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CFOs versus CEOs: Equity incentives and crashes ☆

Jeong-Bon Kim [a,1], Yinghua Li [b], Liandong Zhang [a,*]

[a] Department of Accountancy, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong
[b] Baruch College, The City University of New York, One Bernard Baruch Way, New York, NY 10010-5585, USA

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ABSTRACT

Using a large sample of U.S. firms for the period 1993–2009, we provide evidence that the sensitivity of a chief financial officer's (CFO) option portfolio value to stock price is significantly and positively related to the firm's future stock price crash risk. In contrast, we find only weak evidence of the positive impact of chief executive officer option sensitivity on crash risk. Finally, we find that the link between CFO option sensitivity and crash risk is more pronounced for firms in non-competitive industries and those with a high level of financial leverage.

1. Introduction

The separation of ownership and control in modern corporations creates a conflict of interest between shareholders and managers (Jensen and Meckling, 1976). Executive compensation contracts are one potential mechanism for aligning the interests of shareholders and managers. However, Jensen and Murphy (1990b) show that during the 1970s and 1980s, corporate managers were not paid for performance but were compensated, like bureaucrats, based on the size of the organization. Furthermore, Jensen (1993) argues that such inefficient executive pay schemes created empire-building incentives, which exacerbated the excess capacity problem that had emerged since 1973[2] and contributed to the widespread value destruction by corporate America during the era. To address this problem of empire building, Jensen and Murphy (1990a) recommend increasing the use of equity-based compensation, which they believe to be an effective tool for aligning the interests of managers and shareholders by exposing managers' wealth to their firms' stock prices. Perhaps partially inspired by Jensen and Murphy (1990a), the use of stock- and option-based

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* Corresponding author. Tel.: +852 34427843; fax: +852 34420349.
E-mail addresses: jeong.bon.kim@cityu.edu.hk (J.-B. Kim), yinghua.li@gmail.com (Y. Li), liandong.zhang@cityu.edu.hk (L. Zhang).
[1] Tel: +852 3442 7909.

[2] Jensen (1993) describes the year 1973 as the beginning of the "Third Industrial Revolution."

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compensation increased dramatically during the 1990s.[3] Arguably, this shift in compensation structure toward greater pay for performance may have discouraged managerial empire-building behavior and contributed to the enormous value creation by U.S. corporations in the 1990s.

However, the solution to yesterday's problem can sow the seeds of today's problem. The widespread use of equity-based compensation coincides with several recent catastrophic events, including the dot-com bubble in the late 1990s, the 2001–2002 corporate scandals, and the recent financial crisis. This unfortunate coincidence has led regulators, the media, and academics to question whether the large portfolios of stocks and options held by managers were the culprit in these financial disasters. Specifically, there is an argument that the high sensitivity of managers' wealth to stock price afforded by stock option holdings motivates managers to engage in short-termist behavior to inflate current share prices at the expense of long-term firm value (Bebchuk, 2009). The primary purpose of this paper is to investigate whether equity incentives, particularly stock option incentives, are related to future firm-specific stock price crash risk.

Using a dynamic rational expectations model with asymmetric information, Benmelech, Kandel, and Veronesi (2010) show that stock-based compensation not only induces managers to exert costly effort, but also incentivizes them to conceal bad news about future growth options. Such concealment of bad news can lead to severe overvaluation and a subsequent crash in stock price. While bad news hoarding is a somewhat unintended consequence of the compensation contract in the Benmelech, Kandel, and Veronesi (2010) framework, Bolton, Scheinkman, and Xiong (2006) present a multiperiod agency model showing that incumbent investors use stock-based compensation to intentionally encourage managers to adopt short-termist behavior to boost the speculative component of the share price. The key tension of this model is the conflict of interest between the incumbent investors and future generations of investors. Although based on somewhat different underlying assumptions, the models of both Benmelech, Kandel, and Veronesi (2010) and Bolton, Scheinkman, and Xiong (2006) predict that equity incentives induce managers to engage in short-termist behavior, such as bad news hoarding, to inflate short-term share price.

Though not focusing on equity incentives, Jin and Myers (2006) and Bleck and Liu (2007) offer more analysis of how bad news hoarding can lead to stock price crashes. For example, Jin and Myers (2006) argue that there is an upper limit to the amount of bad news that managers can absorb or successfully accumulate. When the accumulated bad news reaches this upper limit, it will come out all at once, leading to a large and sudden price decline. Moreover, Bleck and Liu (2007) argue that hiding bad news prevents investors and the board of directors from discerning negative net present value (NPV) projects at an early stage and forcing managers to take timely abandonment actions. As a result, the bad performance of negative NPV projects accumulates and eventually materializes, which results in asset price crashes.

This study conducts a simple test to show whether the predicted (positive) relation between equity incentives and crash risk is consistent with real world data. Our empirical strategy involves the identification of an empirical proxy for managers in the bad news hoarding and crash story. Previous empirical research on managerial compensation has largely focused on chief executive officers (CEO). However, recent research provides evidence suggesting that the incentives of chief financial officers (CFO) could be more influential in a decision setting where sophisticated financial expertise is required. For example, Jiang, Petroni, and Wang (2010) find that CFO equity incentives are more important than CEO incentives in determining earnings management. Chava and Purnanandam (2010) show that while CEO incentives are associated with capital structure and cash holding decisions, CFO incentives dominate in debt maturity choices and earnings smoothing decisions. Because our predicted link between equity incentives and crash risk is largely built on the manipulation of information flow by managers, we expect that CFO incentives play a more important role in this setting. However, Benmelech, Kandel, and Veronesi (2010), Kedia and Philippon (2009), and McNichols and Stubben (2008), among others, argue that managers also hide bad news by mimicking the investment behavior of firms with truly high growth potential. Thus, CEO incentives may also be significant because we expect CEOs to be more influential in investment decisions. Therefore, the differential impact of CFOs' versus CEOs' incentives on crash risk is an empirical question.

Following Bergstresser and Philippon (2006), we measure the strength of CEO/CFO equity-based incentives as the dollar change in the value of the stock or option holdings of a CEO/CFO given a one-percentage-point increase in the company stock price. Firm-level crash risk is proxied by the probability of extreme, negative firm-specific weekly returns, the negative skewness of firm-specific weekly returns, and the asymmetric volatility of negative and positive stock returns (Chen, Hong, and Stein, 2001; Hutton, Marcus, and Tehranian, 2009; Kim, Li, and Zhang, in press). Using a sample of U.S. firms from the Compustat Executive Compensation database (ExecuComp) during the period 1993–2009, we find that the strength of CFO option incentives is significantly and positively related to future stock price crash risk. In contrast, we find only weak evidence that the strength of CEO option incentives is positively related to crash risk. More importantly, we find that CFO option incentives dominate CEO option incentives in determining future crash risk when we include both CFO and CEO option incentives in the regression. This result suggests that CFOs are more influential in firms' bad news hoarding decisions.

Theoretical analyses such as that of Benmelech, Kandel, and Veronesi (2010) do not discriminate between option and stock incentives. However, we find no significant empirical relation between the strength of stock incentives and crash risk. This result is consistent with Burns and Kedia (2006), who find that option incentives, but not stock incentives, have a significant

[3] Other possible drivers for the increasing level of stock options include tax rules introduced in 1994 (Section 162(m) of the Internal Revenue Code), the accounting treatment of stock options (the "intrinsic value" method), and the lack of cash flows of new economy firms. See Hall and Murphy (2003) for more discussions on this issue.

impact on a firm's misreporting. Thus, these results suggest that option holdings provide more powerful incentives for managers to inflate short-term share prices, possibly because the loss to manager wealth from option holdings is limited in the event of a stock price crash.

Giroud and Mueller (2010, 2011) find that the incentive provided by a firm's corporate governance system matters only if the firm operates in non-competitive industries. The authors suggest that researchers take into consideration the disciplining role of the product market when examining the consequence of corporate governance arrangements. Following their suggestion, we conduct subsample analysis for firms with high and low product market competition. Consistent with the argument that agency problems are more severe for non-competitive industries, we find that the positive relation between CFO option incentives and crash risk is significant only for the subsample of firms in non-competitive industries.

Finally, some regulators and academics argue that excessive risk taking induced by stock options contributed to the recent financial crisis (e.g., Bebchuk, 2009). Motivated by this argument, we examine whether the sensitivity of option portfolio values to stock return volatility (i.e., vega) is positively related to crash risk. However, we find no evidence of such a relation. Expanding on our bad news hoarding story, we conjecture that the *hiding* of excessive risk taking rather than risk taking itself leads to crashes.[4] Using financial leverage as a proxy for the ex ante incentive to mask risk taking, we show that the positive relation between CFO option incentives and crash risk exists only for the subsample of firms with high leverage (i.e., firms with high ex ante incentive to mask risks).[5]

This study contributes to the literature by identifying a perverse effect of option-based compensation: it can increase future stock price crash risk. The results in this paper are largely supportive of the predictions of the theoretical model of Benmelech, Kandel, and Veronesi (2010), with two important differences. First, Benmelech, Kandel, and Veronesi (2010) predict that both stock and option incentives can increase crash risk, while we find that only option incentives matter empirically. Second, Benmelech, Kandel, and Veronesi (2010) do not discriminate between CEO and CFO incentives, while we find that CFOs' option incentives dominate those of CEOs in determining crash risk. This difference between CEO and CFO incentives has attracted increasing attention from the recent literature, partially motivated by the recent Securities and Exchange Commission (SEC) rule of requiring the disclosure of CFO pay (Chava and Purnanandam, 2010; Jiang, Petroni, and Wang, 2010).

Our study also extends a long and large literature on the relation between equity incentives and firm performance or firm value (Core, Guay, and Larcker, 2003; Frydman and Jenter, 2010; Murphy, 1999). Using accounting return or Tobin's q as a proxy for firm performance, this literature, in general, finds some inconclusive evidence, partly due to difficulties in research design.[6] Instead of focusing on the average and concurrent valuation effect, we examine the impact of equity incentives on future extreme outcomes. This exercise can add significantly to the literature, because extreme outcomes reflect an extraordinary cumulative effect that can provide more valuable insight into the true nature of a phenomenon (Kim, Li, and Zhang, in press; Taleb, 2007).

This paper is closely related to those of Bergstresser and Philippon (2006), Burns and Kedia (2006), and Jiang, Petroni, and Wang (2010), which link CEO or CFO equity incentives to earnings management. However, our study provides additional insights into this literature, because earnings management is only one of many ways for managers to withhold bad news (Hutton, Marcus, and Tehranian, 2009).[7] For example, Kim, Li, and Zhang (forthcoming) argue that managers can also hide bad news through complex tax shelters. In our empirical tests, we explicitly control for earnings management and find that the relation between option incentives and crash risk remains significant.

Finally, our research is related to the emerging literature examining the causes for the recent financial crisis, although our investigation is more general and does not focus on the crisis. Fahlenbrach and Stulz (2010) investigate whether bank performance during the crisis is related to CEO incentives before the crisis and find evidence that CEOs with stronger equity incentives performed worse during the financial crisis for a sample of large banks.[8] Our results of the positive relation between managers' incentives and crash risk are somewhat consistent with these authors' findings.

The remainder of the paper is structured as follows. Section 2 conducts a review of the related literature. Section 3 describes the data and the measurement of key variables. Section 4 presents the empirical analysis and Section 5 presents our conclusions.

2. Related literature and empirical predictions

Stock and option holdings tie managers' wealth to a firm's stock price, and have long been viewed as an effective tool to align managers' incentives to shareholder interests. One of the underlying assumptions for this belief is that stock price is an unbiased indicator of the firm's

[4] Here, excessive risk taking is considered to be bad news, because the disclosure of it can depress stock prices.

[5] Financial leverage could be a proxy for many other things, and thus we suggest that readers exercise caution in accepting our explanations. Please refer to Section 4.3.3 for more details on the motivation, the design, and the limitation of this test.

[6] Section 2 provides a short review of this literature.

[7] In addition, some recent studies fail to find a significant positive relation between equity incentives and misreporting (e.g., Armstrong, Jagolinzer, and Larcker, 2010; Erickson, Hanlon, and Maydew, 2006). Thus, mixed evidence of the relation between equity incentives and earnings management also makes our study more necessary. Moreover, the financial statement's bottom line is only one of many ways of conveying information (Lambert, 2010).

[8] In particular, the authors find that banks with a larger "dollar gain from +1%" (a measure similar to the equity incentive measures in our paper) had significantly lower stock and accounting performance during the crisis.

fundamental value. However, there is both anecdotal and empirical evidence showing that managers can manipulate market expectations and that a firm's stock price can deviate from its fundamental value for an extended period of time (Peng and Roell, 2008). For example, Enron's managers were able to conceal Enron's bad performance through means such as earnings management, tax sheltering, and related party transactions, which led the market to overvalue Enron's stock for a prolonged period in the late 1990s. Empirically, Sloan (1996) shows that managers can manipulate the share price through accounting accruals. The above evidence suggests that equity incentives can have the perverse effect of inducing managers to inflate a firm's short-term share price without improving its true underlying performance.

Recent literature on the consequences of equity incentives has focused on earnings management. The maintained assumption of this line of research is that managers can successfully inflate share prices by manipulating financial statement bottom lines.[9] Cheng and Warfield (2005), Bergstresser and Philippon (2006), Burns and Kedia (2006), and Efendi, Srivastava, and Swanson, 2007), among others, show a positive relation between CEO equity incentives and earnings management. More recently, Chava and Purnanandam (2010) and Jiang, Petroni, and Wang (2010) provide an important extension to this line of research by showing that CFO incentives dominate CEO incentives in determining earnings management. Admittedly, the evidence in the literature is not unanimous. For instance, Erickson, Hanlon, and Maydew (2006) find no significant positive relation between executive equity incentives and accounting irregularities. Moreover, Armstrong, Jagolinzer, and Larcker (2010) find a modest *negative* relation between executive equity incentives and accounting fraud. The mixed evidence above may reflect the difficulties in capturing managerial earnings management behavior empirically, a problem that has long been recognized by the accounting literature (Dechow, Ge, and Schrand, 2010).

A number of earlier studies examine the relation between equity incentives and firm value, again producing mixed results. Morck, Shleifer, and Vishny (1988) and McConnell and Servaes (1990) show nonmonotonic relations between managerial ownership and firm value. Mehran (1995) finds that firm performance is positively related to the percentage of equity held by management and to the percentage of their compensation that is equity-based. Habib and Ljungqvist (2005) find a positive relation between firm value and CEO stock holdings, but a negative relation between firm value and option holdings. In contrast, Himmelberg, Hubbard, and Palia (1999) find no relation between managerial ownership and firm performance after controlling for firm fixed effects. However, Zhou (2001) argues that fixed effects estimators may not detect an effect of managerial ownership on performance, even if the effect exists, because fixed effects estimation relies on within-firm variations and managerial ownership typically changes slowly over time within a firm.

This paper extends the prior research by examining the relation between equity incentives and future stock price crash risk. Our empirical exercise is mainly motivated by the theoretical predictions in the model of Benmelech, Kandel, and Veronesi (2010). Using a hidden action model, the authors show that equity incentives induce managers to conceal bad news about future growth options, and this bad news hoarding by managers leads to an overvaluation of a firm's stock, which eventually results in a crash of the stock price. In a similar vein, Jin and Myers (2006) show analytically that the hoarding and accumulation of bad news for an extended period lead to an abrupt decline in stock price when a tipping point is crossed.

Moreover, managers' short-termist behaviors are not limited to the manipulation of financial information. To support the pretense of strong investment opportunities, managers can also choose suboptimal investment policies (Benmelech, Kandel, and Veronesi, 2010; McNichols and Stubben, 2008; Kedia and Philippon, 2009). For instance, McNichols and Stubben (2008) find that managers overinvest in property, plant, and equipment in the period of overstated earnings. Similarly, Kedia and Philippon (2009) show that during periods of inflated performance, firms hire and invest excessively. In Benmelech, Kandel, and Veronesi's (2010) theoretical model, the suboptimal investment policy after the slowdown in growth rate eventually leads to undercapitalization and a stock price crash.

Based on Benmelech, Kandel, and Veronesi (2010), we predict that managerial equity incentives are positively related to future crash risk. In addition, our empirical exercise also incorporates recent developments in the executive compensation literature. Specifically, following Jiang, Petroni, and Wang (2010), we separately and jointly examine the association between CFO and CEO equity incentives and crash risk. Fuller and Jensen (2010) argue that increasing the proportion of stock options in executive compensation makes the preservation and enhancement of short-term stock price a personal priority for both CEOs and CFOs. Jiang, Petroni, and Wang (2010) find that CFO equity incentives are more strongly related to earnings management than CEO equity incentives. Moreover, Chava and Purnanandam (2010) argue that CFOs are more influential in decisions requiring financial expertise, such as earnings smoothing. Thus, there is a reason to expect CFO equity incentives to have a different effect on crash risk from that of CEO equity incentives, because bad news hoarding requires financial expertise and CFOs are generally in direct charge of processing financial information about the firm and disseminating it to the stock market. However, Feng, Ge, Luo, and Shevlin (2011) argue that CFOs are simply CEOs' agents and that they engage in accounting manipulations because of CEO pressure. Thus, it is an empirical question whether CEO or CFO incentives matter more in determining bad news hoarding and crash risk.

Drawing on the findings of prior research, we also separately examine the incentives induced by stock

[9] Jiang, Petroni, Wang (2010) provide evidence that CFO incentives to manipulate earnings are stronger for firms with higher return-earnings relations.

Table 1
Yearly frequencies of stock price crash events.
This table presents descriptive statistics on the frequencies of stock price crash events for both the Compustat universe and the ExecuComp firm sample from 1993 to 2009. Stock price crash is defined in Appendix A.

	Compustat universe			ExecuComp firms		
Fiscal year	No. of firms	No. of firms with price crash	Percentage of firms with price crash	No. of firms	No. of firms with price crash	Percentage of firms with price crash
1993	5,360	825	0.154	1,553	317	0.204
1994	5,832	805	0.138	1,648	264	0.160
1995	6,698	864	0.129	1,719	239	0.139
1996	6,942	847	0.122	1,819	249	0.137
1997	7,405	948	0.128	1,870	271	0.145
1998	7,436	1,331	0.179	1,910	346	0.181
1999	6,888	895	0.130	1,811	261	0.144
2000	6,746	1,012	0.150	1,736	286	0.165
2001	6,498	1,443	0.222	1,754	488	0.278
2002	6,091	993	0.163	1,777	313	0.176
2003	5,709	788	0.138	1,813	268	0.148
2004	5,553	944	0.170	1,765	302	0.171
2005	5,503	980	0.178	1,678	302	0.180
2006	5,414	812	0.150	1,784	266	0.147
2007	5,228	941	0.180	1,700	303	0.170
2008	5,051	1,374	0.272	1,520	474	0.276
2009	4,646	362	0.078	1,482	93	0.063
Total	103,000	16,164	0.157	29,638	5,040	0.170

holdings and option holdings. Peng and Roell (2008) analytically show that options have a more powerful impact than stock awards on managers' incentives to engage in share price manipulation, given their higher pay-performance elasticity. Burns and Kedia (2006) argue that option holdings create a more powerful incentive than stock holdings for managers to inflate short-term share prices at the expense of long-term value. This is because the loss to option holdings is limited when future price declines occur. In contrast, the payoff from stock holdings has a symmetric relation to share price, which exposes managers' wealth to price declines as well as price appreciation. Thus, we expect that, compared to stock holdings, option holdings induce more aggressive bad news hoarding behavior by managers, which, in turn, leads to higher future crash risk.

3. Data and variable measurement

3.1. Data

The initial sample consists of firm-year observations in the ExecuComp database during the period 1993–2009. We then delete observations with missing Compustat accounting data and missing Center for Research in Security Prices (CRSP) price, return, and trading volume data. We also exclude firms with a year-end share price that is lower than $1. The final sample includes 29,638 firm-year observations. The exact number of observations used in our regression analyses varies, depending on the data requirement for the variables included in the regression. Table 1 presents a comparison of annual observations as well as the percentage of firms experiencing crashes for the Compustat universe and the ExecuComp sample. It shows that about 30% of Compustat firms are covered by the ExecuComp database. In addition, Table 1 shows a slightly higher crash frequency for firms in the ExecuComp database than those in the Compustat universe.

3.2. Measuring firm-specific crash risk

This study employs three measures of crash risk, which are constructed following previous studies in the crash risk literature. Since we are interested in firm-specific factors that contribute to firm-specific crash risk, we first estimate firm-specific weekly returns for each firm and year. Specifically, we define the firm-specific weekly return, denoted by W, as the natural log of one plus the residual return from the expanded market model regression[10]

$$r_{j,\tau} = \alpha_j + \beta_{1j} r_{m,\tau-2} + \beta_{2j} r_{m,\tau-1} + \beta_{3j} r_{m,\tau} + \beta_{4j} r_{m,\tau+1} + \beta_{5j} r_{m,\tau+2} + \varepsilon_{j\tau}, \quad (1)$$

where $r_{j,\tau}$ is the return on stock j in week τ, and $r_{m,\tau}$ is the return on the CRSP value-weighted market index in week τ. We include the lead and lag terms for the market index return to allow for nonsynchronous trading (Dimson, 1979). The firm-specific weekly return for firm j in week τ, $W_{j,\tau}$, is measured by the natural log of one plus the residual return in Eq. (1), that is, $W_{j,\tau} = \ln(1+\varepsilon_{j,\tau})$.

Following Hutton, Marcus, and Tehranian (2009) and Kim, Li, and Zhang (in press), this paper defines crash weeks in a given fiscal year for a given firm as those

[10] All the empirical results are qualitatively unchanged if we also include industry index return (and its lead and lag terms) in the expanded market model (e.g., Hutton, Marcus, and Tehranian, 2009). Results are available upon request.

weeks during which the firm experiences firm-specific weekly returns 3.2 standard deviations below the mean firm-specific weekly returns over the entire fiscal year. The first measure of crash likelihood for each firm in each year, denoted by *CRASH*, is an indicator variable that equals one for a firm-year that experiences one or more crash weeks (as defined above) during the fiscal-year period, and zero otherwise.

The second measure of crash risk is the negative conditional return skewness (*NCSKEW*) measure of Chen, Hong, and Stein (2001) and Kim, Li, and Zhang (in press). Specifically, *NCSKEW* for a given firm in a fiscal year is calculated by taking the negative of the third moment of firm-specific weekly returns for each sample year and dividing it by the standard deviation of firm-specific weekly returns raised to the third power. Specifically, for each firm j in year t, we compute *NCSKEW* as

$$NCSKEW_{jt} = -\left[n(n-1)^{3/2}\sum W_{j\tau}^3\right] \Big/ \left[(n-1)(n-2)\left(\sum W_{j\tau}^2\right)^{3/2}\right]. \quad (2)$$

The third measure we use is the down-to-up volatility (*DUVOL*) measure of crash likelihood from Chen, Hong, and Stein (2001), which is computed as follows. For each firm j over a fiscal-year period t, we separate all the weeks with firm-specific weekly returns below the annual mean ("down" weeks) from those with firm-specific returns above the annual mean ("up" weeks) and calculate the standard deviation for each of these subsamples separately. Then, the *DUVOL* measure is the log of the ratio of the standard deviation on the down weeks to the standard deviation on the up weeks.

3.3. Measurement of equity incentives

We use Bergstresser and Philippon's (2006) incentive ratio to measure the strength of CEO and CFO incentives from stock holdings and option holdings. Specifically, the incentive ratio for option holdings is calculated as

$$INCENTIVE_{i,t} = ONEPCT_{i,t,}/(ONEPCT_{i,t} + SALARY_{i,t} + BONUS_{i,t}), \quad (3)$$

where *ONEPCT* is the dollar change in the value of a manager's option holdings that would come from a one-percentage-point increase in the company stock price (i.e., 0.01 × share price × option delta × number of options). Following Core and Guay (2002), the options delta is estimated separately for each of the following three groups of options using the Black–Scholes formula: newly granted options in the current year, options granted in previous years but not yet exercisable, and options granted in previous years that are currently exercisable.[11]

The incentive ratio for stock holdings is calculated similarly as in Eq. (3). As discussed, we estimate the incentive ratios separately for CEOs and CFOs. The compensation data for CEOs are extracted from the ExecuComp database using the data item *CEOANN*=CEO. Following Jiang, Petroni, and Wang (2010), we obtain CFO data from ExecuComp using the data item *TITLEANN*.[12] Because ExecuComp only contains compensation data for the top five highest paid executives, including the CEO, not all firms in the database have CFO compensation data. Therefore, for the sample of firms with both CEO and CFO data, the CFO is likely to be relatively more influential than for firms without CFO data in ExecuComp. To address this potential sample selection bias, we report the regression results for both the sample with only CEO data (the "CEO sample") and the sample with both CEO and CFO data (the "CEO–CFO sample").

4. Empirical analysis

4.1. Descriptive statistics

Table 2 presents the descriptive statistics for the variables used in our regression analysis. Panel A of Table 2 reports the descriptive statistics for the CEO sample. The mean value for *CRASH* is 0.172, suggesting that the unconditional probability of a firm-specific stock price crash event during a year is 17.2%. The option and stock incentive ratios for an average CEO in the CEO sample are 0.113 and 0.160, respectively.

Panel B of Table 2 presents the descriptive statistics for the CEO–CFO sample. The option and stock incentive ratios for an average CEO in this sample are 0.115 and 0.154, respectively, which are similar in magnitude to those for the CEO sample. The option and stock incentive ratios for an average CFO in this sample are 0.072 and 0.037, respectively. The stock incentive ratio of CEOs is much larger than that of CFOs. In contrast, the difference between CEOs' and CFOs' option incentive ratios is relatively small.

4.2. Main regression analysis

To examine the relation between managers' equity incentives and future stock price crash risk, we employ the following regression:

$$CrashRisk = \beta_0 + \beta_1 * INCENTIVE + \gamma' * ControlVariables + \varepsilon. \quad (4)$$

In Eq. (4), when crash risk is proxied by *CRASH*, a logit regression is used, and when crash risk is proxied by *NCSKEW* or *DUVOL*, ordinary least squares (OLS) regressions are used. The dependent variable in Eq. (4) is measured in year t, while the independent variables are measured in year $t-1$. Following Chen, Hong, and Stein (2001) and Hutton, Marcus, and Tehranian (2009), we include a set of control variables that are deemed to be potential predictors of crash risk. The variable *DTURN* is the detrended stock trading volume, which is a proxy for investor heterogeneity, or the difference of opinions among investors, in Chen, Hong, and Stein (2001). The authors find that firms with high stock turnovers are

[11] We do not describe the detailed procedures here, since we use exactly the same procedure as that of Core and Guay (2002).

[12] We classify managers as CFOs if their title includes any of the following terms: *CFO*, *chief financial officer*, *treasurer*, *controller*, *finance*, and *vp-finance*.

Table 2
Descriptive statistics.

This table presents descriptive statistics on stock price crash risk, executive compensation, and control variables. The sample contains firms in ExecuComp from 1993 to 2009 with nonmissing values for the incentive ratio measures and all control variables. All variables are defined in Appendix A.

Panel A: Sample of firm-years with available CEO equity incentive information

Variable	N	Mean	Std	5%	25%	Median	75%	95%
Crash risk measures								
$CRASH_t$	22,612	0.172	0.377	0.000	0.000	0.000	0.000	1.000
$NCSKEW_t$	22,610	0.034	0.693	−1.823	−0.356	−0.001	0.380	1.238
$DUVOL_t$	22,610	0.004	0.332	−0.798	−0.217	−0.003	0.215	0.572
CEO compensation variables								
$INCENTIVE\_OPT\_CEO_{t-1}$	22,612	0.113	0.146	0.000	0.015	0.066	0.152	0.401
$ABINCENTIVE\_OPT\_CEO_{t-1}$	22,452	0.044	0.127	−0.339	−0.013	0.015	0.080	0.297
$INCENTIVE\_STK\_CEO_{t-1}$	21,267	0.160	0.235	0.000	0.017	0.053	0.187	0.755
$BONUS\_CEO_{t-1}$	22,514	0.853	1.207	0.000	0.000	0.563	1.095	2.712
Other control variables								
$DTURN_{t-1}$	22,612	0.009	0.073	−0.246	−0.014	0.005	0.029	0.131
$NCSKEW_{t-1}$	22,612	0.054	0.666	−1.608	−0.341	0.003	0.383	1.248
$SIGMA_{t-1}$	22,612	0.053	0.028	0.016	0.033	0.046	0.065	0.108
RET_{t-1}	22,612	−0.173	0.202	−1.152	−0.207	−0.104	−0.053	−0.022
$SIZE_{t-1}$	22,612	7.032	1.570	3.221	5.968	6.949	8.065	9.755
MB_{t-1}	22,612	3.121	2.766	0.484	1.547	2.278	3.617	8.340
LEV_{t-1}	22,612	0.325	0.243	0.000	0.100	0.323	0.503	0.740
ROA_t	22,612	0.048	0.105	−0.390	0.016	0.050	0.096	0.194
$ABACC_{t-1}$	22,612	0.052	0.062	0.001	0.015	0.034	0.067	0.164

Panel B: Sample of firm-years with both CEO and CFO equity incentive information

Variable	N	Mean	Std	5%	25%	Median	75%	95%
Crash risk measures								
$CRASH_t$	17,367	0.174	0.379	0.000	0.000	0.000	0.000	1.000
$NCSKEW_t$	17,366	0.038	0.695	−1.859	−0.352	0.004	0.390	1.249
$DUVOL_t$	17,366	0.007	0.334	−0.808	−0.215	0.000	0.219	0.578
CEO compensation variables								
$INCENTIVE\_OPT\_CEO_{t-1}$	17,367	0.115	0.148	0.000	0.016	0.067	0.154	0.405
$ABINCENTIVE\_OPT\_CEO_{t-1}$	17,264	0.047	0.126	−0.295	−0.012	0.016	0.081	0.300
$INCENTIVE\_STK\_CEO_{t-1}$	16,403	0.154	0.228	0.000	0.016	0.051	0.179	0.729
$BONUS\_CEO_{t-1}$	17,288	0.818	1.130	0.000	0.000	0.550	1.087	2.516
CFO compensation variables								
$INCENTIVE\_OPT\_CFO_{t-1}$	17,367	0.072	0.093	0.000	0.013	0.043	0.096	0.241
$ABINCENTIVE\_OPT\_CFO_{t-1}$	17,264	0.023	0.071	−0.131	−0.012	0.004	0.042	0.162
$INCENTIVE\_STK\_CFO_{t-1}$	16,020	0.037	0.081	0.000	0.003	0.013	0.036	0.148
$BONUS\_CFO_{t-1}$	17,351	0.565	0.652	0.000	0.060	0.427	0.790	1.667
Other control variables								
$DTURN_{t-1}$	17,367	0.010	0.075	−0.246	−0.014	0.005	0.031	0.136
$NCSKEW_{t-1}$	17,367	0.055	0.670	−1.623	−0.338	0.006	0.389	1.251
$SIGMA_{t-1}$	17,367	0.053	0.028	0.016	0.033	0.047	0.066	0.110
RET_{t-1}	17,367	−0.177	0.208	−1.189	−0.211	−0.106	−0.054	−0.022
$SIZE_{t-1}$	17,367	6.963	1.521	3.284	5.945	6.886	7.958	9.592
MB_{t-1}	17,367	3.051	2.703	0.472	1.537	2.246	3.531	8.025
LEV_{t-1}	17,367	0.322	0.241	0.000	0.095	0.321	0.500	0.733
ROA_t	17,367	0.046	0.106	−0.396	0.015	0.050	0.095	0.193
$ABACC_{t-1}$	17,367	0.053	0.063	0.001	0.015	0.035	0.067	0.166

more crash prone. The variable *NCSKEW* is the negative skewness of past firm-specific stock returns, which is included to capture the potential persistence of the third moment of stock returns. The variable *SIGMA* is the standard deviation of past firm-specific stock returns. Chen, Hong, and Stein (2001) argue that more volatile stocks are more likely to crash in the future. Here *RET* is the average firm-specific weekly return over the past year. Chen, Hong, and Stein (2001) find that firms with high past returns are more likely to crash. Following Hutton, Marcus, and Tehranian (2009), we also include the standard control variables firm size (*SIZE*), market-to-book ratio (*MB*), financial leverage (*LEV*), and return on assets (*ROA*). In all regressions, we also include industry and year dummies to control for industry and time fixed effects.

In the regression, we also include *BONUS* as a control variable, which is the CEO/CFO bonus in the current year scaled by cash salary (Fahlenbrach and Stulz, 2010). Prior research argues that managers' bonus plans can also induce short-termist behavior (Healy, 1985). This paper

focuses on the effect of equity incentives, particularly, option incentives; we therefore make *BONUS* only a control variable. Core and Guay (1999) argue that most managers' incentives stem from the existing portfolio of stocks and options, and not from annual pay. Finally, we also control for earnings management using absolute abnormal accruals from the modified Jones model (Dechow, Sloan, and Sweeney, 1995). Hutton, Marcus, and Tehranian (2009) find that accrual management increases future crash risk and Bergstresser and Philippon (2006) find that managers' equity incentives are positively related to accrual manipulation. Thus, we control for accrual management to make sure that our results regarding the relation between equity incentives and crash risk is not simply driven by accrual management. Our theoretical prediction is built on the notion that equity incentives induce managers to engage in short-termist behavior to inflate share prices, such as bad news hoarding. Note, however, that accrual manipulation is only one potential way to hide bad news. That being said, accrual manipulation is also part of our line of reasoning. Untabulated robustness results show that all the regression results are similar, even if we exclude abnormal accruals from the equation.

Table 3 presents the regression results. Panel A of Table 3 reports the results of the logit model regressions, and Panels B and C report those of the OLS regressions. The *t*-statistics below the coefficient estimates are based on robust standard errors corrected for firm and year clustering (Thompson, 2011). As noted previously, we report the results separately for both the CEO and CEO–CFO samples.

Column 1 of Panels A–C of Table 3 presents the results for the CEO sample, where CEO option and stock incentives are the key variables of interest. We can see that CEO option incentives are positively related to future crash risk, and this positive relation is highly significant in the OLS regressions where *NCSKEW* and *DUVOL* are used as the proxies for crash risk (Panels B and C). However, it is not significant in the logit model specification where *CRASH* is the dependent variable (Panel A). The coefficients for CEO stock incentives are not significant for all of column 1 of Panels A–C of Table 3.

Columns 2–4 of Table 3 present the results for the CEO–CFO sample. Column 2 repeats the regressions in column 1 using this reduced sample with CFO data and shows much less significant relations between CEO option incentives and crash risk. The relation between CEO stock incentives and crash risk continues to be insignificant.

Now, we turn our attention to the CFOs. Column 3 of Panels A–C of Table 3 reports the regression results where CFO option and stock incentives are the key variables of interest. We can see that CFO option incentives are positively and significantly associated with future crash risk for all three crash risk measures. The magnitudes of the coefficients are much larger than those of the CEO option incentives reported in column 2. However, similar to the findings for the CEOs, the CFOs' stock incentives are not related to crash risk.

Finally, in column 4 of Panels A–C of Table 3, we include CEO and CFO incentives jointly into the regression models. Interestingly, we find that only CFO option incentives are significantly related to future crash risk, and CEO option incentives become insignificant for all three measures of crash risk. Thus, we conclude that CFO option incentives dominate CEO option incentives in predicting future crash risk. We interpret this result as evidence that CFOs are more influential in the bad news hoarding behavior of a firm because of their expertise in financial arrangements and disclosure. This is consistent with recent studies that compare CEO and CFO equity incentives and firms' finance and disclosure decisions (e.g., Chava and Purnanandam, 2010; Jiang, Petroni, and Wang, 2010). However, we cannot rule out the possibility that this result is driven by the selection bias of ExecuComp including only the top five highest paid executives. That is, for the sample of firms with CFO data, it is likely that CFOs are more influential than for the sample of firms without CFO data.

In sum, we find strong evidence that CFO option incentives are positively related to future crash risk, and weaker evidence that CEO option incentives are also positively related to future crash risk. In addition, with caveats, we show that CFO option incentives dominate CEO option incentives in determining future crash risk. Finally, neither CEO nor CFO stock incentives are related to crash risk.

4.3. Additional analysis

4.3.1. Abnormal option incentives

Burns and Kedia (2006) conjecture that there is a desired level of option incentives that can increase firm value. Excessive option incentives above the desired level can cause dysfunctional effects such as misreporting. This section estimates the abnormal level of CEO or CFO option sensitivity following the model of Core and Guay (1999) and examines whether it is related to crash risk. Specifically, the abnormal level of option incentives is the residual from a cross-sectional regression of CEO/CFO option incentives on the market value of equity, idiosyncratic risk, the book-to-market ratio, CEO/CFO tenure, free cash flow, and industry dummies.[13]

Table 4 reports the regression results that replace CEO/CFO option incentives with the abnormal level of CEO/CFO option incentives (i.e., *ABINCENTIVE_OPT_CEO* and *ABINCENTIVE_OPT_CFO*). Table 4 shows that only the abnormal CFO option incentive is significantly and positively related to future crash risk. Although we expect the coefficients of abnormal option sensitivity in Table 4 to be greater than those of option sensitivity in Table 3, we find that this is not the case. However, this result is somewhat similar in spirit to the study of Burns and Kedia (2006), which also finds no evidence that abnormal option incentives are more strongly related to misreporting than total option incentives.

[13] Similar to Core and Guay (2002), we find CEOs' option incentives to be significantly positively associated with firm size, idiosyncratic risk, and CEO tenure. We find a negative but insignificant coefficient for both the book-to-market and the indicator for a free cash flow problem. The results for the CFO option incentive regression are similar to those for the CEO option incentive regression, except that the coefficient of the book-to-market is significantly negative.

Table 3
Impact of executive equity incentives on stock price crash risk.

This table presents the results of the impact of executive equity incentives on stock price crash risk. The sample contains firms in ExecuComp from 1993 to 2009 with nonmissing values for all the incentive and control variables. The *t*-statistics reported in parentheses are based on standard errors clustered by both firm and time. Year and industry fixed effects are included. Here *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in Appendix A.

Panel A: Logistic regression of CRASH on executive equity incentives

	Sample with CEO equity incentive info	Sample with both CEO and CFO equity incentive info		
	(1) CEO	(2) CEO	(3) CFO	(4) CEO vs. CFO
$INCENTIVE\_OPT\_CEO_{t-1}$	0.112	0.079		−0.209
	(0.61)	(0.38)		(−0.86)
$INCENTIVE\_OPT\_CFO_{t-1}$			0.552**	0.757**
			(2.07)	(2.24)
$INCENTIVE\_STK\_CEO_{t-1}$	0.072	0.029		0.033
	(0.70)	(0.22)		(0.25)
$INCENTIVE\_STK\_CFO_{t-1}$			−0.228	−0.299
			(−0.66)	(−0.83)
$BONUS\_CEO_{t-1}$	0.005	−0.012		−0.044*
	(0.24)	(−0.44)		(−1.69)
$BONUS\_CFO_{t-1}$			0.028	0.076
			(0.55)	(1.60)
$DTURN_{t-1}$	0.627**	0.551	0.521	0.479
	(2.21)	(1.57)	(1.37)	(1.23)
$NCSKEW_{t-1}$	0.079***	0.078**	0.095***	0.095***
	(3.11)	(2.25)	(2.71)	(2.62)
$SIGMA_{t-1}$	15.069***	16.570***	15.816***	15.769***
	(2.64)	(3.12)	(2.88)	(2.84)
RET_{t-1}	2.244**	2.260***	2.197**	2.177**
	(2.50)	(2.66)	(2.51)	(2.49)
$SIZE_{t-1}$	−0.021	0.003	−0.017	−0.011
	(−0.78)	(0.08)	(−0.52)	(−0.31)
MB_{t-1}	0.001	0.004	0.001	0.001
	(0.15)	(0.40)	(0.08)	(0.09)
LEV_{t-1}	−0.154	−0.197*	−0.129	−0.141
	(−1.05)	(−1.66)	(−1.01)	(−1.15)
ROA_t	−0.784***	−0.850***	−0.858***	−0.815***
	(−3.72)	(−3.41)	(−3.33)	(−2.99)
$ABACC_{t-1}$	0.238	−0.045	−0.155	-0.047
	(0.68)	(−0.10)	(−0.37)	(−0.11)
Constant	−1.762***	−2.340***	−1.985***	−2.301***
	(−7.23)	(−4.06)	(−4.21)	(−3.98)
No. of observations	21,166	16,319	15,997	15,763
Pseudo-R^2	0.031	0.032	0.034	0.034

Panel B: OLS regression of NCSKEW on executive equity incentives

	Sample with CEO equity incentive info	Sample with both CEO and CFO equity incentive info		
	(1) CEO	(2) CEO	(3) CFO	(4) CEO vs. CFO
$INCENTIVE\_OPT\_CEO_{t-1}$	0.129***	0.097*		−0.009
	(2.61)	(1.66)		(−0.14)
$INCENTIVE\_OPT\_CFO_{t-1}$			0.267***	0.278***
			(2.81)	(2.91)
$INCENTIVE\_STK\_CEO_{t-1}$	0.006	0.013		0.012
	(0.18)	(0.35)		(0.33)
$INCENTIVE\_STK\_CFO_{t-1}$			−0.026	−0.037
			(−0.29)	(−0.42)
$BONUS\_CEO_{t-1}$	0.011**	0.008		−0.000
	(2.11)	(1.54)		(−0.08)
$BONUS\_CFO_{t-1}$			0.019*	0.018
			(1.74)	(1.38)
$DTURN_{t-1}$	0.251***	0.245***	0.249***	0.222***
	(4.20)	(3.33)	(3.06)	(2.60)
$NCSKEW_{t-1}$	0.008	0.005	0.008	0.007
	(0.79)	(0.39)	(0.76)	(0.64)
$SIGMA_{t-1}$	2.376	2.294	2.166	2.147
	(1.48)	(1.43)	(1.33)	(1.32)
RET_{t-1}	0.464**	0.417*	0.400*	0.399*
	(2.05)	(1.90)	(1.84)	(1.83)

Table 3 (*continued*)

$SIZE_{t-1}$	0.016***	0.020***	0.017**	0.018***
	(2.79)	(3.04)	(2.53)	(2.67)
MB_{t-1}	0.007***	0.008***	0.007***	0.007***
	(2.83)	(3.75)	(3.22)	(3.02)
LEV_{t-1}	−0.105***	−0.131***	−0.126***	−0.123***
	(−4.43)	(−6.34)	(−4.79)	(−5.03)
ROA_t	0.058	0.018	−0.002	0.015
	(0.99)	(0.29)	(−0.02)	(0.22)
$ABACC_{t-1}$	0.116*	0.074	0.030	0.059
	(1.77)	(0.89)	(0.35)	(0.70)
Constant	−0.201**	−0.249	−0.219	−0.240
	(−2.33)	(−1.61)	(−1.62)	(−1.59)
No. of observations	21,179	16,333	16,011	15,777
Adjusted R^2	0.037	0.037	0.037	0.037

Panel C: OLS regression of DUVOL on executive equity incentives

	Sample with CEO equity incentive info	Sample with both CEO and CFO equity incentive info		
	(1) CEO	(2) CEO	(3) CFO	(4) CEO vs. CFO
$INCENTIVE\_OPT\_CEO_{t-1}$	0.060***	0.046		−0.005
	(2.64)	(1.63)		(−0.17)
$INCENTIVE\_OPT\_CFO_{t-1}$			0.124**	0.131**
			(2.47)	(2.46)
$INCENTIVE\_STK\_CEO_{t-1}$	−0.002	0.001		0.001
	(−0.11)	(0.07)		(0.08)
$INCENTIVE\_STK\_CFO_{t-1}$			−0.009	−0.011
			(−0.21)	(−0.27)
$BONUS\_CEO_{t-1}$	0.005*	0.004		−0.000
	(1.95)	(1.59)		(−0.14)
$BONUS\_CFO_{t-1}$			0.010*	0.010
			(1.85)	(1.34)
$DTURN_{t-1}$	0.138***	0.131***	0.131***	0.119***
	(4.58)	(3.82)	(3.31)	(2.87)
$NCSKEW_{t-1}$	0.002	0.001	0.002	0.002
	(0.46)	(0.18)	(0.46)	(0.29)
$SIGMA_{t-1}$	0.857	0.856	0.819	0.815
	(1.05)	(1.08)	(1.03)	(1.03)
RET_{t-1}	0.192*	0.175	0.170	0.169
	(1.70)	(1.62)	(1.61)	(1.60)
$SIZE_{t-1}$	0.009***	0.011***	0.009***	0.010***
	(3.34)	(3.73)	(3.11)	(3.29)
MB_{t-1}	0.003**	0.004***	0.003***	0.003**
	(2.47)	(3.10)	(2.69)	(2.54)
LEV_{t-1}	−0.047***	−0.056***	−0.054***	−0.052***
	(−3.95)	(−4.99)	(−3.72)	(−3.84)
ROA_t	0.062**	0.047*	0.039	0.047
	(2.18)	(1.75)	(1.23)	(1.62)
$ABACC_{t-1}$	0.052*	0.039	0.021	0.033
	(1.67)	(0.99)	(0.54)	(0.85)
Constant	−0.095**	−0.116	−0.106*	−0.115
	(−2.40)	(−1.60)	(−1.72)	(−1.64)
No. of observations	21,179	16,333	16,011	15,777
Adjusted R^2	0.044	0.043	0.043	0.043

4.3.2. The effect of product market competition

Economists have long argued that competitive pressure from the product market can incentivize managers to maximize long-term firm value by forcing unprofitable firms out of the business (Machlup, 1967). This argument motivates Giroud and Mueller (2010, 2011) to predict that the incentive provided by a firm's corporate governance system matters only if the firm operates in non-competitive industries. Consistent with their prediction, Giroud and Mueller (2010, 2011) find that the value-enhancing role of the corporate control market is significant only for firms facing low product market competition. Drawing on this recent literature, we now extend our main analysis to examine whether the impacts of equity incentives on crash risk are different for firms in competitive and non-competitive industries.

Following Giroud and Mueller (2010, 2011), we measure product market competition using the Herfindahl–Hirschman Index (*HHI*). A high *HHI* indicates low product market competition. Specifically, the *HHI* is computed as

$$HHI_{jt} = \sum_{i=1}^{N_j} S_{ijt}^2, \tag{5}$$

Table 4
Impact of abnormal executive option incentives.

This table presents the results of the impact of abnormal executive option incentives on stock price crash risk. The sample contains firms in ExecuComp from 1993 to 2009 with nonmissing values for the option incentive ratio measure and all the control variables. The *t*-statistics reported in parentheses are based on standard errors clustered by both firm and time. Year and industry fixed effects are included. Here *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in Appendix A.

Panel A: Logistic regression of CRASH on executive equity incentives

	Sample with CEO equity incentive info	Sample with both CEO and CFO equity incentive info		
	(1) CEO	(2) CEO	(3) CFO	(4) CEO vs. CFO
$ABINCENTIVE\_OPT\_CEO_{t-1}$	0.250	0.130		−0.094
	(1.27)	(0.61)		(−0.38)
$ABINCENTIVE\_OPT\_CFO_{t-1}$			0.632**	0.732*
			(2.12)	(1.85)
$INCENTIVE\_STK\_CEO_{t-1}$	0.079	0.030		0.031
	(0.78)	(0.24)		(0.24)
$INCENTIVE\_STK\_CFO_{t-1}$			−0.214	−0.275
			(−0.62)	(−0.76)
$BONUS\_CEO_{t-1}$	0.004	−0.010		−0.036
	(0.17)	(−0.36)		(−1.32)
$BONUS\_CFO_{t-1}$			0.020	0.061
			(0.39)	(1.25)
$DTURN_{t-1}$	0.589**	0.514	0.489	0.452
	(2.01)	(1.45)	(1.28)	(1.17)
$NCSKEW_{t-1}$	0.079***	0.079**	0.096***	0.096***
	(3.01)	(2.25)	(2.69)	(2.61)
$SIGMA_{t-1}$	15.092**	16.259***	15.713***	15.526***
	(2.55)	(2.99)	(2.83)	(2.76)
RET_{t-1}	2.264**	2.233***	2.184**	2.152**
	(2.44)	(2.60)	(2.48)	(2.46)
$SIZE_{t-1}$	−0.021	0.002	−0.013	−0.009
	(−0.81)	(0.06)	(−0.40)	(−0.27)
MB_{t-1}	0.000	0.003	0.003	0.003
	(0.04)	(0.31)	(0.28)	(0.24)
LEV_{t-1}	−0.137	−0.186	−0.142	−0.146
	(−0.94)	(−1.57)	(−1.17)	(−1.23)
ROA_t	−0.772***	−0.833***	−0.844***	−0.795***
	(−3.59)	(−3.21)	(−3.17)	(−2.82)
$ABACC_{t-1}$	0.255	−0.033	−0.143	−0.037
	(0.72)	(−0.08)	(−0.34)	(−0.08)
Constant	−1.769***	−2.324***	−1.994***	−2.290***
	(−6.13)	(−3.85)	(−4.01)	(−3.76)
No. of observations	21,023	16,222	15,904	15,672
Pseudo-R^2	0.031	0.032	0.034	0.034

Panel B: OLS regression of NCSKEW on executive equity incentives

	Sample with CEO equity incentive info	Sample with both CEO and CFO equity incentive info		
	(1) CEO	(2) CEO	(3) CFO	(4) CEO vs. CFO
$ABINCENTIVE\_OPT\_CEO_{t-1}$	0.117**	0.078		0.018
	(2.20)	(1.41)		(0.28)
$ABINCENTIVE\_OPT\_CFO_{t-1}$			0.227**	0.219*
			(2.28)	(1.93)
$INCENTIVE\_STK\_CEO_{t-1}$	0.013	0.016		0.015
	(0.40)	(0.44)		(0.41)
$INCENTIVE\_STK\_CFO_{t-1}$			−0.006	−0.017
			(−0.06)	(−0.20)
$BONUS\_CEO_{t-1}$	0.009*	0.007		0.000
	(1.75)	(1.34)		(0.08)
$BONUS\_CFO_{t-1}$			0.015	0.013
			(1.41)	(1.01)
$DTURN_{t-1}$	0.241***	0.235***	0.241***	0.214***
	(4.06)	(3.30)	(3.07)	(2.61)
$NCSKEW_{t-1}$	0.007	0.004	0.007	0.006
	(0.71)	(0.32)	(0.67)	(0.54)
$SIGMA_{t-1}$	2.537	2.424	2.313	2.282
	(1.58)	(1.51)	(1.43)	(1.42)
RET_{t-1}	0.478**	0.426*	0.409*	0.408*
	(2.10)	(1.96)	(1.90)	(1.89)

Table 4 (*continued*)

$SIZE_{t-1}$	0.018***	0.022***	0.020***	0.020***
	(3.38)	(3.48)	(3.11)	(3.19)
MB_{t-1}	0.008***	0.009***	0.009***	0.008***
	(2.96)	(3.69)	(3.70)	(3.43)
LEV_{t-1}	−0.110***	−0.135***	−0.137***	−0.132***
	(−4.63)	(−6.21)	(−5.19)	(−5.46)
ROA_t	0.061	0.025	0.009	0.023
	(1.02)	(0.38)	(0.12)	(0.32)
$ABACC_{t-1}$	0.117*	0.070	0.029	0.056
	(1.73)	(0.82)	(0.33)	(0.66)
Constant	−0.225***	−0.273*	−0.245**	−0.264*
	(−2.98)	(−1.91)	(−1.99)	(−1.89)
No. of observations	21,037	16,236	15,918	15,686
Adjusted R^2	0.037	0.037	0.037	0.037

Panel C: OLS regression of DUVOL on executive equity incentives

	Sample with CEO equity incentive info	Sample with both CEO and CFO equity incentive info		
	(1) CEO	(2) CEO	(3) CFO	(4) CEO vs. CFO
$ABINCENTIVE\_OPT\_CEO_{t-1}$	0.055**	0.041		0.012
	(2.20)	(1.52)		(0.39)
$ABINCENTIVE\_OPT\_CFO_{t-1}$			0.109**	0.101*
			(2.07)	(1.70)
$INCENTIVE\_STK\_CEO_{t-1}$	0.002	0.003		0.003
	(0.11)	(0.18)		(0.18)
$INCENTIVE\_STK\_CFO_{t-1}$			0.001	−0.001
			(0.04)	(−0.02)
$BONUS\_CEO_{t-1}$	0.004	0.004		−0.000
	(1.60)	(1.36)		(−0.01)
$BONUS\_CFO_{t-1}$			0.008	0.007
			(1.50)	(1.01)
$DTURN_{t-1}$	0.134***	0.127***	0.128***	0.116***
	(4.45)	(3.80)	(3.34)	(2.90)
$NCSKEW_{t-1}$	0.002	0.001	0.002	0.001
	(0.39)	(0.10)	(0.35)	(0.18)
$SIGMA_{t-1}$	0.935	0.918	0.887	0.879
	(1.15)	(1.17)	(1.12)	(1.12)
RET_{t-1}	0.198*	0.179*	0.174*	0.173*
	(1.76)	(1.67)	(1.67)	(1.66)
$SIZE_{t-1}$	0.010***	0.012***	0.011***	0.011***
	(3.96)	(4.29)	(3.68)	(3.82)
MB_{t-1}	0.003***	0.004***	0.004***	0.003***
	(2.63)	(3.06)	(3.04)	(2.84)
LEV_{t-1}	−0.049***	−0.058***	−0.059***	−0.057***
	(−4.18)	(−4.99)	(−4.20)	(−4.28)
ROA_t	0.064**	0.050*	0.044	0.051*
	(2.22)	(1.82)	(1.38)	(1.71)
$ABACC_{t-1}$	0.053*	0.037	0.020	0.031
	(1.65)	(0.92)	(0.52)	(0.81)
Constant	−0.107***	−0.129*	−0.120**	−0.129*
	(−3.07)	(−1.89)	(−2.09)	(−1.94)
No. of observations	21,037	16,236	15,918	15,686
Adjusted R^2	0.044	0.043	0.043	0.043

where S_{ijt} is the market share of firm i in industry j in year t. Market shares are computed based on firm sales. We estimate *HHI* for each of the Fama–French 48 industry classifications. Based on the magnitude of *HHI*, we classify firms into either a low product market competition group (above-median *HHI*) or a high product market competition group (below-median *HHI*).

Table 5 displays the subsample regressions of crash risk on equity incentives for low and high product market competition groups. Similar to our main analysis, the coefficients for CEO option incentives are largely insignificant for both the low and high competition groups. Interestingly, we find that the coefficients for CFO option incentives are significant only for firms in low product market competition industries. This result is consistent with the argument and findings of Giroud and Mueller (2010, 2011), suggesting that option incentives have the perverse effect of increasing crash risk only for firms in non-competitive industries.

The results presented in Table 5 are also consistent with recent disclosure theories that incorporate the interaction between the capital market and the product

Table 5
Subsample analysis: the effects of product market competition.

This table presents the results of the subsample analysis of the impact of executive equity incentives on stock price crash risk. The sample contains firms in ExecuComp from 1993 to 2009 with nonmissing values for all the incentive and control variables. The low product market competition subsample includes firms with above-median Herfindahl–Hirschman indexes and the high product market competition subsample includes firms with below-median Herfindahl–Hirschman indexes. The *t*-statistics reported in parentheses are based on standard errors clustered by both firm and time. Year and industry fixed effects are included. Here *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in Appendix A.

	CRASH Product market competition		*NCSKEW* Product market competition		*DUVOL* Product market competition	
	Low	High	Low	High	Low	High
$INCENTIVE\_OPT\_CEO_{t-1}$	−0.469*	0.045	−0.066	0.037	−0.037	0.022
	(−1.65)	(0.14)	(−0.88)	(0.47)	(−1.10)	(0.54)
$INCENTIVE\_OPT\_CFO_{t-1}$	1.169***	0.422	0.489***	0.120	0.222***	0.064
	(2.74)	(0.74)	(3.45)	(0.84)	(2.93)	(0.85)
$INCENTIVE\_STK\_CEO_{t-1}$	0.013	0.055	0.012	0.008	0.006	−0.006
	(0.08)	(0.26)	(0.31)	(0.16)	(0.32)	(−0.27)
$INCENTIVE\_STK\_CFO_{t-1}$	−0.737*	−0.006	−0.063	−0.035	−0.022	−0.009
	(−1.85)	(−0.02)	(−0.52)	(−0.33)	(−0.37)	(−0.18)
$BONUS\_CEO_{t-1}$	−0.064	−0.026	0.001	−0.002	0.001	−0.002
	(−1.10)	(−0.60)	(0.13)	(−0.27)	(0.12)	(−0.34)
$BONUS\_CFO_{t-1}$	0.153***	0.011	0.031*	0.005	0.015*	0.003
	(2.64)	(0.14)	(1.81)	(0.33)	(1.65)	(0.40)
$DTURN_{t-1}$	0.505	0.483	0.233*	0.223**	0.145**	0.102**
	(1.05)	(0.76)	(1.96)	(2.24)	(2.40)	(2.44)
$NCSKEW_{t-1}$	0.133***	0.069	0.003	0.013	0.001	0.003
	(4.11)	(1.14)	(0.24)	(0.73)	(0.10)	(0.37)
$SIGMA_{t-1}$	11.975**	18.124**	0.499	3.516*	0.193	1.339
	(2.01)	(2.26)	(0.23)	(1.90)	(0.19)	(1.47)
RET_{t-1}	1.603**	2.457**	0.188	0.558**	0.087	0.233**
	(2.12)	(1.99)	(0.70)	(2.39)	(0.71)	(2.03)
$SIZE_{t-1}$	−0.017	−0.005	0.018*	0.018***	0.011**	0.009**
	(−0.33)	(-0.13)	(1.75)	(2.69)	(2.56)	(2.57)
MB_{t-1}	0.021*	−0.011	0.009***	0.007*	0.004**	0.003
	(1.68)	(−0.75)	(2.80)	(1.66)	(2.41)	(1.57)
LEV_{t-1}	−0.252	−0.108	−0.159***	−0.094**	−0.072***	−0.035*
	(−1.44)	(−0.64)	(−4.41)	(−2.25)	(−4.11)	(−1.69)
ROA_t	−1.576***	−0.460	−0.043	0.011	0.024	0.043
	(−3.74)	(−1.37)	(−0.26)	(0.12)	(0.32)	(1.00)
$ABACC_{t-1}$	−0.034	−0.066	0.070	0.068	0.052	0.025
	(−0.05)	(−0.11)	(0.49)	(0.55)	(0.83)	(0.46)
Constant	−2.561***	−0.608	−0.244	0.290***	−0.130	0.112***
	(−3.68)	(−1.08)	(−1.32)	(3.02)	(−1.57)	(2.90)
No. of observations	7,869	7,889	7,884	7,893	7,884	7,893
Pseudo-/adjusted R^2	0.047	0.037	0.037	0.049	0.041	0.054
Subsample comparison of coefficients on						
$INCENTIVE\_OPT\_CEO_{t-1}$	*Chi squared* = 1.31 (*p-value* = 0.253)		*Chi squared* = 0.82 (*p-value* = 0.367)		*Chi squared* = 1.13 (*p-value* = 0.287)	
$INCENTIVE\_OPT\_CFO_{t-1}$	*Chi squared* = 1.09 (*p-value* = 0.298)		*Chi squared* = 4.09 (*p-value* = 0.043)		*Chi squared* = 3.26 (*p-value* = 0.071)	

market. For example, Evans and Sridhar (2002) argue that when the product market and the capital market use the same set of disclosures, the offsetting demands from the two markets can enhance disclosure quality. For example, managers' incentives to inflate share price by withholding bad news can be dampened by competitive pressures from the product market. This is because the timely disclosure of bad news can discourage competition and overproduction by firms in the same industry. Li (2010) empirically shows that product market competition enhances disclosure quality by reducing the optimism in profit forecasts.

Overall, the findings in this section have implications for the design of managers' compensation contracts. Specifically, regulators or firms should take into consideration the disciplining role of product market competition when regulating and designing executives' incentive pay for efficiency purposes.

4.3.3. Stock options, risk taking, and the masking of risk taking

One of the rationales for using equity-based compensation, especially stock options, is to overcome the managerial risk aversion problem and induce optimal risk taking (Guay, 1999). Until now, the empirical literature has been largely consistent with the prediction that the use of stock options is positively related to managerial risk-taking behavior. For example, Rajgopal and Shevlin (2002) find that the sensitivity of the value of a CEO's options to stock return volatility (i.e., vega) is positively related to exploration risk for a sample of oil and gas producers. Coles, Daniel, and Naveen (2006) show that

higher sensitivity of CEO wealth to stock volatility (i.e., vega) induces riskier policy choices, including relatively more research and development investments, fewer property, plant, and equipment investments, more focus, and higher leverage. Finally, using the mid-1990s changes in the Delaware takeover regime as an exogenous shock, Low (2009) finds that managers of Delaware-incorporated firms, on average, decreased firm risk and destroyed shareholder value in response to the greater protection brought about by the takeover regime shift. The author also finds that increased sensitivity of CEO portfolio value to stock return volatility (i.e., vega) induces risk-taking behavior.[14]

Although the empirical literature has held the view that stock options encourage optimal managerial risk taking and increase shareholder wealth, some regulators, practitioners, and academics blame stock options for inducing *excessive* managerial risk taking and contributing to the recent financial crisis. For example, in his testimony on the U.S. Treasury budget on June 9, 2009, Treasury Secretary Geithner argued:

> I think that although many things caused this crisis, what happened to compensation and the incentives in creative risk taking did contribute in some institutions to the vulnerability that we saw in this financial crisis. We need to help encourage substantial reforms in compensation structures particularly in the financial industry.

This section examines whether risk-taking incentives afforded by stock options increase future stock price crash risk for our broad sample of firm-years. Specifically, we regress firm-specific crash risk measures on CEO and CFO option portfolio vegas, controlling for option portfolio deltas and all the other control variables used in our main tests.[15] Following Guay (1999), the option vega is calculated as the natural log of the dollar change in the value of executive option holdings amounting from a 1% increase in the firm's stock return volatility. Table 6 reports the results. Overall, Table 6 shows no evidence that there is a significant positive relation between the CEO or CFO option portfolio vega and future stock price crash risk.[16]

Our findings regarding the relation between the option vega and crash risk are largely consistent with the spirit of the finding of Fahlenbrach and Stulz (2010). Focusing on the banking industry, Fahlenbrach and Stulz (2010) investigate whether bank CEO incentives were related to bank performance during the recent credit crisis. Though options have been blamed for leading to excessive risk taking, the authors find no evidence that greater sensitivity of CEO stock option portfolio value to stock volatility led to worse stock returns during the credit crisis.

Based on the findings of our study and that of Fahlenbrach and Stulz (2010), we argue that it is unlikely that option-induced managerial risk taking per se increases crash risk. However, given the extensive risk-taking behavior of the financial industry before the financial crisis, it is still early to completely rule out the role of excessive risk taking in creating crashes. To continue our bad news hoarding story, we conjecture that, rather than risk taking itself, the hiding of excessive risk-taking behavior from investors contributes to crash risk. If rational investors and the board of directors are aware of an undesired high level of managerial risk-taking behavior, they will take timely corrective actions to stop or constrain such risk-taking behavior. However, given that managers' wealth is tied to stock price by equity incentives, managers will withhold information about excessive risk taking to maintain share price.[17] As a result, managers take too much risk and the uninformed investors/boards are unable to take timely corrective actions or adjust price levels accordingly until a crash occurs. This line of argument seems to be consistent with the recent SEC investigation of the Lehman bankruptcy case. According to the Wall Street Journal (2010), an SEC examiner found that Lehman engaged in an accounting device known within the firm as 'Repo 105' to achieve extensive short-term off-balance-sheet financing, which helped Lehman look like it had less debt on its books.[18]

The Wall Street Journal (2010) also reports that:

> The SEC now is seeking detailed information from nearly two dozen large financial firms about repos, signaling that the agency is looking for accounting techniques that could hide a firm's risk-taking. The SEC's inquiry follows recent disclosures that Lehman used repos to mask some $50 billion in debt before it collapsed in 2008.

To investigate the possibility that option incentives contribute to crash risk by inducing the hiding of risk-taking behavior, we design a test to provide some indirect evidence. Specifically, we want to examine whether the relation between option incentives and crash risk is more pronounced for firms that have more ex ante incentives to hide risk taking. Empirically, we use the existing leverage level as a proxy for the ex ante incentive to hide risk taking. We argue that managers of firms with already high levels of leverage should worry more about investor

[14] Recently, Cheng, Hong, and Scheinkman (2009) developed a measure of residual compensation. The authors find that their measure of residual compensation is positively related with risk-taking measures, including firm beta, return volatility, tail cumulative return performance, and the sensitivity of firm stock price to the ABX subprime index for a sample of financial firms during 1992–2008.

[15] Here, we follow Chava and Purnanandam (2010) to include both the log-transformed delta and vega to examine the risk-taking effects of stock options. Our main tests use a deflated version of delta (incentive ratio) following Bergstresser and Philippon (2006) and Jiang, Petroni, and Wang (2010), where the focus is on the price-related incentive effect of stocks and options.

[16] Chava and Purnanandam (2010) use delta to capture managers' *risk-decreasing* incentives. The overall positive coefficients on delta in our table may indicate that risk taking is not the contributing factor to crash risk. Rather, a high delta can motivate managers to mask risk taking, as discussed later.

[17] If the perceived risk becomes higher from holding the cash flow constant, investors will adjust the share price downward. Thus, we argue that managers care more about the price effect (delta) of their decisions than the volatility effect (vega) of their decisions on option values.

[18] See Valukas (2010) for detailed explanations on the Lehman 'Repo 105' transactions.

Table 6
Executive option portfolio vega and crash risk.

This table presents the results of the impact of option deltas and option vegas on stock price crash risk. The sample contains firms in ExecuComp from 1993 to 2009 with nonmissing values for the option incentive ratio measure and all the control variables. The *t*-statistics reported in parentheses are based on standard errors clustered by both firm and time. All the control variables in Table 5 are included but not reported for conciseness. Year and industry fixed effects are included. Here *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in Appendix A.

	Sample with CEO equity incentive info	Sample with both CEO and CFO equity incentive info		
	(1) CEO	(2) CEO	(3) CFO	(4) CEO vs. CFO
Logistic regression of *CRASH*				
$OPTDELTA\_CEO_{t-1}$	0.009	0.083		−0.202
	(0.23)	(0.78)		(−1.42)
$OPTDELTA\_CFO_{t-1}$			0.338**	0.442**
			(2.31)	(2.14)
$OPTVEGA\_CEO_{t-1}$	0.004	0.027		0.099
	(0.08)	(0.26)		(0.69)
$OPTVEGA\_CFO_{t-1}$			−0.142	−0.123
			(−0.89)	(−0.59)
OLS regression of *NCSKEW*				
$OPTDELTA\_CEO_{t-1}$	0.038***	0.031**		0.011
	(3.32)	(2.37)		(0.68)
$OPTDELTA\_CFO_{t-1}$			0.045***	0.035*
			(2.85)	(1.86)
$OPTVEGA\_CEO_{t-1}$	−0.030**	−0.022		−0.006
	(−2.36)	(−1.54)		(−0.34)
$OPTVEGA\_CFO_{t-1}$			−0.033**	−0.027
			(−1.97)	(−1.22)
OLS regression of *DUVOL*				
$OPTDELTA\_CEO_{t-1}$	0.017***	0.015**		0.006
	(3.04)	(2.22)		(0.77)
$OPTDELTA\_CFO_{t-1}$			0.021**	0.016*
			(2.57)	(1.74)
$OPTVEGA\_CEO_{t-1}$	−0.014**	−0.010		−0.003
	(−2.13)	(−1.40)		(−0.38)
$OPTVEGA\_CFO_{t-1}$			−0.015*	−0.012
			(−1.77)	(−1.16)

perception of their risk-taking behavior and thus have stronger incentives to hide risk taking. Note that this argument is consistent with some observations of practitioners. For example, a former Goldman analyst, William Tanona, says, "You want your leverage to look better at quarter-end than it actually was during the quarter, to suggest that you're taking less risk (Wall Street Journal, 2010)."

Table 7 reports the subsample analysis of the relation between CEO/CFO equity incentives and crash risk for high- and low-leverage firms. Similar to our earlier findings, only CFO option incentives are significantly related to future crash risk. More importantly, Table 7 shows that this significantly positive relation emerges only for the subsample of firms with high levels of financial leverage.[19] We interpret this result as evidence that option incentives are more strongly related to crash risk when managers' incentives to hide risk taking are higher. It is also interesting to note that CFOs may have more expertise in hiding risk taking through accounting techniques such as those used by Lehman before its collapse. However, we suggest that readers exercise caution in accepting our interpretation, since leverage can be a proxy for many other things. We do hope our tentative evidence helps motivate future studies that examine directly whether hiding risk taking (rather than risk taking itself) contributes to stock price crashes.

5. Conclusions

This paper investigates whether CEO and CFO equity incentives are associated with firm-specific stock price crash risk. Using a sample of U.S. firms during 1993–2009, we find that the incentives from CFOs' option holdings are significantly and positively related to future crash risk. In contrast, we find only weak evidence that the incentives from CEOs' option holdings contribute to crash risk, and this weak effect disappears after the CFO option incentives are included. Moreover, we find that neither CEO stock incentives nor CFO stock incentives are related to crash risk. Our results are somewhat consistent with the theoretical prediction of Benmelech, Kandel, and Veronesi

[19] Product market competition and financial leverage can be correlated (e.g., Brander and Lewis, 1986; Chevalier, 1995; Phillips, 1995; MacKay and Phillips, 2005). Thus, it is possible that the results in Table 7 are not that different from those in Table 5. To address this concern, we conduct Pearson's 2×2 Chi-Square Test of Independence for financial leverage and product market competition and find that the two splitting variables are independent.

Table 7
Masking risk taking: subsamples cut by financial leverage.

This table presents the results of the subsample analysis on the impact of executive equity incentives on stock price crash risk. The sample contains firms in ExecuComp from 1993 to 2009 with nonmissing values for all the incentive and control variables. The high-leverage subsample includes firm-years with above-median financial leverage, and the low-leverage subsample includes firm-years with below-median financial leverage. The *t*-statistics reported in parentheses are based on standard errors clustered by both firm and time. Year and industry fixed effects are included. Here *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in Appendix A.

	CRASH Leverage		*NCSKEW* Leverage		*DUVOL* Leverage	
	High	Low	High	Low	High	Low
$INCENTIVE\_OPT\_CEO_{t-1}$	−0.649*	0.035	−0.095	0.037	−0.047	0.015
	(−1.68)	(0.13)	(−1.23)	(0.47)	(−1.25)	(0.37)
$INCENTIVE\_OPT\_CFO_{t-1}$	1.578**	0.200	0.504***	0.093	0.234***	0.047
	(2.53)	(0.50)	(3.65)	(0.73)	(2.90)	(0.67)
$INCENTIVE\_STK\_CEO_{t-1}$	0.085	0.003	0.059	−0.014	0.018	−0.006
	(0.36)	(0.02)	(0.85)	(−0.37)	(0.55)	(−0.35)
$INCENTIVE\_STK\_CFO_{t-1}$	0.027	−0.432	0.022	−0.064	0.049	−0.041
	(0.05)	(−1.01)	(0.13)	(−0.61)	(0.59)	(−0.78)
$BONUS\_CEO_{t-1}$	−0.078	−0.017	−0.003	0.001	−0.001	−0.001
	(−1.59)	(−0.44)	(−0.28)	(0.06)	(−0.18)	(−0.22)
$BONUS\_CFO_{t-1}$	0.133*	0.028	0.023	0.016	0.012	0.009
	(1.84)	(0.34)	(1.13)	(0.92)	(1.14)	(0.94)
$DTURN_{t-1}$	−0.867	1.009***	0.001	0.287***	0.067	0.123***
	(−1.46)	(2.82)	(0.01)	(4.92)	(0.80)	(3.87)
$NCSKEW_{t-1}$	0.190***	0.018	0.019	−0.008	0.005	−0.004
	(4.06)	(0.32)	(1.56)	(−0.48)	(0.80)	(−0.54)
$SIGMA_{t-1}$	2.945	22.700***	−0.839	5.007***	−0.600	2.246***
	(0.46)	(2.98)	(−0.41)	(3.45)	(−0.58)	(3.63)
RET_{t-1}	0.759	2.896***	0.083	0.674***	0.026	0.303***
	(0.88)	(2.62)	(0.33)	(3.57)	(0.19)	(3.69)
$SIZE_{t-1}$	−0.006	−0.012	0.017**	0.019*	0.009**	0.010**
	(−0.14)	(−0.31)	(2.18)	(1.93)	(2.30)	(2.20)
MB_{t-1}	−0.005	0.012	0.008**	0.011***	0.003*	0.006***
	(−0.38)	(0.87)	(1.99)	(3.38)	(1.70)	(3.28)
LEV_{t-1}	−0.220	−0.433	−0.265***	−0.092	−0.109***	−0.012
	(−0.64)	(−1.00)	(−3.71)	(−0.92)	(−3.39)	(−0.28)
ROA_t	−1.906***	−0.465	−0.192	0.064	−0.028	0.060**
	(−4.36)	(−1.64)	(−1.16)	(1.09)	(−0.44)	(2.36)
$ABACC_{t-1}$	−0.504	0.177	0.038	0.084	0.027	0.042
	(−0.90)	(0.38)	(0.29)	(0.69)	(0.41)	(0.65)
Constant	−0.874*	−19.425***	0.123	−0.588***	0.044	−0.274***
	(−1.68)	(−14.20)	(0.61)	(−3.20)	(0.47)	(−2.83)
No. of observations	7,877	7,824	7,913	7,864	7,913	7,864
Pseudo-/adjusted R^2	0.056	0.030	0.057	0.025	0.061	0.032
Subsample comparison of coefficients on						
$INCENTIVE\_OPT\_CEO_{t-1}$	*Chi squared*=2.01 (*p-value*=0.156)		*Chi squared*=1.17 (*p-value*=0.280)		*Chi squared*=1.08 (*p-value*=0.300)	
$INCENTIVE\_OPT\_CFO_{t-1}$	*Chi squared*=3.34 (*p-value*=0.068)		*Chi squared*=4.67 (*p-value*=0.031)		*Chi squared*=4.23 (*p-value*=0.040)	

(2010), that equity incentives induce managers to hide bad news and increase crash risk. However, while Benmelech, Kandel, and Veronesi (2010) formulate their model with CEOs in mind, we find that CFO incentives matter more. This finding is consistent with the recent empirical findings of Chava and Purnanandam (2010) and Jiang, Petroni, and Wang (2010), who argue that CFO incentives are more influential in situations where financial expertise is particularly important. Moreover, while the empirical implication of Benmelech, Kandel, and Veronesi (2010) applies to all components of equity incentives, including stock and option holdings, we find that only option incentives contribute significantly to crash risk. One explanation for this finding is that option incentives are more powerful in inducing managerial bad news hoarding behavior, because managers' losses from option holdings are limited when a stock price crash event occurs in the future. Our empirical results suggest that it may be desirable for future analytical research to consider the different features of options and stocks, as well as the different characteristics of CFOs and CEOs, when modeling the relation between managerial equity incentives and stock price crash risk.

Furthermore, we show that the positive relation between CFO option incentives and crash risk is more pronounced for the subsample of firms in a non-competitive industry. This additional evidence suggests that product market competition deters managerial bad news hoarding behavior. In addition, we find some tentative evidence that CFO option incentives and crash risk are more significant for firms with greater ex ante incentives to hide risk taking.

Our results have important implications for the design and disclosure of executive compensation structure. As a standard solution to the agency problems in modern corporations, managers' equity holdings have the potential to align the incentives of managers with the interests

of shareholder-owners. There is empirical evidence that managers' equity incentives increase firm value (e.g., Mehran, 1995). However, since the burst of the dot-com bubble, there is growing concern that equity incentives will lead managers to engage in short-termist behavior for the sake of boosting short-term share prices. Earlier research on the perverse effect of equity incentives has focused on CEO incentives and earnings management (e.g., Bergstresser and Philippon, 2006). Partially motivated by recent SEC disclosure rules on CFO compensation, more recent studies have begun to examine CFO incentives and earnings management (e.g., Chava and Purnanandam, 2010; Jiang, Petroni, and Wang, 2010). However, our paper is the first empirical study that shows a positive relation between executive incentives and crash risk. Our findings suggest that boards need to take special caution in using equity incentives, particularly stock options, to compensate their CFOs. In addition, our results also serve to rationalize the SEC's recent requirement that firms disclose the compensation packages of their CFOs.

Appendix A. Variable definitions

A.1. Dependent variables: Crash risk measures

CRASH is an indicator variable that takes the value one for a firm-year that experiences one or more firm-specific weekly returns falling 3.2 standard deviations below the mean firm-specific weekly returns over the fiscal year, with 3.2 chosen to generate frequencies of 0.1% in the normal distribution during the fiscal-year period, and zero otherwise.

NCSKEW is the negative skewness of firm-specific weekly returns over the fiscal-year period.

DUVOL is the log of the ratio of the standard deviations of down-week to up-week firm-specific returns.

For the above variables, *the firm-specific weekly return* (W) is equal to ln (1 + residual), where the residual is from the following expanded market model regression:

$$r_{j,\tau} = \alpha_j + \beta_{1j} r_{m,\tau-2} + \beta_{2j} r_{m,\tau-1} + \beta_{3j} r_{m,\tau} + \beta_{4j} r_{m,\tau+1} + \beta_{5j} r_{m,\tau+2} + \varepsilon_{j\tau}.$$

A.2. Compensation variables

INCENTIVE_OPT is the incentive ratio for executive option holdings, which is measured as *ONEPCT_OPT*/(*ONEPCT_OPT* + *SALARY* + *BONUS*). The variable *ONEPCT_OPT* (or option sensitivity) is the dollar change in the value of executive option holdings resulting from a 1% increase in the firm's stock price.

ABINCENTIVE_OPT is the abnormal option incentive ratio, defined similarly to *INCENTV_OPT*. We estimate abnormal option sensitivity using the methodology in Core and Guay (1999). Specifically, the abnormal option sensitivity is the residual from a cross-sectional regression of executive option sensitivity on the market value of equity, idiosyncratic risk, the book-to-market, executive tenure, free cash flow, and industry dummies.

OPTDELTA is the natural log of the dollar change in the value of executive option holdings resulting from a 1% increase in the firm's stock price.

OPTVEGA is the natural log of the dollar change in the value of executive option holdings resulting from a 1% increase in the firm's stock volatility.

INCENTIVE_STK is the incentive ratio for executive stock holdings, defined similarly to *INCENTV_OPT*.

BONUS is executive bonus divided by salary.

In the regression result tables, we denote CEO compensation compensation variables with the suffix *_CEO* after each variable, and CFO compensation variables with the suffix *_CFO* after each variable.

A.3. Other control variables

DTURN is the average monthly share turnover over the current fiscal-year period minus the average monthly share turnover over the previous fiscal-year period, where monthly share turnover is calculated as the monthly trading volume divided by the total number of shares outstanding during the month.

SIGMA is the standard deviation of firm-specific weekly returns over the fiscal-year period.

RET is the mean of firm-specific weekly returns over the fiscal-year period, times 100.

SIZE is the log of the market value of equity.

MB is the market value of equity divided by the book value of equity.

LEV is total long-term debts divided by total assets.

ROA is income before extraordinary items divided by lagged total assets.

ABACC is the absolute value of discretionary accruals, where discretionary accruals are estimated from the modified Jones model (Dechow, Sloan, and Sweeney, 1995).

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