−0.2325***	△Intangibles$_{t-1,t}$	−0.0868	−0.1174***
	(−2.99)	(−4.56)		(−0.90)	(−3.02)
ILLIQ$_t$	−0.0436*	−0.2127**	△ILLIQ$_{t-1,t}$	−0.1894***	−0.0091
	(−1.78)	(−2.16)		(−3.80)	(−0.11)
σCF$_t$	−0.2210**	−0.8064***	△σCF$_{t-1,t}$	−0.8897***	−0.7226***
	(−2.16)	(−5.47)		(−3.15)	(−3.89)
σSales$_t$	−0.0503***	−0.0909***	△σSales$_{t-1,t}$	−0.0500**	−0.0899***
	(−3.46)	(−4.35)		(−2.09)	(−5.42)
Top5_Instown$_t$	−0.1082***	−0.6542***	△Top5_Instown$_{t-1,t}$	−0.1777***	0.1497*
	(−3.80)	(−6.96)		(−3.20)	(1.85)
Constant	−2.8974***	2.1223***	Constant	0.3142***	−0.1321***
	(−7.17)	(7.58)		(10.67)	(−4.49)
Adj R-squared	0.8257	0.877	Adj R-squared	0.721	0.3228
Observations	17,444	18,964	Observations	15,215	16,599

Dependent variables are Report quality index and Readability index constructed using principal components analysis (PCA) and changes in these variables from t to t+3. Report quality index is the first factor of a PCA using the five traditional disclosure variables. Readability index is the first factor of a PCA using the five linguistic measures of disclosure quality. Both indices are standardized to have zero mean and a standard deviation of 1. In Change-on-Change models, changes in explanatory variables are from t-1 to t. t-values reported are based on robust standard errors clustered by firm and by year (two-way) and are reported in parentheses. Firm and year fixed effects are included in all models. The sample period is 1992–2018. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Detailed variable definitions are in Appendix A. PCA models are in Appendix B. – = not applicable.

such that it has a mean of one, with a higher value indicating higher narrative quality. Results, presented in Table 3, are also consistent with our hypothesis; CEO ln(1+ vega) is negatively associated with the narrative quality of future financial reports for all five measures. CEO ln(1+ delta) is also negatively associated with the narrative quality of future financial reports in all models. Again, in contrast, CEO salarycomp is positively associated with narrative quality of future financial reports across all models.

Among other CEO variables, CEO tenure, CEO age, and CEO ability are positively associated with narrative quality across all models. Other CEO variables are not consistently significant. Results for firm-level control variables are qualitatively similar to those in Table 2 and, in addition, σCF and σSales are negatively associated with readability measures in most models (except -G-F Readability index). Once more, we estimate analogous change-on change models and replace firm fixed effects with industry fixed effects in all models; untabulated results from these models confirm Table 3 findings.

To summarize, by using a broad range of measures of disclosure quality, we contribute clarifying evidence to the debate on the relation between equity-based CEO compensation and the quality and quantity of accounting disclosures. Models using all ten measures unanimously document a significant negative association between CEO ln(1 + vega) and the quality of future accounting disclosures. Because our models include firm fixed effects, only the effects of within-firm changes in CEO ln(1 + vega) are taken into account, so firm-specific omitted variables cannot explain the observed statistically significantly negative relation between CEO ln(1 + vega) and the quality of future accounting disclosures.

4.2. Formation and analysis of disclosure quality indices

Perhaps not surprisingly, there are significant positive correlations among many of the measures of disclosure quality, in particular, among the linguistic measures. As reported in Table 4, the Pearson pairwise correlations among all the measures of disclosure quality range from 0.031 (the correlation between DQ_BS (%)$_{t+1,t+3}$ and -ln(1 + Complex words)$_{t+1,t+3}$) to 0.955 (the correlation between -ln (1 + Complex words)$_{t+1,t+3}$ and -ln(1 + L-M Uncertainty words)$_{t+1,t+3}$).

These significant correlations provide a basis for employing principal components analysis (PCA) to reduce the dimensionality of the data with minimal loss of information. More specifically, we use PCA models, presented in Appendix B, to create two composite disclosure quality indices. The first, Report quality index, is based on the first factor of a PCA analysis using the five traditional disclosure quality measures. The second, Readability index, is based on the first factor of a PCA analysis using the five linguistic measures of narrative accounting disclosures. By construction, Report Quality and Readability Indices have a mean of zero and a standard deviation of one. An eigenvalue of 1 is a common rule of thumb for determining if a factor should be used in subsequent analysis.

As reported in Appendix B, Panel A, each of the five traditional disclosure quality variables has a positive loading and only the first principal component has an eigenvalue greater than one (eigenvalue of 1.792). Similarly, as reported in Appendix B, Panel B, each of the five linguistic variables has a positive loading and only the first principal component has an eigenvalue greater than one (eigenvalue of 3.564). The resulting indices are:

Report quality index = 0.07 (DAQ) + 0.19 (ERC) + 0.55 (ln (1 + Voluntary disclosure frequency)) + 0.55 (Forecast precision) + 0.59 (DQ%) and

Readability index = 0.39(−1*F-K readability) + 0.39(−1*G-F readability) + 0.48(−ln(1 + Complex words)) + 0.48(−ln(1+ L-M Modal weak words)) + 0.48(−ln(1+ L-M Uncertainty words)),

Table 5 presents models estimated using Report quality index, Readability index and changes in these indices as dependent variables. In level specifications, the explanatory variables are the same as those in Tables 2 and 3. For first-differenced specifications, changes in dependent variables are from t to t + 3 and changes in explanatory variables are from t-1 to t.[18]

As the Report quality index extracts common components from the five traditional disclosure quality variables, it is not surprising that the coefficients for CEO ln(1 + vega) (changes in CEO ln(1 + vega)) in the Report quality index (changes in Report quality index) regression are significantly negative at the 1% level. Along the same lines, as the Readability index extracts common components from the five linguistic variables, it is not surprising that the coefficients for CEO ln(1 + vega) (changes in CEO ln(1 + vega)) in the Readability index (changes in Readability index) regression are significantly negative at the 1% level. Again, the results reported in Table 5 are consistent with our hypothesis.

The effect also seems economically important. Using the estimates in the level specification, a one standard deviation increase in CEO ln(1 + vega) is associated with 0.028 standard deviation decrease in Report quality index and 0.176 standard deviation decrease in Readability index.[19] CEO ln(1 + delta) is also both economically and statistically significant in the level specification; a one standard deviation increase in the CEO ln(1+ delta) is associated with 0.021 standard deviation decrease in Report quality index and 0.127 standard deviation decrease in Readability index. However, changes in CEO ln(1 + delta) are either insignificant or marginally significantly positive. Having shown that our disclosure quality indices capture information contained in the ten individual measures, we use these indices in the remainder of our analyses.

4.3. Two-stage least squares analysis using instrumental variables

Our results thus far establish a strong negative relationship between CEO equity incentives and the quality of future accounting disclosures. It is possible, however, that CEO equity incentive contracts and disclosure quality are endogenously or jointly determined. This limits our ability to make causal inferences regarding our findings. In this and the two sections that follow, we employ a battery of analyses whose purpose is to test for a causal relationship between CEO equity incentives and subsequent accounting disclosure policy. In this section, we conduct two-stage least squares (2SLS) analysis using instrumental variables (IVs).

[18] For change-on-change models, some of the discrete explanatory variables become irrelevant because their changes are not meaningful or informative, so they are excluded from these models.

[19] The standard deviation of CEO ln(1 + vega) is 1.7368. If we increase CEO ln(1 + vega) by one standard deviation, the predicted increase in Report quality index is 1.7368*−0.0160 = −0.0278. The standard deviation of Report quality index is one. Thus, an increase of one standard deviation in CEO ln(1 + vega) causes an increase of −0.0278/1 = −0.0278 of a standard deviation in Report quality index. Similarly, if we increase CEO ln(1 + vega) by one standard deviation, the predicted increase of Readability index is 1.7368* − 0.1013 = −0.1759. The standard deviation of Report quality index is one. Thus, an increase of one standard deviation in CEO ln(1 + vega) causes an increase of −0.1759/1 = −0.1759 of a standard deviation in Readability index.

To implement 2SLS, we treat CEO ln(1 + vega)$_t$ and CEO ln(1 + delta)$_t$ as endogenous and estimate first-stage models that regress them on three IVs and the exogenous control variables used in Tables 2, 3 and 5. The predicted values of CEO ln(1 + vega)$_t$ and CEO ln (1 + delta)$_t$ from stage one are then used in stage two to estimate the disclosure quality indices.

To satisfy the exclusion restriction for valid IVs, we use three IVs. The first and second IVs are median CEO ln(1 + vega)$_{t-1}$ and median CEO ln(1 + delta)$_{t-1}$ for firms that are in the same market capitalization decile and use the same compensation consultant as the sample firm but are not in the same Fama and French (1997) 48 industry classification in year t-1. Excluding firms in the same industry reduces the possibility of violating the exclusion restriction due to industry-related compensation practices; firms in the same industry face an economic environment similar to that of the focal firm, which suggests that they may make similar decisions regarding CEO compensation and accounting disclosure policies (Cai et al. (2018); Bereskin and Cicero (2013)). The third IV is a State R&D tax credit indicator which equals one if the firm is headquartered in a state where the effective state R&D tax credit rate in year t-1 is positive and zero otherwise. State R&D tax credits allow firms to reduce their state income tax liability by deducting qualified R&D expenditures. All else constant, the tax shelter benefits of executive compensation expense become less valuable in the presence of an R&D tax credit.[20]

Table 6, Panel A presents first and second-stage results for level models. For brevity, Table 6 presents coefficient estimates for CEO compensation and characteristic variables but omits coefficients for firm-level control variables. In the first stage, all three instruments have statistically significant coefficients and are of the predicted sign. For both endogenous variables, the high partial R-squared and the strongly significant first-stage partial F-statistics suggest that the excluded instruments, jointly, provide a significant degree of incremental explanatory power and that our results are not susceptible to biases from weak instruments.

Second-stage models document a significant negative relation between both predicted CEO ln(1 + vega) and predicted CEO ln(1 + delta) and future disclosure quality indices. Weak-identification tests, specifically the Anderson and Rubin (1949) Wald F-statistic and the Cragg and Donald (1993) Wald F-statistic, strongly reject the null hypothesis that the endogenous variables are jointly equal to zero at the 1% level. In addition, using the Hansen (1982) J-statistic, we cannot reject the over-identifying restrictions test (*p*-values of 0.58 and 0.46 for models (3) and (4), respectively). Thus, for second-stage models, we have confidence that the instruments are valid (and satisfy the exclusion restriction). Overall, the 2SLS/IV models in Panel A of Table 6 support the hypothesis of a deleterious effect of CEO vega on future disclosure quality.

Table 6, Panel B presents first- and second-stage results for first-differenced specifications. Again, partial F-statistics confirm that excluded instruments are strongly correlated with both endogenous variables in stage one. Second-stage models document a significant negative relation between predicted changes in CEO ln(1 + vega) and future changes in disclosure quality indices. Further, all IV specifications pass the tests for weak instruments and the Hansen (1982) over-identification test. Thus, Panel B of Table 6 also supports the hypothesis of a negative causal relationship between changes in CEO vega and future changes in disclosure quality.

4.4. The impact of FAS 123R

FAS 123R represented an exogenous shock that reduced the use of stock options (and hence CEO vega) for many firms (Hayes et al. (2012); Bakke et al. (2016)). We examine two-years prior to (2003–2004) and two years following (2005–2006) the adoption of FAS 123R for treated and untreated (or control) firms.[21] Treated firms are those likely to be impacted by the adoption of FAS 123R; they granted CEO options prior to FAS 123R and did not voluntarily expense them. In contrast, control firms are those unlikely to be impacted by the adoption of FAS 123R; they either did not grant CEO options prior to FAS 123R or granted CEO options and voluntarily expensed them.[22] We predict that treated firms will exhibit an improvement in disclosure quality following the adoption of FAS 123R relative to untreated firms due to a reduction in the use of CEO options.

We define Post-FAS 123R as an indicator variable that equals one if the observation is in the post-treatment period and zero if it is in the pre-treatment period and Treated is an indicator variable that equals one for treated firms and zero for control firms. The interaction variable (Treated*Post-FAS 123R) serves as an instrument for CEO vega. In first-stage models, we regress CEO ln(1 + vega)$_t$ on this IV and the exogenous control variables used in Tables 2, 3 and 5. We then estimate the reduced-form models as follows:

$$\text{Disclosure quality indices}_{i,t+1,t+3} = \beta_0 + \beta_1\,(\text{Treated}_i{*}\text{Post-FAS 123R}_t) + \sum_k \beta_k\,\text{Control}_{i,k,t} + \text{Fixed effects} + \varepsilon_{i,t+1,t+3}. \tag{2}$$

In reduced-form models, disclosure quality indices are regressed directly on the instrument (i.e. Treated*Post-FAS 123R) and the exogenous control variables. We use reduced-form regressions rather than the traditional 2SLS to examine the direct causal effect of Treated*Post-FAS 123R rather than its indirect effect through CEO ln(1 + vega). If our prediction is correct, β_1 in Eq. (2), the coefficient for Treated*Post-FAS 123R, should be positive in reduced-form regressions.

Table 7 presents first-stage and the reduced-form regressions. Odd-numbered models include only the interaction variable (Treated*Post-FAS 123R) and firm and year fixed effects as explanatory variables. Even-numbered models also include control

[20] These data are obtained from Wilson (2009) and Chang (2018).

[21] We choose these two-year pre- and post-FAS 123R periods because they are after the enactment of the Sarbanes–Oxley Act of 2002 but before the 2008 global financial crisis. Hence, this relatively short sample period helps keep the regulatory policies and macroeconomic health roughly constant across the pre- and post- periods.

[22] We thank Professor Kelly Shue for her generosity in sharing data used in Shue and Townsend (2017a) on the voluntary expensing of option compensation.

Table 6
Two-stage least squares estimation: equity-based CEO compensation and future disclosure quality.

Panel A	Stage 1		Stage 2	
	CEO ln(1+vega)$_t$	CEO ln(1+delta)$_t$	Report quality index	Readability index
	1	2	3	4
Non-Ind/size/Consultant	0.6307***	0.0421***	–	–
Median CEO ln(1+vega)$_{t-1}$	(52.01)	(3.87)	–	–
Non-Ind/size/Consultant	0.0801***	0.2741***	–	–
Median CEO ln(1+delta)$_{t-1}$	(6.72)	(25.64)	–	–
State R&D tax credit$_{t-1}$	0.1991***	0.1626***	–	–
	(5.24)	(4.77)	–	–
Predicted CEO ln(1+vega)$_t$	–	–	−0.2079***	−0.4227***
	–	–	(−13.43)	(−12.11)
Predicted CEO ln(1+delta)$_t$	–	–	−0.1747***	−0.5491***
	–	–	(−5.54)	(−7.52)
CEO salarycomp$_t$	−0.4722***	−1.3318***	0.1389*	0.5238***
	(−5.86)	(−18.43)	(1.79)	(2.97)
ln (1+CEO tenure)$_t$	0.2610***	0.4225***	0.1992***	0.5260***
	(12.44)	(22.45)	(8.95)	(10.17)
ln(CEO age)$_t$	−0.7674***	−0.4087***	0.2976***	−0.0665
	(−5.66)	(−3.36)	(2.75)	(−0.27)
CEO duality$_t$ (0,1)	0.0248	0.1365***	−0.0132	0.0462
	(0.74)	(4.54)	(−0.49)	(0.75)
Founder CEO$_t$ (0,1)	−0.0161	0.3876***	−0.2653***	−0.2223
	(−0.21)	(5.60)	(−4.24)	(−1.55)
CEO ability$_t$	0.0541	−0.0078	0.1289	0.7793***
	(0.54)	(−0.09)	(1.60)	(4.32)
Control Variables	YES	YES	YES	YES
R-squared	0.7093	0.7147	–	–
Partial R-squared	0.4545	0.2520	–	–
First-stage partial F-statistics	995.31***	282.28***	–	–
WID (Anderson-Rubin Wald F-statistic)	–	–	172.78***	220.67***
WID (Cragg-Donald Wald F-statistic)	–	–	251.082***	258.103***
OID (Hansen J-statistic)	–	–	0.3113	0.5419
[*P*-value]	–	–	[0.5769]	[0.4616]
Observations	8398	8398	7827	8398

Panel B	Stage 1		Stage 2	
	△CEO ln(1+vega)$_{t-1,t}$	△CEO ln(1+delta)$_{t-1,t}$	△Report quality index	△ Readability index
	5	6	7	8
△Non-Ind/size/Consultant	0.0870***	0.0209**	–	–
Median CEO ln(1+vega)$_{t-2,t-1}$	(7.69)	(2.14)	–	–
△Non-Ind/size/Consultant	0.0406***	0.1351***	–	–
Median CEO ln(1+delta)$_{t-2,t-1}$	(4.14)	(13.81)	–	–
△State R&D tax credit$_{t-2,t-1}$	1.6244**	0.8634*	–	–
	(2.37)	(1.82)	–	–
Predicted △CEO ln(1+vega)$_{t-1,t}$	–	–	−0.5298***	−1.1707***
Predicted △CEO ln(1+delta)$_{t-1,t}$	–	–	(−4.01)	(−6.16)
	–	–	0.3457***	0.4728***
	–	–	(3.77)	(3.40)
△CEO salarycomp$_{t-1,t}$	−0.4001***	−0.9681***	0.1801**	0.1925
	(−4.98)	(−12.10)	(2.02)	(1.15)
△CEO ability$_{t-1,t}$	0.1968**	0.0197	0.3104***	0.2260
	(2.04)	(0.21)	(2.69)	(1.42)
Control Variables	YES	YES	YES	YES
R-squared	0.176	0.235	–	–
Partial R-squared	0.0305	0.0483	–	–
First-stage partial F-statistics	34.53***	67.35***	–	–
WID (Anderson-Rubin Wald F-statistic)	–	–	10.45***	35.25***
WID (Cragg-Donald Wald F-statistic)	–	–	21.604***	23.77***
OID (Hansen J-statistic)	–	–	0.397	0.0054
[P-value]	–	–	[0.5286]	[0.9416]
Observations	6081	6081	5590	6081

Dependent variables are Report quality index and Readability index constructed using principal components analysis (PCA) (Panel A) and changes in these variables from t to t+3 (Panel B). The Report quality index is the first factor of a PCA using the five traditional disclosure quality variables. The Readability index is the first factor of a PCA using the five linguistic measures of disclosure quality. Both indices are standardized to have zero mean and a standard deviation of 1. In Change-on-Change models changes in explanatory variables are from t-1 to t. CEO ln(1+vega) and CEO ln(1+delta) are treated as endogenous in the first-stage models (reported in models (1/5) and (2/6), respectively) which include instrumental variables (IVs) and control variables. The three instruments are: (1) median CEO $\ln(1+vega)_{t-1}$ for firms that are in the same market capitalization decile and share the same compensation consultant as sample firms, excluding firms in the sample firm's Fama French (1997) 48 industry classification in year t-1; (2) median CEO $\ln(1+delta)_{t-1}$ for firms that are in the same market capitalization decile and share the same compensation consultant as sample firms, excluding firms in the sample firm's Fama French (1997) 48 industry classification in year t-1; (3) State R&D tax credit indicator which equals one if the firm is headquartered in a state where the effective state R&D tax credit rate in year t-1 was positive and zero otherwise. In Change-on-Change models, our first two instruments reported in models (5/6) are changes in the first two instruments reported in models (1/2) from year t-2 to t-1 and the third instrument equals the changes in the effective state R&D tax credit rate from year t-2 to year t-1. Models (3/7) and (4/8) present the second-stage regression results. Control variables are the same as those used in Tables 2, 3 and 5. Firm and year fixed effects are included in all models. The sample period is 1992–2018. t-values are based on robust standard errors clustered by firm and by year (two-way) and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. – indicates not applicable. WID indicates weak identification tests. OID indicates over-identification tests. Detailed variable definitions are in Appendix A. PCA models are in Appendix B.

Table 7

First-stage and reduced-form regressions of the effect of FAS 123R on equity-based CEO compensation and future information disclosure quality indices.

	Stage 1				Reduced-form		Reduced-form	
	CEO $\ln(1+vega)_t$		CEO $\ln(1+delta)_t$		Report quality $index_{t+1\ to\ t+3}$		Readability $index_{t+1\ to\ t+3}$	
	1	2	3	4	5	6	7	8
Treated*Post-FAS 123R	−0.1990***	−0.1052***	−0.0289	−0.0336	0.0640***	0.0533*	0.0645***	0.0537**
	(−8.42)	(−2.60)	(−1.37)	(−1.04)	(3.09)	(1.91)	(4.28)	(2.15)
CEO $\ln(1+delta)_t$	–	–	–	–	–	0.0070	–	−0.0052
	–	–	–	–	–	(0.60)	–	(−0.81)
CEO $salarycomp_t$	–	−0.2264**	–	−0.3100***	–	−0.0222	–	0.0185
	–	(−2.27)	–	(−3.94)	–	(−0.40)	–	(0.47)
$\ln(1+\text{CEO tenure})_t$	–	0.3715***	–	0.4414***	–	0.0197	–	−0.0062
	–	(8.63)	–	(12.68)	–	(0.80)	–	(−0.36)
$\ln(\text{CEO age})_t$	–	−1.0664***	–	−0.1939	–	−0.1893	–	−0.0716
	–	(−3.81)	–	(−0.87)	–	(−1.21)	–	(−0.65)
CEO $duality_t$ (0,1)	–	−0.0132	–	0.3067***	–	−0.0216	–	−0.0403
	–	(−0.18)	–	(5.34)	–	(−0.54)	–	(−1.42)
Founder CEO_t (0,1)	–	−0.5174***	–	0.7913***	–	−0.1030	–	0.0719
	–	(−3.90)	–	(7.49)	–	(−1.39)	–	(1.36)
CEO $ability_t$	–	−0.1639	–	−0.2722	–	0.0051	–	0.0655
	–	(−0.68)	–	(−1.41)	–	(0.04)	–	(0.69)
Controls	NO	YES	NO	YES	NO	YES	NO	YES
Adj R-squared	0.8342	0.8733	0.8184	0.8805	0.8362	0.8503	0.948	0.9549
First-stage partial F-statistics	92.78***	124.53***	–	–	–	–	–	–
Observations	6442	3260	6820	3314	4153	3050	8283	3328

Dependent variables are CEO ln(1+vega), CEO ln(1+delta) in year t, and Report quality index and Readability index constructed using principal components analysis (PCA) for years t+1 to t+3. Post-FAS 123R is an indicator variable that equals one if the observation is after the adoption of FAS 123R (years 2005 and 2006) and zero if the observation is before the adoption of FAS 123R (years 2003 and 2004). Treated is an indicator variable that equals one for firms that used options in their CEO pay and did not adopt the fair value method for expensing options prior to the adoption of FAS 123R and zero for firms that did not grant their CEO stock options or preemptively adopted the fair value method prior to the adoption of FAS 123R. Detailed variable definitions are in Appendix A. Firm and year fixed effects are included in all models. t-values are based on robust standard errors clustered by firm and by year (two-way) and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. – indicates not applicable.

variables. In all specifications, we include firm and year fixed effects which subsume stand-alone Treated and Post-FAS 123R, respectively. The significantly negative coefficients for Treated*Post-FAS 123R in first-stage Models (1) and (2), where CEO $\ln(1 + vega)_t$ is the dependent variable, confirm that treated firms significantly reduce their use of CEO options in the post-treatment period. Models (3) and (4), where CEO $\ln(1 + delta)_t$ is the dependent variable, show no significant change in the use of stock-based compensation for CEOs among treated firms compared to control firms in the post-treatment period. This suggests that

Table 8
First-stage and reduced form regressions of the effect of multiyear CEO options grants on disclosure quality.

Panel A: firm-years with fixed-value CEO option grants

	Stage 1		Stage 1		Reduced-form		Reduced-form	
	CEO ln(1+vega)$_t$		CEO ln(1+delta)$_t$		Report quality index$_{t+1\ to\ t+3}$		Readability index$_{t+1\ to\ t+3}$	
	1	2	3	4	5	6	7	8
Predicted First Year	0.1478***	0.0418*	0.1851***	0.1475***	−0.1501***	−0.0431*	−0.2247***	−0.0611**
	(6.84)	(1.84)	(7.38)	(5.81)	(−7.47)	(−1.91)	(−11.45)	(−2.49)
CEO salarycomp$_t$	–	−1.5009***	–	−0.9103***	–	0.3499**	–	0.9774***
	–	(−7.98)	–	(−4.98)	–	(2.32)	–	(5.57)
ln(1+CEO tenure)$_t$	–	0.3142***	–	0.7905***	–	0.0071	–	0.2067***
	–	(5.24)	–	(13.16)	–	(0.16)	–	(3.96)
ln(CEO age)$_t$	–	−1.9664***	–	−1.1699***	–	1.1975***	–	0.8791***
	–	(−6.26)	–	(−3.19)	–	(4.14)	–	(2.67)
CEO duality$_t$ (0,1)	–	0.1546**	–	0.1984***	–	0.0144	–	−0.2091***
	–	(2.27)	–	(3.07)	–	(0.26)	–	(−3.18)
Founder CEO$_t$ (0,1)	–	−0.6865**	–	−0.5955*	–	−0.2611	–	0.4004*
	–	(−2.32)	–	(−1.64)	–	(−1.21)	–	(1.87)
CEO ability$_t$	–	0.0405	–	−0.1194	–	0.5827***	–	0.6564***
	–	(0.24)	–	(−0.71)	–	(3.12)	–	(3.14)
Controls	NO	YES	NO	YES	NO	YES	NO	YES
First-stage partial F-statistics	25.00***	15.51***	13.74***	9.67***	–	–	–	–
Adj R-squared	0.8961	0.9184	0.8543	0.8763	0.8645	0.8884	0.917	0.929
Observations	4887	2797	4887	2797	3109	2668	4887	2804

Panel B: firm-years with fixed-value or fixed-number multi-year CEO option grants (excluding the first years of cycles)

	1	2	3	4	5	6	7	8
FN * Industry Return	0.1088***	0.1017**	0.3331***	0.2207***	−0.2127***	−0.1357***	−0.2465***	−0.1020**
	(2.58)	(2.18)	(6.74)	(4.56)	(−7.26)	(−3.03)	(−8.55)	(−2.40)
CEO salarycomp$_t$	–	−1.4554***	–	−0.8910***	–	0.7339***	–	1.2395***
	–	(−10.59)	–	(−3.10)	–	(4.72)	–	(7.04)
ln (1+CEO tenure)$_t$	–	0.2187***	–	0.6427***	–	0.1115***	–	0.1546***
	–	(6.67)	–	(18.08)	–	(3.08)	–	(3.78)
ln(CEO age)$_t$	–	−1.1834***	–	−0.5720**	–	0.1641	–	0.7277***
	–	(−5.58)	–	(−2.51)	–	(0.72)	–	(2.81)
CEO duality$_t$ (0,1)	–	0.1020**	–	0.1220**	–	−0.1293**	–	−0.2357***
	–	(2.19)	–	(2.44)	–	(−2.52)	–	(−4.01)
Founder CEO$_t$ (0,1)	–	−0.2352**	–	0.1285	–	0.1133	–	0.3257**
	–	(−2.23)	–	(1.13)	–	(0.96)	–	(2.46)
CEO ability$_t$	–	−0.3798*	–	−0.2296	–	0.3555**	–	0.8780***
	–	(−1.93)	–	(−1.28)	–	(1.97)	–	(4.34)
Controls	NO	YES	NO	YES	NO	YES	NO	YES
First-stage partial F-statistics	53.95***	35.07***	19.13***	6.32**	–	–	–	–
Adj R-squared	0.9328	0.955	0.9317	0.9471	0.8819	0.8829	0.9172	0.9259
Observations	6051	3399	6095	3407	3842	3260	6107	3409

Dependent variables are CEO ln(1+vega), CEO ln(1+delta), and Report quality index and Readability index constructed using principal components analysis (PCA). Panel A includes only firm-years where the CEO has a fixed-value multiyear option grant cycle. Panel B includes only firm-years where the CEO has a fixed-value or a fixed-number multiyear option grant as part of his compensation package (excluding the first years of cycles). In Panel A, Predicted First Year is equal to one in the year the firm would be predicted to start a new fixed-value option grant cycle (based only on the history of past fixed-value option granting behavior) and zero otherwise. In Panel B, FN is equal to one for firm-years where the CEO has a fixed-number option grant and zero otherwise. Industry Return is the average industry return to the firm's Fama French 48 industry over the 12 months preceding the option grant. The interaction FN*Industry Return captures sample firm-years in which value of option grants for CEOs on fixed-number multiyear option grant relative to CEOs on fixed-value option plans is mechanically positively linked to industry performance. Detailed variable definitions are in Appendix A. The sample period is 1992 to 2018. Firm and year fixed effects are included in all models. t-values are based on robust standard errors clustered by firm and by year (two-way) and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. – indicates not applicable.

Table 9
Subsample analysis of equity-based CEO compensation and future disclosure quality.

Dependent variables measured from t+1 to t+3	Project duration[†]		Industry specialist auditor		CEO network size	
	Short	Long	No	Yes	Small	Large
	1	2	3	4	5	6
Panel A: univariate analysis						
DAQ	−0.094	0.005***	−0.023	0.018***	−0.007	0.068***
ln(1+Voluntary disclosure frequency)	2.276	2.548***	2.250	2.357***	2.108	2.618***
ERC	0.187	0.280***	0.192	0.243***	0.087	0.161***
Forecast precision	2.129	2.153**	2.125	2.137*	2.149	2.155
DQ (%)	56.0%	64.12%***	61.4%	61.92%***	58.9%	63.91%***
−ln(1+Complex words)	−7.918	−7.884**	−7.923	−7.812***	−8.241	−7.614***
−ln(1+ L-M Uncertainty words)	−4.910	−4.753***	−4.875	−4.768***	−5.252	−4.566***
−F-K readability Index	−15.588	−15.407***	−15.506	−15.480	−15.897	−15.232***
−G-F Readability Index	−19.644	−19.424***	−19.512	−19.512	−19.888	−19.295***
−ln(1+L-M Modal weak words)	−3.758	−3.576***	−3.743	−3.618***	−4.095	−3.413***
Report quality index	−0.067	0.052***	−0.037	0.131***	0.209	1.127***
Readability index	−0.054	−0.020***	−0.304	0.003***	−1.180	0.001***
Panel B: report quality index regressions						
CEO ln(1+vega)$_t$	−0.0197***	−0.0097*	−0.0174***	−0.0119***	−0.0343***	−0.0160**
	(−5.40)	(−1.83)	(−7.16)	(−2.58)	(−5.26)	(−2.23)
CEO ln(1+delta)$_t$	−0.0137***	−0.0102	−0.0123***	−0.0121**	−0.0117	0.0032
	(−3.30)	(−1.30)	(−3.84)	(−2.15)	(−1.49)	(0.36)
CEO salarycomp$_t$	0.0442**	0.0787**	0.0438***	0.0375	0.0323	0.0407
	(2.25)	(2.18)	(2.86)	(1.35)	(0.90)	(0.76)
ln(1+CEO tenure)$_t$	0.0508***	−0.0401	0.0346**	0.0262	−0.0030	0.0002
	(2.75)	(−1.34)	(2.35)	(1.10)	(−0.07)	(0.00)
ln(CEO age)$_t$	0.1482	0.1603	0.1935**	−0.1489	0.2424	1.4917***
	(1.43)	(0.92)	(2.18)	(−1.05)	(0.68)	(2.60)
CEO duality$_t$ (0,1)	−0.0167	−0.0293	−0.0175	−0.0399	0.0078	0.0679
	(−0.58)	(−0.65)	(−0.80)	(−1.02)	(0.10)	(0.97)
Founder CEO$_t$ (0,1)	−0.0791	−0.1836**	−0.0750	−0.1580	−0.1925	−0.1929
	(−1.26)	(−2.19)	(−1.52)	(−1.61)	(−1.38)	(−0.48)
CEO ability$_t$	0.0796*	0.0604	0.1128***	0.0327	0.0058	0.0884
	(1.85)	(0.98)	(3.63)	(0.64)	(0.07)	(1.08)
Controls	YES	YES	YES	YES	YES	YES
[p-value] – CEO ln(1+vega) are equal	[0.0522]		[0.0389]		[0.0098]	
[p-value] – CEO ln(1+delta) are equal	[0.2323]		[0.5990]		[0.5969]	
Adj R-squared	0.8487	0.8027	0.8395	0.844	0.8527	0.8624
Observations	5873	5905	12,545	4899	2202	2181
Panel C: readability index regressions						
CEO ln(1+vega)$_t$	−0.1127***	−0.0607***	−0.1074***	−0.0983***	−0.1216***	−0.0998***
	(−12.13)	(−4.02)	(−14.76)	(−6.90)	(−6.96)	(−5.01)
CEO ln(1+delta)$_t$	0.0003***	−0.0940***	0.0002**	0.0014	−0.0100	0.0178
	(2.71)	(−5.78)	(2.37)	(0.10)	(−0.63)	(0.93)
CEO salarycomp$_t$	0.2555***	0.2382***	0.3067***	0.2965***	0.0191	−0.0595
	(5.98)	(3.16)	(8.19)	(4.75)	(0.24)	(−0.58)
ln(1+CEO tenure)$_t$	0.1617***	0.2014***	0.0865***	0.1937***	0.1292***	0.0094
	(7.90)	(5.94)	(5.27)	(6.17)	(2.63)	(0.12)
ln(CEO age)$_t$	−0.1909	0.2069	0.2526**	0.2490	−1.7206***	−5.2411***
	(−1.58)	(1.02)	(2.55)	(1.33)	(−4.36)	(−6.20)
CEO duality$_t$ (0,1)	−0.0271	−0.0764	−0.0638**	−0.0320	−0.1995**	−0.2921***
	(−0.83)	(−1.41)	(−2.44)	(−0.68)	(−2.39)	(−4.03)
Founder CEO$_t$ (0,1)	0.0970*	−0.0493	0.0161	−0.4840***	0.8702***	0.5027
	(1.86)	(−0.51)	(0.36)	(−5.71)	(6.34)	(1.49)
CEO ability$_t$	0.5113***	0.4993***	0.5732***	0.6963***	0.0933	0.0608
	(4.54)	(2.97)	(6.42)	(4.12)	(0.42)	(0.34)

(*continued on next page*)

Table 9 (*continued*)

Dependent variables measured from t+1 to t+3	Project duration†		Industry specialist auditor		CEO network size	
	Short	Long	No	Yes	Small	Large
	1	2	3	4	5	6
Controls	YES	YES	YES	YES	YES	YES
[p-value] – CEO ln(1+vega) are equal	[0.0220]		[0.0018]		[0.1847]	
[p-value] – CEO ln(1+delta) are equal	[0.0283]		[0.0014]		[0.2114]	
Adj R-squared	0.8945	0.8781	0.8869	0.9028	0.9221	0.9234
Observations	6425	6526	13,489	5475	2384	2366

Dependent variables for regression models are Report quality index and Readability index constructed using principal components analysis (PCA). Project duration is the median ratio of PP&E plus goodwill-to-noncash total assets for all firms in the sample firm's Fama-French 48 industry. For each year, bottom tercile values are classified as short duration and top tercile values are classified as long duration. An auditor's industry specialization is the within-industry market share based on clients' assets relative to total industry assets. Auditors are classified as industry experts if they have the largest market share in a given industry-year; otherwise they are classified as non-experts. CEO network size is the number of overlaps through employment, other activities (i.e. clubs, memberships, non-profit activities), and education based on data from *BoardEx*. For each year, values in the bottom tercile are classified as small networks and values in the top tercile are classified as large. Panel A compares the mean of disclosure quality variables across subsample groupings. *, **, and *** indicates significance at the 10%, 5%, and 1% level, respectively. In Panels B and C, the *p*-value row represents the *p*-value of the Chow test that the regression coefficients are equal across subsamples. Firm and year fixed effects are included in all models. The sample period is 1992–2018. t-values are based on robust standard errors clustered by firm and by year (two-way) and are reported in parentheses. Detailed variable definitions are in Appendix A.

† Note that in these regressions PP&E-to-total assets is removed as a control variable.

Treated*Post-FAS 123R should be used as an instrument only for CEO ln(1 + vega).[23]

Models (5) through (8) present reduced-form models in which disclosure quality indices are regressed directly on our instrument, Treated*Post-FAS 123R. The significantly positive coefficients for the interaction variable in all four reduced-form models are consistent with our prediction that the decline in CEO option use after the adoption of FAS 123R for treated firms causes a corresponding improvement in disclosure quality.

4.5. *Multi-year CEO option grants*

Our next test for a causal relationship between CEO options and accounting disclosure quality employs two instruments that capture exogenous variation in the value of CEO option grants induced by the features of multiyear compensation plans. Shue and Townsend (2017b) note that in about 30% of Execucomp firm-years, CEO options are granted according to fixed-number or fixed-value multi-year plans. In a fixed-number (value) plan, the executive receives the same number (value) of options each year within a fixed-number (value) cycle. Thus, when a firm uses a fixed-value multi-year CEO option grants plans, there is, on average, a sharp increase in the value of new option grants at the start of a new cycle.[24] The timing of the beginning of a new fixed-value cycle is staggered across firms over time, which provides exogenous variation in the value of new option grants to CEOs. Usually new option grants are at-the-money. Shue and Townsend (2017b) demonstrate that when more at-the-money options are granted, Black-Scholes option value, delta, and vega increase simultaneously. Thus, for the subsample of firm-years with fixed-value multi-year CEO option plans, we use predicted first year, an indicator variable equal to one if a firm-year is the predicted first year of a new fixed-value cycle and zero otherwise, as an IV for CEO ln(1 + vega) and CEO ln(1 + delta).[25] Predicted first year is estimated using the length of the CEO's previous fixed-value cycle.

A second instrument is motivated by the fact that when stock returns are high, the value of fixed-number CEO option plans rises, but (by definition) the value of fixed-value plans is not affected. To ensure that stock returns are unaffected by the focal firm's CEO, following Shue and Townsend (2017b), we use industry stock return. Thus, for the subsample of firm-year observations with either

[23] Bakke et al. (2016) also find an insignificant change in CEO ln(1 + delta) following the adoption of FAS 123R relative to firms in their control group, suggesting that the overall increases in CEO ln(1 + delta) following the adoption of FAS 123R that are documented by Hayes et al. (2012) and others are not caused by FAS 123R.

[24] Following Shue and Townsend (2017b), we consider an executive to be on a fixed-value cycle in two consecutive years if the value of the options that the executive receives is within 3% of the previous year. Value is computed as either the Black-Scholes value or the face value (i.e., the number of options granted multiplied by the grant-date price of the underlying stock).

[25] Following Shue and Townsend (2017b), we use predicted first year rather than actual first year of a fixed-value option grant to construct our first IV because the timing of when a new cycle actually begins may be endogenously renegotiated between a manager and the board, and thus biasing the validity of the IV were the actual first year to be used.

Table 10
Subsample analysis of equity-based CEO compensation based on stock price performance and future disclosure quality.

Dependent variables measured from t+1 to t+3	Stock return terciles based on annual return					
	Bottom tercile	Middle tercile	Top tercile	Bottom tercile	Middle tercile	Top tercile
	1	2	3	4	5	6
Panel A: report quality index regressions						
CEO ln(1+vega)$_t$	−0.0094*	−0.0207***	−0.0122***	–	–	–
	(−1.83)	(−6.72)	(−3.17)	–	–	–
CEO ln(1+current vega)$_t$	–	–	–	−0.0101	−0.0262***	−0.0040
	–	–	–	(−0.69)	(−3.32)	(−0.40)
CEO ln(1+prior vega)$_t$	–	–	–	−0.0151	−0.0330***	−0.0249***
	–	–	–	(−1.50)	(−7.01)	(−4.48)
CEO ln(1+delta)$_t$	−0.0109	−0.0144***	−0.0146***	−0.0220*	−0.0214***	−0.0264***
	(−1.55)	(−3.24)	(−3.46)	(−1.92)	(−3.25)	(−3.47)
CEO salarycomp$_t$	0.0472*	0.1065***	0.0091	0.1391*	0.1381***	0.0016
	(1.72)	(4.66)	(0.32)	(1.74)	(2.58)	(0.02)
ln (1+CEO tenure)$_t$	0.0190	0.0338**	0.0406*	0.0195	0.0454***	0.0212
	(0.70)	(1.96)	(1.84)	(1.09)	(4.54)	(1.57)
ln(CEO age)$_t$	−0.0350	0.1228	0.0262	−0.0935	0.1546***	−0.0583
	(−0.23)	(1.19)	(0.21)	(−0.92)	(2.60)	(−0.76)
CEO duality$_t$ (0,1)	−0.0078	−0.0230	−0.0021	0.0018	0.0268*	−0.0169
	(−0.18)	(−0.86)	(−0.07)	(0.07)	(1.85)	(−0.89)
Founder CEO$_t$ (0,1)	−0.0568	−0.1845***	−0.0786	−0.2483*	−0.1377	−0.2059*
	(−0.67)	(−2.78)	(−1.01)	(−1.66)	(−1.34)	(−1.69)
CEO ability$_t$	0.0318	0.1110***	0.1152**	0.1249	0.1378***	0.0866
	(0.48)	(2.72)	(2.08)	(1.33)	(2.73)	(1.16)
Controls	YES	YES	YES	YES	YES	YES
[p-value] – CEO ln(1+vega) are equal	[0.0093]	–	[0.0770]	–	–	–
[*p*-value] – CEO ln(1+ current vega) are equal	–	–	–	[0.0831]	–	[0.0010]
[p-value] – CEO ln(1+ prior vega) are equal	–	–	–	[0.842]	–	[0.0000]
[p-value] – CEO ln(1+delta) are equal	[0.0478]	–	[0.9626]	[0.0055]	–	[0.4155]
Adj R-squared	0.8712	0.8540	0.8553	0.8898	0.8651	0.8631
Observations	4449	7867	5049	3159	3903	3205
Panel B: readability index regressions						
CEO ln(1+vega)$_t$	−0.0241*	−0.1379***	−0.0877***	–	–	–
	(−1.70)	(−14.28)	(−7.50)	–	–	–
CEO ln(1+current vega)$_t$	–	–	–	0.0080	−0.0930***	−0.0470*
	–	–	–	(0.80)	(−3.84)	(−1.65)
CEO ln(1+prior vega)$_t$	–	–	–	−0.1551***	−0.2204***	−0.1389***
	–	–	–	(−5.09)	(−15.24)	(−8.77)
CEO ln(1+delta)$_t$	−0.0597***	−0.0902***	−0.0606***	−0.0143	−0.0580***	−0.0985***
	(−3.15)	(−6.42)	(−3.84)	(−0.40)	(−2.92)	(−3.95)
CEO salarycomp$_t$	0.1293**	0.5273***	0.2973***	0.4125**	0.5635***	0.7424***
	(2.00)	(9.95)	(4.97)	(2.08)	(5.34)	(5.88)
ln (1+CEO tenure)$_t$	0.1051***	0.1458***	0.1232***	0.1268**	0.2152***	0.2161***
	(3.44)	(6.64)	(4.34)	(2.33)	(6.96)	(5.55)
ln(CEO age)$_t$	0.6117***	0.1116	0.0980	0.7785**	0.1912	−0.2495
	(3.50)	(0.81)	(0.61)	(2.51)	(1.04)	(−1.14)
CEO duality$_t$ (0,1)	−0.0584	−0.0658*	−0.0314	−0.0707	−0.0938**	−0.0172
	(−1.22)	(−1.85)	(−0.75)	(−0.87)	(−2.09)	(−0.31)
Founder CEO$_t$ (0,1)	−0.1316*	−0.1745***	−0.0029	−0.4021***	−0.0898	−0.0501
	(−1.65)	(−2.67)	(−0.04)	(−2.70)	(−0.94)	(−0.50)
CEO ability$_t$	0.3189*	0.8949***	0.2603*	0.3407	0.7753***	0.6805***
	(1.83)	(7.32)	(1.75)	(1.22)	(5.00)	(3.71)
Controls	YES	YES	YES	YES	YES	YES
[p-value] – CEO ln(1+vega) are equal	[0.0000]	–	[0.0000]	–	–	–
[*p*-value] – CEO ln(1+ current vega) are equal	–	–	–	[0.0028]	–	[0.0640]
[p-value] – CEO ln(1+ prior vega) are equal	–	–	–	[0.000]	–	[0.0001]
[p-value] – CEO ln(1+delta) are equal	[0.0930]	–	[0.0389]	[0.0419]	–	[0.6973]
Adj R-squared	0.9113	0.8916	0.8925	0.9171	0.8917	0.9130
Observations	4688	8583	5688	3401	4225	3448

Dependent variables for regression models are Report quality index and Readability index constructed using PCA analysis. Subsamples are formed based on annual stock return terciles. The p-value row represents the *p*-value of the Chow test that the regression coefficients are equal between middle performance tercile and other terciles. Firm and year fixed effects are included in all models. Control variables are the same as prior models with the exception of stock return, which is excluded. The sample period is 1992–2018. t-values are based on robust standard errors clustered by firm and by year (two-way) and are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. – indicates not applicable. Detailed variable definitions are in Appendix A.

Table 11
Alternative measures of CEO Vega: the association between equity-based CEO compensation and future disclosure quality.

Dependent variables measured from t+1 to t+3	Report quality index	Readability index	Dependent variables are changes from t to t+3	Change-on-Change Report quality index	Change-on-Change Readability index
Panel A: subjective vega	1	2		3	4
CEO ln(1+subjective vega)$_t$	−0.0184***	−0.0314***	△CEO ln(1+subjective vega)$_{t-1,t}$	−0.0135***	−0.0073*
	(−3.40)	(−5.76)		(−3.33)	(−1.94)
CEO ln(1+delta)$_t$	−0.0310***	−0.0873***	△CEO ln(1+delta)$_{t-1,t}$	−0.0132**	−0.0011
	(−4.93)	(−10.06)		(−2.45)	(−0.32)
CEO salarycomp$_t$	0.1099***	0.4010***	△CEO salarycomp$_{t-1,t}$	0.0568***	0.0032
	(3.88)	(12.58)		(3.27)	(0.30)
ln (1+CEO tenure)$_t$	0.0205*	0.1349***	–	–	–
	(1.74)	(8.59)		–	–
ln(CEO age)$_t$	0.0761	0.3864***	–	–	–
	(1.07)	(4.07)		–	–
CEO duality$_t$ (0,1)	−0.0148	−0.0512**	–	–	–
	(−0.81)	(−2.16)		–	–
Founder CEO$_t$ (0,1)	−0.1226***	0.0193	–	–	–
	(−2.97)	(0.46)		–	–
CEO ability$_t$	0.1135***	0.6306***	△CEO ability$_{t-1,t}$	0.0350*	0.0328
	(3.90)	(8.11)		(1.75)	(1.26)
Controls	Yes	Yes	Controls	Yes	Yes
Adj R-squared	0.8227	0.8763	Adj R-squared	0.7043	0.3275
Observations	17,444	18,964	Observations	15,215	16,599
Panel B: current and prior option grants	1	2		3	4
CEO ln(1+current vega)$_t$	−0.0910***	−0.0567***	△CEO ln(1+current vega)$_{t-1,t}$	−0.0271**	−0.0144**
	(−4.99)	(−3.43)		(−2.39)	(−2.13)
CEO ln(1+prior vega)$_t$	−0.1485***	−0.1714***	△CEO ln(1+prior vega)$_{t-1,t}$	−0.0295***	−0.0128**
	(−13.74)	(−17.54)		(−3.54)	(−2.07)
CEO ln(1+delta)$_t$	−0.0333***	−0.0990***	△CEO ln(1+delta)$_{t-1,t}$	−0.0245***	−0.0137***
	(−2.91)	(−6.48)		(−2.94)	(−2.77)
CEO salarycomp$_t$	0.0985	0.5845***	△CEO salarycomp$_{t-1,t}$	0.1229***	0.0080
	(1.37)	(8.34)		(2.73)	(0.26)
ln (1+CEO tenure)$_t$	0.0794***	0.2021***	–	–	–
	(4.58)	(8.94)		–	–
ln(CEO age)$_t$	0.024	0.1954	–	–	–
	(0.23)	(1.44)		–	–
CEO duality$_t$ (0,1)	−0.0072	−0.0555*	–	–	–
	(−0.28)	(−1.76)		–	–
Founder CEO$_t$ (0,1)	−0.1364**	−0.1605**		–	–
	(−2.09)	(−2.54)		–	–
CEO ability$_t$	0.0467	0.5932***	△CEO ability$_{t-1,t}$	0.0620**	0.0493
	(1.12)	(5.84)		(2.35)	(1.44)
Controls	YES	YES	Controls	YES	YES
Adj R-squared	0.8274	0.8797	Adj R-squared	0.7271	0.3693
Observations	10,267	11,074	Observations	8325	8690
Panel C: vega and stock performance	1	2		3	4
CEO ln(1+ vega perf)$_t$	−0.1526***	−0.1612***	△CEO ln(1+ vega perf)$_{t-1,t}$	−0.0495***	−0.0297***
	(−12.00)	(−13.08)		(−4.96)	(−4.52)
CEO ln(1+ vega non perf)$_t$	−0.1755***	−0.1768***	△CEO ln(1+vega non perf)$_{t-1,t}$	−0.0523***	−0.0328***
	(−16.03)	(−16.34)		(−5.46)	(−5.18)
CEO ln(1+delta)$_t$	−0.0270***	−0.1016***	△CEO ln(1+delta)$_{t-1,t}$	−0.0322***	−0.0081
	(−2.79)	(−7.80)		(−4.31)	(−1.31)
CEO salarycomp$_t$	0.1262**	0.5369***	△CEO salarycomp$_{t-1,t}$	0.0837***	0.0102
	(2.55)	(10.47)		(2.56)	(0.43)
ln (1+CEO tenure)$_t$	0.0436***	0.1565***	–	–	–
	(2.92)	(8.00)		–	–
ln(CEO age)$_t$	0.0386	0.2392**	–	–	–
	(0.42)	(2.01)		–	–
CEO duality$_t$ (0,1)	−0.0001	−0.0460*	–	–	–
	(−0.00)	(−1.69)		–	–

(continued on next page)

Table 11 (*continued*)

Dependent variables measured from t+1 to t+3	Report quality index	Readability index	Dependent variables are changes from t to t+3	Change-on-Change Report quality index	Change-on-Change Readability index
Founder CEO_t (0,1)	−0.1604***	−0.1335**		–	–
	(−2.68)	(−2.42)		–	–
CEO $ability_t$	0.0532	0.5724***	△CEO $ability_{t-1,t}$	0.0722***	0.0588
	(1.48)	(6.48)		(2.87)	(1.53)
Controls	YES	YES	Controls	YES	YES
Adj R-squared	0.8177	0.8719	Adj R-squared	0.7318	0.3227
Observations	12,840	13,899	Observations	10.295	10,781

Dependent variables are Report quality index and Readability index constructed using principal components analysis (PCA) and changes in these variables from t to t+3. In Change-on-Change models, changes in explanatory variables are from t-1 to t. In Panel A, the subjective value of vega is measured using the Ingersoll (2006) model. Panel B presents results from decomposing CEO ln(1+vega) into the portion from new option grants during the year (CEO ln(1+current vega)) and the portion from existing option holdings (CEO ln(1+prior vega)). Panel C presents results from decomposing CEO ln(1+Vega) into the portion correlated with recent stock performance and the portion uncorrelated with recent stock performance. t-values are based on robust standard errors clustered by firm and by year (two-way) and are reported in parentheses. Firm and year fixed effects are included in all models. The sample period is 1992–2018. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Detailed variable definitions are in Appendix A. – = not applicable.

fixed-number or fixed-value multiyear option plans (excluding the first year of a plan),[26] we use the interaction between industry return and FN, an indicator variable equal to one if the CEO has a fixed-number multi-year option grant and zero if the CEO has a fixed-value multi-year option grant, FN*Industry return, as our second IV. Neither of the two IVs are likely to be directly related to disclosure quality, making them valid IVs and satisfying the exclusion restriction.

Table 8, Panel A presents results using Predicted first year as an IV. Table 8 Panel B presents results using FN*Industry return as an IV. Odd-numbered models include only the IV and firm and year fixed effects as explanatory variables. Even-numbered models also include control variables. Models (1) to (4) present first-stage regressions of CEO $\ln(1 + vega)_t$ and CEO $\ln(1 + delta)_t$ on the instrument. Panel A, Model (1) shows that, without controls, CEO ln(1 + vega) increases approximately 0.1478 (3.7%) at the predicted first year of a new fixed-value cycle relative to the subsample median of 4.04. Panel B, Model (1) shows that, when industry returns increase, without controls, CEO ln(1 + vega) for CEOs with fixed-number option grants is 0.1088 (2.8%) higher than that of CEOs with fixed-value option grants relative to the subsample median of 3.88.

Models (5) through (8) present reduced-form regressions in which future disclosure quality indices are regressed directly on the IVs. Panel A shows that an increase in CEO ln(1 + vega) and CEO ln(1+ delta) at the predicted first year of a new fixed-value cycle leads to a decrease in future disclosure quality. Panel B shows that the increased CEO ln(1 + vega) and CEO ln(1+ delta) associated with fixed-number relative to fixed-value option grants induced by an increase in industry return lead to a decrease in future disclosure quality. Table 8 results are consistent with our prediction that increased CEO ln(1 + vega) causes a decline in disclosure quality.

In summary, Tables 6, 7 and 8 employ very different approaches to testing for a negative causal relationship between CEO ln(1 + vega) and the quality of future accounting disclosures. Yet despite their very different approaches, evidence from all three tables strongly supports the existence of such a causal relationship.

5. Subsample analysis and robustness tests

5.1. Subsample analysis: high versus low impact disclosure environments

Here we use subsample analysis to assess the robustness of our findings. Our approach is to identify factors that let us split sample firms into those facing high versus low impact disclosure environments. We expect that the negative effect of option-based CEO compensation on future disclosure quality to be greater for firms where the impact of disclosure quality is relatively high.

Specifically, we divide firms into three subsample groupings based on whether i) the firm's project duration is short or long, ii) the firm retains an auditor with industry expertise or not and iii) the CEO has a small or large social network. We expect the adverse effect of CEO vega on disclosure quality to be more severe for firms with relatively short project horizons. While misreporting can drive up stock price or accounting performance, once it is detected stock price will dramatically decline. Incentives for CEOs to manipulate stock price or accounting performance are stronger for short-duration projects which generate early results, relative to long-term projects. Also, the board relies on near-term stock and accounting performance to make decisions regarding CEO compensation and retention. In contrast, the value impact is likely to be particularly negative when misreporting is detected for firms with long-duration projects, so incentives for CEOs to misreport in such firms are weaker. We use the median ratio of (PP&E plus goodwill)/(noncash total assets) in the firm's Fama French 48 industry classification to measure project duration (Gopalan et al. (2014)). For each year, bottom

[26] Following Shue and Townsend (2017b), we exclude the first year of a fixed-number or fixed-value plan to construct our second IV. This is because we exploit a source of exogenous variation in the value of CEO new option grants induced by industry returns within cycles. Therefore, our second IV (FN*Industry return) is robust to the potential concern that timing regarding when a new cycle actually begins may be endogenously renegotiated between a manager and the board.

tercile observations are classified as short-duration and top tercile observations as long-duration.

Retaining an auditor with (without) industry expertise sends a positive (negative) signal about earnings quality to investors (Gul et al. (2009)). Thus, the adverse effect of CEO vega on disclosure quality should be more severe for firms that do not have an auditor with industry expertise. An auditor's industry specialization is defined as the within-industry market share of clients' assets relative to total industry assets. Auditors are classified as industry experts if they have the largest market share in a given industry-year; otherwise they are classified as non-experts.[27]

Finally, the impact of disclosure quality should be stronger for CEOs with small social networks due to the lack of information regarding CEO quality in the managerial labor market and, relatedly, greater CEO career concerns (Faleye et al. (2014)). CEO network size is defined as the number of overlaps through employment, other activities (i.e. clubs, memberships, non-profit activities), and education based on data from *BoardEx*. For each year, CEOs with network size in the lowest tercile are classified as CEOs with small networks and those in the highest tercile are classified as having large networks.

Table 9, Panel A presents univariate results for all individual disclosure quality measures and disclosure quality indices. It compares mean values across subsample groupings. Univariate results show that, in general, disclosure quality is lower in high impact disclosure environments (short project duration, auditors classified as industry non-experts, and CEOs with small social networks).

Table 9, Panel B presents subsample regression results with Report quality index as the dependent variable. We use Chow tests to determine if the coefficients of CEO ln(1 + vega) and CEO ln(1 + delta) are equal across regressions for each subsample grouping. Results in Panel B show that the deleterious effect of CEO ln(1 + vega) on the Report quality index is stronger in high impact disclosure environments: firms with short project duration, lacking an industry specialist auditor, and whose CEO has a small social network size; *p*-values for Chow tests of differences in these coefficients are significant for all the three subsample groupings. In contrast, there is no significant difference between coefficients on CEO ln (1 + delta) for any subsample grouping. Panel C presents similar findings for models using Readability index as the dependent variable.[28]

5.2. Subsample analysis: stock price performance and option moneyness

The moneyness of CEO options influences incentives. If CEO options are deep out-of-the-money, incentives to increase stock return volatility or stock price are minimized as the likelihood of taking actions that push stock price beyond the strike price is small. When CEO options are at (near)-the-money, incentives are strong; just a small increase (decrease) in stock return volatility or stock price can cause a significant increase (decrease) in option value. For deep in-the-money CEO options, with a price-to-strike ratio much larger than one, the value of options increases almost linearly with stock price, and as such, will be relatively insensitive to changes in stock return volatility. Thus, we expect that the deleterious effect of CEO vega on future disclosure quality will be the strongest when CEO options are at (near)-the-money.

Data on the moneyness of CEO options are not readily available.[29] Thus, to assess the impact of CEO option moneyness on disclosure quality, we divide our sample into terciles based on each year's annual stock return. We assume that CEOs with stock price performance in the bottom tercile are more likely to have out-of-the-money options, CEOs with stock price performance in the middle tercile are more likely to have at (near)-the-money options, and that CEOs with top tercile stock performance are more likely to have deep-in-the-money options. Since most new CEO option grants are awarded at-the-money, we also divide CEO vega into the portion attributable to current option grants (CEO ln(1 + current vega)) and to prior option grants (CEO ln(1 + prior vega)). The moneyness of prior option grants is more likely to be influenced by this year's stock return.

Table 10 presents regressions with Report quality index and Readability index as dependent variables for each stock price performance tercile. All models include control variables used previously, with the exception of stock return, and firm and year fixed effects. Models (1) to (3) use CEO ln (1 + vega) as an explanatory variable. Models (4) to (6) use CEO ln(1 + current vega) and CEO ln (1 + prior vega) as explanatory variables. Chow tests are used to determine if the coefficients are equal across regressions for the middle versus the bottom tercile and the middle versus the top tercile.

As expected, the negative effect of CEO vega on future disclosure quality is the weakest for the bottom stock return tercile, where CEO options are more likely to be out-of-the-money. Also as expected, the negative effect of CEO vega on future disclosure quality is the strongest for the middle stock return tercile, where CEO options are more likely to be at (near)-the-money. For the middle stock return tercile, the negative effect of prior granted options (CEO ln(1 + prior vega)) seems to be stronger than the negative effect of current option grants (CEO ln(1 + current vega)), although both are significantly negative. Finally, we find that CEO vega for the top stock return tercile, in general, has a significantly smaller negative impact on disclosure quality relative to CEO vega for the middle stock return tercile.

[27] Industry is based on Fama and French's (1997) 48 industry classifications. In the case of a change in the audit firm's name as a result of an audit firm merger, the incumbent auditor–client relationship remains unchanged.

[28] We also create subsamples based on alternative measures of project duration or investment horizon such as R&D-to-Assets, Market-to-Book and CEO pay duration terciles. With the exception of the R&D subsample that excludes firms with missing values, there is no significant difference in univariate tests for differences in means or CEO $\ln(1 + \text{vega})_t$ regression coefficients for these subsample groupings.

[29] Proxy statements and therefore *Execucomp* do not report the fraction of previously granted options that are currently out-of-the-money. *Execucomp* only reports the fraction of previously granted options that are currently in-the-money. This complicates the estimation of vega and delta for out-of-the-money options as it is not possible to determine the extent to which the exercise price exceeds the stock price for out-of-the-money executive options.

5.3. Robustness tests: alternative measures of CEO vega

Capturing the incentive properties of CEO options is critical to our analysis. To further assess the robustness of our findings, we test whether our results hold when alternative measures of CEO vega are used. Using Ingersoll's (2006) model, we estimate the subjective value of a CEO's stock options (CEO ln(1 + Subjective vega)), which takes into account the fact that equity-based compensation is worth less to a risk-averse, under-diversified CEO than to an optimally diversified outside investor.[30] Results presented in Table 11, Panel A show that CEO subjective (risk-adjusted) vega is still significantly negatively associated with disclosure quality in both level and first-differenced regressions, although the significance of CEO ln(1 + Subjective vega) is weaker than that of CEO ln(1 + vega) in our original models. This suggests that our results are robust to adjustments for CEO risk-aversion.

Next, CEO vega is decomposed into current and prior option grants. Results presented in Table 11, Panel B show that both components of CEO vega and their changes have significant coefficients across all models. This implies that our results are not predominately driven by either current or prior CEO vega.

Finally, we decompose CEO vega into the component that is correlated with recent stock return (CEO ln(1 + vega perf)) and the component that is not (CEO ln(1 + vega non perf)). CEO ln(1 + vega perf) (CEO ln(1 + vega non perf)) is the predicted value (residual) from a regression of CEO ln(1 + vega) on buy-and-hold returns over the year, estimated for each firm with at least five years of data. Results presented in Panel C show that both components of CEO vega are significantly negatively associated with disclosure quality in level and first-differenced regressions. This implies that our results are not solely attributable to the component of CEO vega that is correlated with recent stock price performance.

6. Conclusion

This paper studies an important question in the area of CEO incentive contracting. While theory predicts a deleterious effect of CEO vega on disclosure quality, there has been scant empirical evidence to date and the evidence that does exist is mixed. Using a comprehensive set of disclosure quality variables, we provide new empirical evidence confirming a negative relation between CEO vega and the quality of future accounting disclosures. In addition, to determine whether or not the effect of CEO vega is causal, we tackle the challenges posed by endogeneity through a battery of analyses and our main findings are robust to adjustments for CEO risk-aversion.

While our study does not address the optimal mix of salary, bonus, stock and stock options in CEO compensation, our results suggest that in setting CEO stock option grants, board of directors should factor in the negative impact of stock options on the quality of accounting disclosures, on which investors rely and which influence the firm's value and its cost of capital.

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Appendix A. Variable Definitions (Arranged in alphabetical order).

Variable Name	Definition
CEO age	Age of the CEO.
CEO ln (1+delta)	Change in the risk-neutral (Black-Scholes) value of the CEO's stock and option portfolio for a 1% change in the price of the underlying stock. It is winsorized at the 1st and 99th percentiles.
CEO duality	Binary variable that equals one when the CEO also holds the position of the chairman of the board and zero otherwise. Data are obtained from RiskMetrics.
CEO ln(1+current vega)	Component of CEO Vega from stock option grants made during the current year.
CEO ln(1+prior vega)	Component of CEO Vega from stock option grants made in prior years.
CEO ln(1+subjective vega)	

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[30] We use the STATA code provided by Peters and Wagner (2014) and follow their assumptions regarding the degree of CEO relative risk aversion and fraction of wealth that the CEO is forced to hold in his firm's stock. Holding total risk constant, the subjective value of stock options is decreasing in idiosyncratic risk because a risk-averse, under-diversified manager is forced to bear more idiosyncratic risk (Ingersoll (2006)).

(*continued*)

Variable Name	Definition
	Change in risk-adjusted, subjective values of the CEO's stock options for a 1% change in the standard deviation of the return of the underlying stock. It is winsorized at the 1st and 99th percentiles. We compute subjective value of vega using the Ingersoll (2006) model.
CEO ln(1+vega non perf)	Component of CEO Vega uncorrelated with recent stock performance, estimated as the residual value from a regression of CEO Ln(1+Vega) on buy-and-hold returns over the year for firms with at least five recent years of data.
CEO ln(1+vega perf)	Component of CEO Vega correlated with recent stock performance, estimated as the predicted value from a regression of CEO Ln(1+Vega) on buy-and-hold returns over the year for firms with at least five recent years of data.
CEO network size	CEO network size is measured as the number of overlaps through employment, other activities (i.e. clubs, memberships, non-profit activities), and education based on data from the *BoardEx Database*.
CEO ability	Updated version of the managerial ability score constructed by Demerjian et al. (2012) estimated by including year fixed effects but not industry fixed effects.
CEO Salarycomp	Ratio of CEO salary to total compensation. It is winsorized at the 1st and 99th percentiles.
CEO tenure	Number of years that the current CEO has been in office.
CEO Vega	Change in the risk-neutral (Black-Scholes) value of the CEO's total portfolio of current and prior outstanding option grants for a 1% change in the standard deviation of the return of the underlying stock. It is winsorized at the 1st and 99th percentiles.
Complex words$_{t+1,t+3}$	The yearly average of the number of words that contain three or more syllables in each of the firm's quarterly reports for years t+1 to t+3.
DAQ$_{t+1,t+3}$	Discretionary accruals quality measured following Francis et al. (2005).
DQ (%)$_{t+1,t+3}$	Equally-weighted of *DQ_BS* and *DQ_IS* constructed by Chen et al. (2015) for the years from t+1 to t+3.
DQ_BS (%)$_{t+1,t+3}$	Value-weighted disclosure quality score of balance sheet items (Chen et al., 2015), where the weight is defined as the asset value of that balance sheet group over total asset value for the years from t+1 to t+3. See Internet appendix A of Chen et al. (2015) for the 11 group accounts.
DQ_IS (%)$_{t+1,t+3}$	Equally-weighted disclosure quality score of income statement items (Chen et al., 2015) for the years from t+1 to t+3.
ERC	Earnings response coefficient measured following Kothari and Sloan (1992), defining ERC as the estimated coefficient from firm-level regressions of annual returns on earnings (scaled by stock price at the beginning of the year) over years t-9 through t with at least 6 annual observations.
Firm age	Number of years since the year of listing.
Flesch-Kincaid (F-K) readability index$_{t+1,t+3}$	Equal to 0.39(# words/# sentences) + 11.8(# syllables /# words) − 15.59 and maps directly to a U.S. grade level; a score of 9 indicates a 9th grade reading level and is the yearly average of Flesch-Kincaid (F-K) readability index for years t+1 to t+3. Data are obtained from Wharton's WRDS SEC Analytics Suite.
FN	An indicator equal to one if the CEO is on a fixed-number multiyear option plan.
Forecast precision	A scaled index based on the following earnings forecast types: qualitative=0, open-ended=1, range=2, and point=3. Data are obtained from I/B/E/S Guidance Database.
Founder CEO	Binary variable that equals one if the current CEO founded the firm and zero otherwise. The CEOs' founder status is obtained from Equilar Consultants.
Growth in sales	Sales less lagged sales over lagged sales.
Gunning-Fog (G-F) readability index$_{t+1,t+3}$	Equal to 0.4 ((# words/# sentences)+100(# complex words/# words)) and measures grade-level readability and is the yearly average of Gunning-Fog (G-F) readability index for years t+1 to t+3. Data are obtained from Wharton's WRDS SEC Analytics Suite.
ILLIQ	Level of illiquidity measured as the average of the square root version of Amihud's (2002) daily illiquidity measure (× 10^3). See Gopalan et al. (2012) for details of the calculation.
Industry specialist auditor	An auditor's industry specialization is the within-industry market share of clients' assets relative to total industry assets based on Fama French 48 industry classification. Auditors are classified as industry experts if they have the largest market share in a given industry-year; otherwise they are classified as non-experts. In case of a change in an audit firm's name as the result of a merger, the incumbent auditor–client relationship remains unchanged.
Intangibles	Ratio of research and development and advertising expense to sales.
Leverage	Book value of total long-term debt over total assets.
Ln(Sales)	The natural log of sales.
Loughran-McDonald (L-M) modal weak words$_{+1,t+3}$	The annual average of the number of Loughran-McDonald financial-modal-weak words in each of the firm's quarterly reports for years t+1 to t+3. Data are obtained from Wharton's WRDS SEC Analytics Suite.
Loughran-McDonald (L-M) uncertainty words$_{t+1,t+3}$	The yearly average of the number of Loughran-McDonald financial uncertainty words in each of the firm's quarterly reports for the years from t+1 to t+3. Data are obtained from Wharton's WRDS SEC Analytics Suite.
Market-to-book	Ratio of market-to-book value of assets.
Non-Ind/size/Consultant CEO Ln (1+Delta)$_{t-1}$	Median Ln(1+ CEO Delta$_{t-1}$) for firms that are both in the same market capitalization decile and share the same compensation consultant as sample firms. Firms in the sample firm's industry are excluded (using Fama-French 48 classification in year t-1).
Non-Ind/size/Consultant CEO Ln (1+Vega)$_{t-1}$	Median Ln(1+ CEO Vega$_{t-1}$) for firms that are both in the same market capitalization decile and share the same compensation consultant as sample firms. Firms in the sample firm's industry are excluded (using Fama-French 48 classification in year t-1).
Post-FAS 123R	An indicator variable that equals one if the observation is after the adoption of FAS 123R (years 2005 and 2006) and zero if the observation is before adoption (years 2003 and 2004).
PP&E/assets	Net property, plant and equipment over total assets.
Predicted First Year	An indicator variable that equals one if the year is predicted to be a cycle first year based on the length of the previous cycle.
Project duration	Measured by industry proportion of long-term assets, which is the median ratio of book value of property, plant, and equity plus goodwill over noncash total assets for all firms in a Fama-French 48 industry classification.
Readability Index$_{t+1,t+3}$	The first factor of a PCA estimation of standardized versions of our five financial report readability variables; it is standardized to have zero mean and a standard deviation of 1. See Appendix B.
Report Quality Index$_{t+1,t+3}$	

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(*continued*)

Variable Name	Definition
	The first factor of a PCA estimation of standardized versions of our five traditional disclosure quality measures; it is standardized to have zero mean and a standard deviation of 1. See Appendix B.
ROA	Ratio of operating income before depreciation to total assets.
State R&D tax credit	A binary variable that equals one if the firm is headquartered in a state where the effective state R&D tax credit rate in year t-1 was positive and zero otherwise. Data are obtained from Wilson (2009) and Chang (2018).
Stock return	Annual stock return including dividends.
Top5_Instown	Stock ownership by the top five institutions as a percentage of total institutional ownership based on data from Thomson-Reuters Institutional Holdings (13F) database.
Treated	An indicator variable that equals one for firms that used options in their CEO pay and did not adopt the fair value method for expensing options prior to the adoption of FAS 123R and zero for firms that did not grant their CEO stock options or preemptively adopted the fair value method prior to the adoption of FAS 123R.
Voluntary disclosure frequency$_{t+1,t+3}$	The total number of SEC Form 8-K disclosure filings of Other Events (Item 5 or 8.01) or Regulation Fair Disclosure (Item 9 or 7.01) for years t+1 to t+3. Data are obtained from Wharton's WRDS SEC Analytics Suite.
σCF	Standard deviation of cash flows from operations scaled by total assets over the prior ten years.
σSales	Standard deviation of net sales scaled by total assets over the prior ten years.

Appendix B. Computation of report quality and readability indices using principal components analysis.

This table presents the results of applying principal components analysis (PCA) to measures of the quality of information disclosure. All information disclosure variables are defined such that a higher number represents higher quality disclosure. Detailed definitions for the variables are in Appendix A. Factor loadings (scores), eigenvalue, and the proportion of variation explained by the first factor of the principal components analysis are presented. Report quality and readability indices are calculated by applying the factor scores (sum of squares of factor scores summing to one) to standardized (mean of zero and standard deviation of one) index components and are the first factor of the principal components analysis which has the highest eigenvalue.

Panel A: Principal components analysis for Report quality index

Dependent variables measured from t+1 to t+3	Discretionary accruals quality (DAQ)	Earnings response coefficient (ERC)	ln(1+Voluntary disclosure frequency)	Forecast precision	Disaggregation quality (DQ)
Factor Loadings (or scores) sum of squares= Eigenvalue	0.0996	0.2585	0.7400	0.7349	0.7925
Factor Loadings (or scores) sum of squares= 1	0.0744	0.1931	0.5527	0.5489	0.5919
Proportion of variation explained by Report quality index					0.3585
Eigenvalue explained by the Report quality index					1.7924

Panel B: Principal components analysis for Readability index

Dependent variables measured from t+1 to t+3	-F-K readability	-G-F readability	-ln(1+Complex words)	-ln(1+L-M Modal weak words)	-ln(1+L-M Uncertainty words)
Factor Loadings (or scores) sum of squares= Eigenvalue	0.7341	0.7391	0.9122	0.9001	0.9147
Factor Loadings (or scores) sum of squares= 1	0.3889	0.3915	0.4832	0.4768	0.4845
Proportion of variation explained by Readability index					0.7128
Eigenvalue explained by the Readability index					3.564

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