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A concave relation between equity-based incentives and misreporting

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ABSTRACT: A fraud mechanism, where managers inflate stock prices via misreporting for post-misreporting insider trading, is well captured by the delta of their equity portfolio. But a widely accepted view in the literature is that the impact of delta on misreporting is unclear because delta-related rewards (e.g., gains from insider trading) and risks (e.g., detection of fraud) likely offset each other. In this paper, we predict and find a concave association between managers' portfolio delta and misreporting propensity, and the misreporting curve's changing maximum points depending on the levels of various risk and reward factors. Our results are consistent with managers who reduce opportunistic misreporting at a higher level of equity incentives to avoid the increasing marginal costs of misreporting.

Keywords: Financial misreporting; Equity-based incentives; Risk-taking incentives; Enforcement risk; Securities fraud

JEL Classification: J33; G34; M41; M52

1. Introduction

Managerial equity-based incentives are often considered a major determinant of misreporting decisions (e.g., Goldman and Slezak 2006). This is because misreporting affects stock prices and creates favorable conditions for managers to benefit from post-misreporting insider trading. To examine the relation between equity-based incentives and misreporting, a body of literature has adopted the delta of managers' equity portfolio, i.e., equity value sensitivity to a one percent change in stock price (Core and Guay 2002). However, as Armstrong et al. (2010) well summarize, empirical findings have been mixed (e.g., Erickson et al. 2006; Johnson et al. 2009). According to Thevenot (2012) and Armstrong et al. (2013), this may be because managers' enforcement and reputational concerns associated with misreporting offset their expected benefits. To address these countervailing effects, follow-up studies have focused on specific circumstances in which either the risk factor (Jayaraman and Milbourn 2015) or the reward factor is enhanced (Cao et al. 2021).

Departing from prior studies, we argue that the countervailing effects generate a predictable non-linear – to be precise, concave – relation between delta and misreporting. To the extent that delta captures “potential gains” from post-misreporting insider trading (Burns and Kedia 2008), an increase in delta paradoxically implies greater risks, including conviction and penalties (i.e., enforcement risk). In this regard, the law of diminishing marginal utility suggests that misreporting managers' benefits from illegal income increase at a decreasing rate (i.e., marginal benefits decrease). In contrast, the U.S. enforcement system suggests that misreporting managers' total costs from gaining illegal income increase at an increasing rate (i.e., marginal costs increase). For example, the Securities and Exchange Commission (SEC) prioritizes *severe* offenses for targeted enforcement based on the amount of illegal income. Furthermore, once a securities fraud case is convicted, the court imposes prison sentences only for *serious* insider trading violations that involve illegal income exceeding \$5 million (U.S.

Sentencing Guidelines Manual; Brody 2009). The SEC's focused targeting and stricter punishment for severe cases imply that the marginal costs of misreporting ultimately exceed its marginal benefits at a certain delta point. Therefore, contrary to prior studies, we hypothesize a concave relation between delta and misreporting propensity.

To test this hypothesis, we regress misreporting, captured by Accounting and Auditing Enforcement Releases (AAERs), on the delta of firm's five top executives' portfolios using a quadratic function and restricted cubic spline (RCS). Our analyses of a U.S. sample for 1992–2009 reveal a concave relation between portfolio delta and misreporting propensity. Specifically, we find that delta has a positive association with misreporting propensity at lower to mid-level deltas, indicated by a positive slope. However, the slope becomes reversed or flattened at higher levels. As our estimation model includes vega,¹ the concave relation between delta and misreporting is not driven by vega. Therefore, our finding suggests that both delta and vega explain executives' misreporting incentives in distinctive manners. These results are robust in regard to alternative non-linear specifications (quadratic or RCS), regression models (probit or bivariate probit), estimation methods (regression or matching), and units of analysis (top five executives or CEOs).

We conduct several additional tests. First, we examine if the non-linearity is indeed driven by the managers' risk concerns and reward expectations related to misreporting. Here, we predict that if managers consider them ex ante, the maximum point of the misreporting curve should move to the left (right) of delta when the risk (reward) level increases. Exploiting cross-sectional (e.g., different levels of managerial discretion or risk-taking incentives) and time-series (i.e., before or after passage of the Sarbanes-Oxley Act – SOX) variations, we find changing maximum points depending on the levels of risk and reward factors, supporting the

¹ Vega refers to the value sensitivity of stocks and stock options to a one percent change in stock volatility. We incorporate it into our empirical model due to its role as an unambiguous indicator of misreporting incentives, even when stock prices decline (Armstrong et al. 2013).

prediction.

Second, we test if our results are susceptible to “partial observability bias” (Poirier, 1980). This concern is warranted in this study because we only analyze *detected* rather than *all* (committed) misreporting cases. We address this issue by employing a bivariate probit model that enables us to consider the probabilities of firms’ misreporting and the SEC’s detection of the misreporting conditional on misreporting commission. Our results are robust relative to the presence of potentially undetected misreporting cases.

This study makes a distinct contribution to literature focused on compensation. It is widely accepted that the relation between delta and misreporting is ambiguous while vega provides an unambiguous misreporting incentive (Armstrong et al. 2013). Complementing this view, this paper elucidates a concave relation between delta and misreporting by drawing insights from the traditional economics of crime (Becker 1968) and considering them as a theoretical underpinning for our hypothesis development. Empirically, we show that both delta and vega explain misreporting in distinctive manners. We believe that these findings enhance the understanding of securities fraud mechanisms. From the regulation perspective, they highlight how the SEC’s constrained resources are directed toward more severe fraud offenses. Thus, accounting and securities regulations are particularly effective at deterring such cases.

In the remainder of this paper, Section 2 describes our data and research design, and Sections 3 and 4 present our main and additional empirical results. Section 5 draws some conclusions.

2. Data and method

2.1. Sample and data

Our sample began with the Compustat universe for the period of 1992-2009. Eliminating observations with missing control variables yielded 74,727 observations. Merging it with Coles et al.’s (2006) equity incentive data, we were left with 20,234 firm-years, including 416

misreporting firm-years (or 136 misreporting firms) identified in AAERs (Dechow et al. 2011).² For robustness checks, we constructed alternative samples using propensity score matching (PSM) and entropy balancing. This is explained in Appendix B.

2.2. Empirical specification

2.2.1. Misreporting model

We construct and estimate Eq. (1) to examine the effect of equity-based incentives (captured by *Portfolio delta*), on a firm's misreporting decision. We use AAERs as the dependent variable (*Misreporting*). AAERs consist of alleged misreporting cases that the SEC has detected after a due investigation process (Blackburn et al. 2021). Consistent with Dechow et al. (2011), we consider them to include more egregious and intentional misreporting cases, of which the Type I error rate is lower than other databases.

As the main variable of interest, we use the top five executives' portfolio delta. We also control for their portfolio vega (*Portfolio vega*) and annual cash compensation (*Cash compensation*) because the earnings management incentives associated with these two variables may confound the association between delta and misreporting. Here, *Portfolio delta* is the value sensitivity of stocks and options to stock price changes (Core and Guay 2002; Coles et al. 2006). To examine the concave relation between delta and misreporting, we apply two non-linear specifications to *Portfolio delta*: quadratic function and RCS. While quadratic function is often used to examine non-linear relations, it may mis-specify the relation due to its symmetric shape. Therefore, we additionally adopt RCS to flexibly fit our sample using multiple curves with different curvatures, diverging at multiple knots of delta. *Portfolio delta (I)* and *delta (II)* are two terms for the concave specifications of *Portfolio delta*. For example,

² The number of misreporting firm-years is consistent with previous studies. For example, Feng et al. (2011) analyzed 116 misreporting firm-years.

for the quadratic specification, *Portfolio delta (I)* and *Portfolio delta (II)* are *Portfolio delta* and *Portfolio delta*², respectively.³

Control variables include general firm characteristics such as firm size (*Size*), leverage (*Leverage*), return on assets (ROA), stock returns (*Returns*), capital (*Capital*), and firm age (*Firm age*), definitions of which are provided in Appendix A. Additionally, book-to-market ratio (*BM*) and sales growth (*Sales growth*) are added to account for the earnings management incentives of high-growth firms. We further include variables capturing firms' financing needs (*Financing*) and acquisitions (*Acquisition*) as additional events that may induce firms to misreport. Next, we incorporate intangible assets (*Intangible*), inventory (*Inventory*), and accounts receivables (*Receivables*) as the major accounts by which firms inflate earnings and stock prices (Dechow et al. 2011). Our model also includes CEO tenure (*CEO tenure*) and Big N auditors (*Big N*) because they may affect managers' perceptions of the detection risk. For example, clients of Big N auditors may perceive a greater detection risk because big auditing firms tend to apply stricter monitoring over financial reporting. Finally, year and industry dummies are included to control for the year- and industry-level factors that affect a firm's misreporting decision.

$$\begin{aligned} Pr(\text{Misreporting}_i) = & \beta_0 + \beta_1 \text{Portfolio delta (I)}_i + \beta_2 \text{Portfolio delta (II)}_i \\ & + \beta_3 \text{Cash compensation}_i + \sum \text{Controls} + \sum \text{Year dummy} + \sum \text{Industry dummy} + \varepsilon \end{aligned} \quad (1)$$

3. Results

3.1. Descriptive statistics

Panel A of Table 1 shows the mean value of the variables in Eq. (1) for misreporting and non-misreporting firms, along with the differences between the two groups. The differences in

³ For the RCS specification, *Option delta (I)* is *Option delta*, and *Option delta (II)* is $(\text{Option delta} - K_1)_+^3 - (\text{Option delta} - K_2)_+^3(K_3 - K_1) / (K_3 - K_2) + (\text{Option delta} - K_3)_+^3(K_2 - K_1) / (K_3 - K_2)$, where the levels of K_1 , K_2 , and K_3 are placed in Harrell's (2015) predetermined deciles.

column (3) indicate that misreporting firms exhibit larger *Portfolio delta*, *Portfolio vega*, and *Cash compensation* than non-misreporting firms (p -values < 0.010). The differences are also statistically significant for most control variables. For instance, misreporting firms are found to be significantly larger in market capitalization than non-misreporting firms (*Size*; p -value < 0.010). As noted, to address confounding effects that may arise from the differences in covariates, we adopt PSM and entropy balancing approaches as robustness checks.

Panel B presents summary statistics. The mean value of AAERs (*Misreporting*) is 0.020. This suggests that misreporting is an infrequent event. However, when it does occur, it causes critical damage to the misreporting firm and capital markets, as exemplified by high-profile accounting scandals. The mean value of *Portfolio delta* and *Portfolio vega* are 4.589 and 3.079, respectively. The Spearman's correlations in Panel C further identify that both *Portfolio delta* and *Portfolio vega* are positively correlated with *Misreporting*. These univariate correlations support the conventional notion that equity-based incentives play a significant role in driving misreporting.

[Insert Table 1 here]

3.2. Equity-based incentives and misreporting

Table 2 presents the probit estimation results of Eq. (1). In columns (1) and (2), we begin by separately examining the effects of *Portfolio delta* and *Portfolio vega* on *Misreporting* using a linear specification. The positive coefficients for these variables (0.063 with p -value < 0.050 and 0.086 with p -value < 0.010 , respectively) are consistent with the univariate results presented above. In column (3), we then run a “horse race” by including both *Portfolio delta* and *Portfolio vega* in a single model. Here, we find that the impact of *Portfolio vega* is greater and more significant than that of *Portfolio delta* (z -statistics: 1.742 vs. 2.557).

Next, column (4) introduces quadratic terms of *Portfolio delta* (i.e., *Portfolio delta (I)/(II)*) to examine any concave relation between delta and misreporting, of which marginal effects are

reported in column (5). In column (4), the coefficients for *Portfolio delta (I)* and *Portfolio delta (II)* are both significant, with the former being positive (0.234, p -value < 0.050) and the latter negative (−0.017, p -value < 0.050). These results support our hypothesis.

This concave relation is robust to an alternative non-linear specification of *Portfolio delta* (i.e., RCS in column (6))⁴ or an alternative unit of analyses (i.e., CEOs in column (7)). The analyses of a PSM sample (column (8)) and an entropy balancing sample (column (9)) confirm that our results are robust relative to controlling for the imbalance in observable firm characteristics. Additional details of the sampling processes are provided in Appendix B.

[Insert Table 2 here]

Fig. 1 depicts the concave misreporting curve reported in columns (4) and (6) of Table 2. In the left panel of Fig. 1, the maximum point of the quadratic curve is approximately 6.883 of *Portfolio delta*. However, in the right panel, the RCS graph shows that increasing misreporting propensity is not necessarily dramatically reversed at higher levels of delta. Instead, the curve flattens out, consistent with our discussion that managerial incentives to engage in *further* misreporting diminish once the marginal costs exceed the marginal benefits. Accordingly, misreporting propensity flattens at the point where marginal costs meet marginal benefits.

[Insert Fig. 1 here]

4. Further analysis

Subsample analyses are conducted to test if the non-linearity indeed arises from managers' consideration of the risks and rewards of misreporting. Specifically, we test if the maximum

⁴ Again, the knots of *Portfolio delta* in the RCS analysis are placed at Harrell's (2015) predetermined levels: the first, fifth, and ninth deciles of portfolio delta.

point of the misreporting curve shifts depending on the level of executives' perceived reward or risk effects related to misreporting.

4.1. Cross-sectional analyses

To this end, we first split our sample at the median value of executives' risk-taking incentives, captured by portfolio vega (Armstrong et al. 2013). Here, we predict that executives with greater vega would overestimate the reward effects of misreporting, and consequently shift the curve to the right of delta. We then construct subsamples using two CEO characteristics: CEO tenure (*CEO tenure*) and CEO-Chairman duality (*Duality*). Extant literature indicates that CEOs with longer tenure (Velikonja 2010; Khanna et al. 2015) or dual positions (Dechow et al. 1996) have been more likely to be involved in risky misreporting schemes because they can weaken board monitoring. Accordingly, we predict that executives working with such CEOs would underestimate the cost effects of misreporting, and therefore shift the curve to the right.

Table 3 reports the probit estimation results of Eq. (1) using the subsamples. Consistent with the aforementioned predictions, we find that firms reach the maximum point at higher levels of *Portfolio delta* when i) the top five executives' equity portfolios are more sensitive to stock volatility changes (5.617 vs. 8.476; *Portfolio vega* in columns (1) and (2) of Panel A); ii) CEOs have longer tenures (4.927 vs. 6.448; *CEO tenure* in columns (1) and (2) of Panel B); or iii) CEOs hold dual positions of Chairman and CEO (5.169 vs. 8.606; *Duality* in columns (3) and (4) of Panel B).

Note that in column (3) of Panel A, we adopt a linear specification of *Portfolio delta* because its quadratic term in column (2) is not significant (-0.015 with $p\text{-value} > 0.100$). Here, the positive and significant coefficient on *Portfolio delta* (0.072 with $p\text{-value} < 0.010$) indicates that executives' misreporting incentives are hardly curbed by the risk effects of delta when their risk-taking incentives are greater.

4.2. Time-series analyses

Next, we test whether the maximum point moves to the *left* of delta following the enactment of SOX in 2002 as it substantially increased the enforcement risk of misreporting. Specifically, SOX increased *punishments* by raising the maximum criminal penalties for illegal insider trading from 10 to 20 years of imprisonment and from \$1 to \$5 million in fines (Brody 2009). Additionally, SOX increased *conviction risk* by strengthening the disclosure requirements for option grants (e.g., the filing of Form 4 within two business days of option receipts) and by introducing various external and internal monitoring mechanisms that facilitate the detection of securities fraud.

Columns (5) and (6) of Panel B report the probit estimation results of Eq. (1) before and after the passage of SOX, respectively. *SOX* is an indicator variable that equals 1 for firm-years after 2002, and 0 otherwise. Here, we find that firms reach the maximum point at lower levels of *Portfolio delta* after SOX (6.930 vs. 5.659).

Together, the cross-sectional and time-series analyses consistently are observed to support the notion that non-linearity arises as executives weigh the risks and rewards associated with misreporting.

[Insert Table 3 here]

4.3. Partial observability bias

So far, our analyses may be subject to observational bias since we only observed *detected* misreporting cases through AAERs. This suggests that the probability of AAERs may not accurately reflect the actual probability of firms engaging in misreporting. To address this concern, we adopt Poirier's (1980) bivariate probit model as shown in Table 4. This approach splits the standard probit model for the probability of (detected) misreporting into two binary models: the probability of committing misreporting (column (1)) and the probability of detecting committed misreporting (column (2)). Thus, $Pr(\text{Detected misreporting}) =$

$Pr(\text{Committing misreporting}) \times Pr(\text{Detection} \mid \text{Committing misreporting})$. Here, by explicitly accounting for the misreporting detection process, we estimate the probability of misreporting commission rather than that of detected misreporting.

To model the detection process, we consider the following factors within the misreporting detection model (i.e., column (2)). We include audit opinion (*Audit opinion*) because non-unqualified opinions may trigger SEC investigations. We also add firms' contributions to Political Action Committees (*Political_cont*) and a firm's physical distance from SEC national or regional offices (*Distance*) as proxies for the SEC's political and geographical biases.⁵ We also include unexpected ROA (*Unexpected performance*) as this potentially attracts the SEC's attention or represents firms' weaker incentives for income-increasing misreporting. Finally, we incorporate *CEO tenure* because, as noted, CEOs with longer tenures generally have more control over their board and thus are more able to hinder the SEC's investigation processes.

We present the estimation results of the model for committing misreporting in column (1) and the model for detecting committed misreporting in column (2). In column (1), the significant coefficients on *Portfolio delta* and *Portfolio delta*² continue to exhibit a concave relationship. This is consistent with the results in Table 2.

[Insert Table 4 here]

5. Concluding remarks

This study revisits the relation between managers' portfolio delta and their misreporting decisions. Contrary to prior studies, we posit that the total costs of misreporting (e.g., conviction and enforcement risk) increase at an increasing rate, whereas the benefits from misreporting (e.g., illegal income) increase at a decreasing rate. Consequently, marginal costs

⁵ Correia (2014) proposes a political bias measure, arguing that SEC enforcement actions are weaker for firms that contribute more to Political Action Committees (PAC). This may be because Congress, which sets the SEC's budget, can influence regulatory processes. Kedia and Rajgopal (2011) suggest a geographical bias measure. They argue that due to resource constraints, geographical distance may constrain the SEC's enforcement efforts, so firms located further from its offices are less likely to be sanctioned.

of misreporting exceed marginal benefits at a certain point of portfolio delta. Therefore, we predict and find a concave relation between managers' portfolio delta and a firm's propensity to misreport. We also find that the maximum points of the misreporting curve vary according to the risk and reward factors associated with misreporting.

These findings elucidate the securities fraud mechanism by which managers make decisions regarding misreporting based on considerations of the risks and rewards related to misreporting commissions. They also explain why their countervailing effects do not completely offset each other. We believe our inferences can be generalized to various fraud contexts with similar risk and reward implications.

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Appendix A. Definition of variables

Variable	Definition	Data source
Dependent variables		
AAERs	Indicator variable that equals 1 for misreporting firms for which the SEC files cases, and 0 otherwise (Dechow et al. 2011).	Center for Financial Reporting and Management
Portfolio delta	Natural logarithm of one plus the mean value of the top five executives' portfolio delta, which is the value sensitivity of stocks and stock options to a 1% change in stock price.	Coles et al. (2006) (https://sites.temple.edu/lnaveen/data/)
Portfolio vega	Natural logarithm of one plus the mean value of top five executives' portfolio vega, which is the value sensitivity of stocks and stock options to a 1% change in stock volatility.	
Cash compensation	Natural logarithm of one plus the mean value of top five executives' salary and bonus.	
CEO tenure	Natural logarithm of one plus the number of years that a CEO has held the position until the current year.	ExecuComp
Big N	Indicator variable that equals 1 for firms audited by Arthur Andersen (Arthur Young), Ernst & Young, Deloitte & Touche (Touche Ross), KPMG, and PricewaterhouseCoopers (Coopers), and 0 otherwise.	Compustat
Duality	Indicator variable that equals 1 for firms where a CEO is also chair of the board, and 0 otherwise.	ExecuComp
Size	Natural logarithm of market capitalization ($prcc \times csho$).	Compustat
BM	Ratio of common equity (ceq) to the market capitalization.	
Leverage	Ratio of total liabilities (lt) to total assets (at).	
Firm age	Number of years from the first Compustat year.	
ROA	Ratio of income before extraordinary items (ib) to average total assets.	
Returns	Buy and hold returns using monthly data.	CRSP
Capital	Ratio of property, plant, and equipment ($ppent$) to total assets.	Compustat
Intangible	Ratio of research and development (xrd) and advertising (xad) expenses to sales ($sale$)	
Financing	Ratio of common and preferred stock ($sstk$) and long-term debt ($dltis$) to total assets.	
Acquisition	Indicator variable that equals 1 for firms whose acquisitions (acq) to sales ($sale$) is greater than or equal to 0.2, and 0 otherwise.	
Sales growth	Ratio of the increase in sales to lagged sales.	
Inventory	Ratio of inventory (inv) to total assets.	
Receivables	Ratio of receivables ($rect$) to total assets.	
Audit opinion	Indicator variable that equals 1 for firms for which audit opinions are not unqualified, and 0 otherwise.	Compustat
Political_cont	Five-year accumulation of Political Action Committee (PAC) contributions, scaled by	Federation Election Commission

Distance	average total assets (Correia 2014). Natural logarithm of the distance between a firm's headquarters and the closest SEC office in Washington, New York, Miami, Chicago, Denver, Los Angeles, Boston, Philadelphia, Atlanta, Fort Worth, Salt Lake, or San Francisco. The latitude and longitude of the headquarters and SEC offices are drawn from the US Census Bureau Gazetteer, and the distance is calculated using the Haversine formula (Kedia and Rajgopal 2011).	(www.fec.gov) U.S. Census Bureau Gazetteer (https://www.census.gov/)
Unexpected performance	Residuals from $ROA_{t+1} = \alpha_0 + \alpha_1 ROA_t + \alpha_2 ROA_{t-1} + \varepsilon$.	Compustat

Appendix B. Matching and entropy balancing

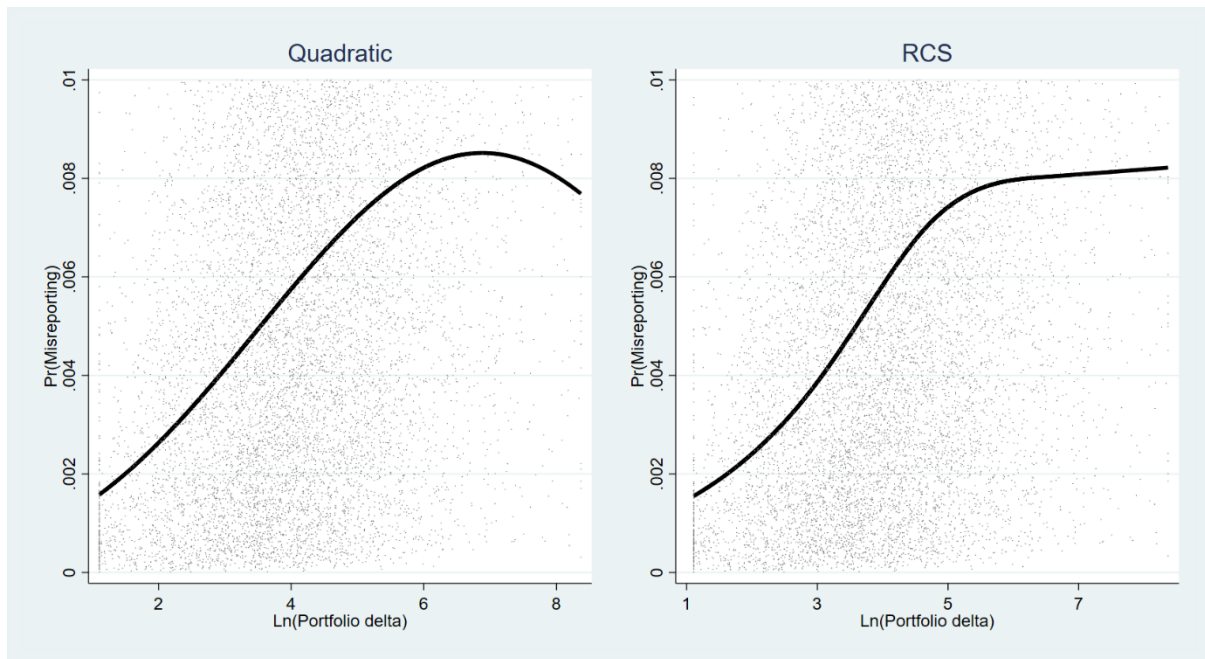
To calculate the propensity scores, representing a firm's ex ante probability of misreporting, we *annually* estimate the logit model where we regress a misreporting dummy on all controls. Using these scores, we identify pairs of misreporting and non-misreporting firms in the first misreporting year (Dechow et al. 1996) without replacement for the propensity score caliper of 0.2 (Austin 2011). Panel A reports the covariate balance after matching. This matching procedure yields 86 pairs as of the first misreporting year (or 2,027 firm-years). In Panel B, we adopt an entropy balancing approach to achieve covariate balance, but without losing any observations (Hainmueller 2012). Contrary to the outcome-based matching (i.e., misreporting vs. non-misreporting) for PSM, we required the mean, variance, and skewness balance conditions for the treatment (i.e., high portfolio delta) and control (i.e., low portfolio delta) firms.

Panel A. Covariate balance – PSM (outcome-based)						
	Misreporting	Non- Misreporting	Mean diff.	Median diff.	Dist'n diff.	
	(1)	(2)	(3)	(4)	(5)	
CEO tenure	0.913	0.885	0.671	0.425	0.606	
BigN	1.000	1.000	1.000	1.000	1.000	
Size	7.854	8.042	0.488	0.439	0.734	
BM	0.373	0.403	0.532	0.954	0.483	
Leverage	0.549	0.561	0.729	0.643	0.851	
Firm age	24.523	25.500	0.704	0.617	0.483	
ROA	0.055	0.069	0.243	0.112	0.069 *	
Returns	0.180	0.067	0.162	0.569	0.483	
Capital	0.264	0.330	0.043 **	0.043 **	0.102	
Intangible	0.054	0.057	0.857	0.531	0.851	
Financing	0.122	0.135	0.598	0.939	0.734	
Acquisition	0.093	0.081	0.789	0.788	1.000	
Sales growth	0.303	0.178	0.032 **	0.138	0.372	
Inventory	0.132	0.120	0.570	0.912	0.734	
Receivables	0.183	0.148	0.060 *	0.095 *	0.205	
Firms	86	86				
Panel B. Covariate balance – Entropy balancing (treatment-based)						
	High Portfolio delta			Low Portfolio delta		
	Mean	Variance	Skewness	Mean	Variance	Skewness
CEO tenure	0.920	0.206	−0.945	0.920	0.206	−0.945
BigN	0.970	0.029	−5.508	0.970	0.029	−5.506
Size	8.127	2.147	0.219	8.126	2.150	0.217
BM	0.378	0.070	1.701	0.378	0.070	1.708
Leverage	0.523	0.047	0.059	0.523	0.047	0.059
Firm age	24.730	268.2	0.467	24.730	268.2	0.467
ROA	0.063	0.007	−2.409	0.063	0.007	−2.411
Returns	0.088	0.217	1.386	0.088	0.217	1.386
Capital	0.278	0.049	0.920	0.278	0.049	0.921
Intangible	0.060	0.014	4.828	0.060	0.014	4.827
Financing	0.104	0.025	2.783	0.104	0.025	2.783
Acquisition	0.044	0.042	4.429	0.044	0.042	4.429
Sales growth	0.177	0.075	2.070	0.177	0.075	2.069
Inventory	0.110	0.016	1.586	0.111	0.016	1.586
Receivables	0.151	0.014	1.537	0.151	0.014	1.537
Firm-years		10,162			10,162	

NOTE: Panels A and B compare the covariates of the PSM and pooled samples after matching and applying

entropy balancing. The PSM sample consists of 2,027 firm-years (172 matched pairs) for 1992–2009, and the pooled sample comprises 20,324 firm-years for the same period. In Panel A, columns (1) and (2) present the mean values of the covariates for each group. Columns (3)–(5) present p -values for the t-test (mean), Wilcoxon rank-sum test (median), and Kolmogorov Smirnov test (distribution), respectively. See Appendix A for definitions of variables.

Fig. 1. Misreporting curves



NOTE: This figure illustrates concave misreporting curves estimated using the probit model of Eq. (1) after applying two non-linear specifications (i.e., quadratic and RCS) and setting all control variables at their respective means and using the pooled sample of 20,324 firm-years for 1992–2009. It shows the predicted values from Eq. (8) (i.e., solid lines) with actual observations (i.e., dots) of the top five executives' portfolio deltas (*Portfolio delta*). See Appendix A for definitions of variables.

Table 1
Summary statistics

Panel A. Covariate balance						
	Mean (pooled sample)					
	Misreporting (1)	Non-misreporting (2)	Mean Diff. (3)			
Main variables						
Portfolio delta	5.431	4.571	0.860 ***			
Portfolio vega	3.767	3.065	0.702 ***			
Cash compensation	6.519	6.330	0.189 ***			
Control variables						
CEO tenure	0.959	0.867	0.092 ***			
BigN	0.974	0.958	0.015			
Size	8.011	7.292	0.719 ***			
BM	0.449	0.503	−0.054 ***			
Leverage	0.519	0.529	−0.010			
Firm age	21.024	24.983	−3.959 ***			
ROA	0.037	0.040	−0.003			
Returns	0.074	0.051	0.023			
Capital	0.304	0.208	−0.096 ***			
Intangible	0.066	0.058	0.008			
Financing	0.129	0.105	0.024 ***			
Acquisition	0.084	0.041	0.043 ***			
Sales growth	0.244	0.137	0.107 ***			
Inventory	0.099	0.116	−0.017 ***			
Receivables	0.174	0.152	0.022 ***			
Audit opinion	0.409	0.440	−0.032			
Political_cont	0.000	0.000	−0.000			
Distance	6.634	7.215	−0.581 ***			
Unexpected performance	0.036	0.040	−0.005			
Max. firms	136	2,523	2,659			
Max. firm-years	416	19,908	20,324			
Panel B. Summary statistics						
Variable	N	Mean	Std Dev	Q1	Median	Q3
Misreporting	20,324	0.020	0.142	0.000	0.000	0.000
Portfolio delta	20,324	4.589	1.446	3.623	4.548	5.525
Portfolio vega	20,324	3.079	1.391	2.194	3.105	4.021
Cash compensation	20,324	6.334	0.615	5.895	6.274	6.706
CEO tenure	20,324	0.869	0.443	0.527	0.959	1.195
BigN	20,324	0.959	0.199	1.000	1.000	1.000
Size	20,324	7.307	1.572	6.203	7.172	8.306
BM	20,324	0.502	0.371	0.258	0.427	0.644
Leverage	20,324	0.414	0.410	0.079	0.361	0.680
Firm age	20,324	24.902	16.175	11	21	40
ROA	20,324	0.040	0.103	0.019	0.049	0.087

Panel C. Spearman's correlation matrix ($N = 22,003$)

Variable	1	2	3	4	5	6	7	8	9	10
1. <i>Misreporting</i>	1.000									
2. <i>Portfolio delta</i>	0.084	1.000								
3. <i>Portfolio vega</i>	0.072	0.588	1.000							
4. <i>Cash compensation</i>	0.044	0.502	0.560	1.000						
5. <i>CEO tenure</i>	0.029	0.141	0.052	0.034	1.000					
6. <i>BigN</i>	0.011	0.089	0.128	0.093	-0.015	1.000				
7. <i>Size</i>	0.065	0.628	0.629	0.671	0.015	0.135	1.000			
8. <i>BM</i>	-0.021	-0.431	-0.261	-0.155	-0.018	-0.046	-0.394	1.000		
9. <i>Leverage</i>	-0.006	-0.055	0.091	0.304	-0.056	0.098	0.185	-0.020	1.000	
10. <i>Firm age</i>	-0.035	-0.048	0.124	0.295	-0.033	0.029	0.333	0.060	0.313	1.000

NOTE: The sample comprises 22,324 firm-years for 1992–2009. Panel A summarizes the covariate balance of misreporting and non-misreporting firms. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Panels B and C present a summary and Spearman's correlations, respectively. Correlations with p -values of less than 0.10 are in bold. See Appendix A for definitions of variables.

Table 2
Equity incentives and misreporting

<i>DV =</i>		<i>Pr(Misreporting)</i>							
Specification:		Linear	Linear	Linear	Quadratic	Quadratic (<i>dF/dx</i>)	RCS	Quadratic	Quadratic
Unit of analysis:		Top five	Top five	Top five	Top five	Top five	Top five	CEO	Top five
Sample:		Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	PSM
	Pred.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept		−4.040 *** (−8.987)	−3.733 *** (−7.792)	−3.764 *** (−7.866)	−4.210 *** (−8.660)		−4.152 *** (−8.774)	−4.356 *** (−9.587)	−2.091 *** (−2.602)
<i>Equity incentives</i>									
Portfolio delta(I)	+	0.063 ** (2.160)		0.050 * (1.742)	0.234 ** (2.390)	0.011 ** (2.390)	0.155 ** (2.269)	0.158 ** (2.396)	0.515 *** (2.784)
Portfolio delta(II)	−				−0.017 ** (−2.236)	−0.001 ** (−2.250)	−0.104 ** (−2.122)	−0.009 ** (−2.036)	−0.035 ** (−2.377)
Portfolio vega	+		0.086 *** (2.678)	0.076 ** (2.557)	0.065 ** (2.278)	0.003 ** (2.290)	0.065 ** (2.254)	0.027 * (1.715)	−0.020 (−0.440)
Cash compensation	?	0.024 (0.454)	−0.004 (−0.076)	−0.013 (−0.224)	−0.014 (−0.249)	−0.001 (−0.250)	−0.014 (−0.244)	0.044 (1.093)	−0.298 *** (−2.817)
<i>CEO power and governance</i>									
CEO tenure	+	0.179 *** (5.763)	0.202 *** (5.955)	0.183 *** (5.789)	0.182 *** (5.577)	0.009 *** (5.810)	0.182 *** (5.765)	0.167 *** (4.729)	
BigN	−	−0.058 (−0.623)	−0.072 (−0.768)	−0.063 (−0.678)	−0.082 (−0.896)	−0.004 (−0.900)	−0.085 (−0.930)	−0.097 (−1.088)	0.196 *** (4.614)
<i>Firm characteristics</i>									
Size	?	0.138 *** (8.650)	0.138 *** (7.569)	0.114 *** (6.182)	0.122 *** (6.617)	0.006 *** (6.590)	0.122 *** (6.514)	0.134 *** (7.904)	0.017 (0.386)
BM	?	0.248 *** (2.606)	0.214 ** (2.220)	0.241 ** (2.520)	0.270 *** (2.818)	0.013 *** (2.830)	0.273 *** (2.812)	0.240 *** (2.582)	0.308 ** (2.024)
Leverage	+	−0.128 (−0.741)	−0.197 (−1.213)	−0.160 (−0.933)	−0.165 (−0.946)	−0.008 (−0.940)	−0.168 (−0.958)	−0.202 (−1.293)	−0.302 (−0.929)
Firm age	+	−0.003 ** (−2.331)	−0.004 ** (−2.522)	−0.003 ** (−2.292)	−0.004 ** (−2.371)	−0.000 ** (−2.380)	−0.004 ** (−2.376)	−0.004 *** (−2.588)	0.003 (1.383)
ROA	?	−0.820 ***	−0.824 ***	−0.841 ***	−0.878 ***	−0.042 ***	−0.886 ***	−0.899 ***	−0.121 (−1.058)

	(−3.641)	(−3.696)	(−3.680)	(−3.733)	(−3.730)	(−3.745)	(−3.986)	(−0.330)	(−3.400)
Returns	0.001	0.017	0.013	0.009	0.000	0.009	0.001	0.026	−0.042
	(0.016)	(0.418)	(0.326)	(0.250)	(0.250)	(0.239)	(0.033)	(0.305)	(−0.510)
Capital	−0.635 ***	−0.612 ***	−0.606 ***	−0.619 ***	−0.030 ***	−0.613 ***	−0.623 ***	−0.500 *	−0.615 **
	(−3.865)	(−3.760)	(−3.778)	(−3.833)	(−3.870)	(−3.809)	(−3.913)	(−1.774)	(−2.495)
Intangible	−0.352 *	−0.419 *	−0.401 *	−0.393 *	−0.019 *	−0.392 *	−0.362 *	−0.684 *	−0.345
	(−1.669)	(−1.947)	(−1.899)	(−1.875)	(−1.870)	(−1.871)	(−1.734)	(−1.748)	(−0.829)
Financing	0.283 *	0.267 *	0.263	0.262	0.013	0.260	0.278 *	0.692 **	0.356
	(1.791)	(1.668)	(1.631)	(1.613)	(1.610)	(1.603)	(1.737)	(1.971)	(1.414)
Acquisition	0.062	0.060	0.062	0.058	0.003	0.058	0.053	0.135	0.077
	(0.604)	(0.575)	(0.596)	(0.557)	(0.560)	(0.557)	(0.518)	(0.979)	(0.693)
Sales growth	0.261 ***	0.289 ***	0.272 ***	0.270 ***	0.013 ***	0.270 ***	0.271 ***	0.463 ***	0.211 ***
	(3.606)	(4.175)	(3.805)	(3.791)	(3.790)	(3.795)	(3.841)	(3.395)	(2.750)
Inventory	0.616 ***	0.695 ***	0.661 ***	0.685 ***	0.033 ***	0.690 ***	0.656 ***	0.202	0.759 ***
	(2.694)	(3.240)	(3.059)	(3.216)	(3.190)	(3.264)	(2.992)	(0.524)	(2.469)
Receivables	0.011	0.076	0.086	0.084	0.004	0.087	0.046	0.533 **	0.231
	(0.088)	(0.614)	(0.699)	(0.688)	(0.690)	(0.710)	(0.362)	(2.004)	(0.982)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	20,324	20,324	20,324	20,324	20,324	20,324	20,324	2,027	20,324
Pseudo R-squared	0.133	0.134	0.135	0.136	—	0.135	0.136	0.133	0.165
Maximum point				6.883	6.883		8.341	7.342	7.877

NOTE: The pooled (PSM) sample comprises 20,324 (2,027) firm-years for 1992–2009. Columns (1) to (9) report probit estimation results of Eq. (1). For quadratic specifications in columns (4), (5), and (7), *Portfolio delta(I)* and *Portfolio delta(II)* are *Portfolio delta* and *Portfolio delta*², respectively. Exceptionally, *Portfolio delta(II)* is $(Portfolio\ delta - K_1)_+^3 - (Portfolio\ delta - K_2)_+^3 (K_3 - K_1) / (K_3 - K_2) + (Portfolio\ delta - K_3)_+^3 (K_2 - K_1) / (K_3 - K_2)$, for restricted cubic spline (RCS) specification in column (6). Here, K_1 , K_2 , and K_3 are placed in Haerell's (2015) predetermined deciles. In columns (8) and (9), we adopt reduced industry dummies for the PSM analyses to facilitate the convergence of log-pseudo-likelihood estimations. The reduced industry dummy equals 1 for the high litigation-risk industries based on 1998–2012 litigation data. High-litigation industries include Biotechnology (2800), Computer software (7300), and Electronics (3600). Column (2) analyzes firm-years three years before and after the first misreporting year ($t - 3$ to $t + 3$) to focus more on firm characteristics around the first misreporting year (t). The coefficient estimates and z-statistics, calculated with standard errors clustered by year, are reported for each covariate (in parentheses). *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. The maximum points of the concave misreporting curves are reported in the final row (in \$ millions). See Appendix A for definitions of variables.

Table 3
Subsample analyses

Panel A: Risk-taking incentives				
DV =		Pr(Misreporting)		
Subsample:		Portfolio vega		
Specification:		Lower		Higher
	Pred.	Quadratic (1)	Quadratic (2)	Linear (3)
Intercept		−5.395 *** (−7.282)	−3.203 *** (−2.971)	−2.727 *** (−3.140)
Portfolio delta	+	0.428 ** (2.346)	0.246 * (1.722)	0.072 *** (2.682)
Portfolio delta ²	−	−0.038 ** (−2.231)	−0.015 (−1.295)	
Controls		Y	Y	Y
Year fixed effects		Y	Y	Y
Industry fixed effects		Y	Y	Y
Observations		10,166	10,158	10,158
Pseudo R-squared		0.114	0.149	0.149
Maximum point		5.617	8.476	
Panel B: Risk consideration				
DV =		Pr(Misreporting)		
Subsample:		CEO tenure		SOX
		Shorter	Longer	
	Pred.	(1)	(2)	No (3) Yes (4) Before (5) After (6)
Intercept		−3.890 *** (−7.711)	−5.042 *** (−6.975)	−4.843 *** (−6.806)
Portfolio delta	+	0.379 ** (2.175)	0.288 ** (2.371)	0.546 ** (2.483)
Portfolio delta2	−	−0.038 ** (−2.485)	−0.022 ** (−2.057)	−0.053 ** (−2.377)
Controls		Y	Y	Y
Year fixed effects		Y	Y	Y

Industry fixed effects	Y	Y	Y	Y	Y	Y
Observations	10,965	9,359	7,917	12,407	10,884	9,440
Pseudo <i>R</i> -squared	0.116	0.204	0.150	0.165	0.156	0.126
Maximum point	4.927	6.448	5.169	8.606	6.930	5.659

NOTE: The pooled sample comprises 20,324 firm-years for 1992–2009. Each column reports probit estimation results. The control variables are the same as those used in column (4) of Table 2. We divide the pooled sample into two subsamples of firm-years stratified at the median value of continuous variables (e.g., *Portfolio delta* in Panel A), or of firm-years falling before or after the passage of SOX in 2002 (i.e., *SOX* in columns (5) and (6) of Panel B). The coefficient estimates and *z*-statistics, calculated with standard errors clustered by year, are reported for each covariate (in parentheses). *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. The maximum point of the concave misreporting curve is reported in the final row of each panel. See Appendix A for definitions of variables.

Table 4
Partial observability bias

<i>DV =</i>		<i>Pr(Misreporting)</i>	
Model:		Misreporting	Detection Misreporting
	Pred.	(1)	(2)
Intercept		−3.230 *** (−2.637)	0.110 (0.148)
<i>Equity incentives</i>			
<i>Portfolio delta</i>	+	0.387 ** (2.416)	
<i>Portfolio delta</i> ²	−	−0.025 * (−0.836)	
Portfolio vega		0.113 ** (2.421)	
Cash compensation		−0.113 (−1.280)	
<i>CEO power and governance</i>			
CEO tenure		0.117 (1.340)	0.070 (0.728)
BigN		0.245 (1.053)	
Audit opinion	+		−0.002 (−0.025)
<i>Firm characteristics</i>			
<i>Size</i>		0.110 ** (2.237)	
<i>BM</i>		0.497 *** (2.887)	
<i>Leverage</i>		0.166 (0.769)	
<i>Firm age</i>		−0.006 * (−1.892)	
<i>ROA</i>		−0.564 (−1.245)	
<i>Returns</i>		0.066 (1.026)	
<i>Capital</i>		−1.150 *** (−3.275)	
<i>Intangible</i>		−0.902 ** (−2.259)	
<i>Financing</i>		−0.043 (−0.213)	
<i>Acquisition</i>		0.123 (0.914)	
<i>Sales growth</i>		0.370 *** (2.592)	
<i>Inventory</i>		−0.298 (−1.071)	
<i>Receivables</i>		−0.195 (−0.594)	
<i>Unexpected performance</i>			−0.541 (−1.121)
<i>Enforcement bias</i>			

Political_cont	—	—24.509 (−0.227)
Distance	—	−0.017 * (−1.676)
Year fixed effects	Y	Y
Industry fixed effects	Y	Y
Observations	20,324	
Log-pseudo-likelihood	−1613	
Converged	Y	

NOTE: The pooled sample comprises 20,324 firm-years for 1992–2009. Each column reports bivariate probit regression estimation results. In this analysis, we combine the misreporting model of firms (column (1)) with the misreporting detection model of the SEC (column (2)). In the misreporting model (column (1)), we include all variables included in column (4) in Table 2. To facilitate the convergence of log-pseudo-likelihood estimations, we adopt reduced industry and year dummies. The reduced industry dummy equals 1 for the high litigation-risk industries based on 1998–2012 litigation data. High-litigation industries include Biotechnology (2800), Computer software (7300), and Electronics (3600). The reduced year dummy is an indicator variable that equals 1 for firm-years after 2001, and 0 otherwise. The coefficient estimates and z-statistics, calculated with standard errors clustered by year, are reported for each covariate (in parentheses). *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. See Appendix A for definitions of variables.