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CEO age and the riskiness of corporate policies

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ABSTRACT

Prior theoretical work generates conflicting predictions with respect to how CEO age impacts risk-taking behavior. Consistent with the prediction that risk-taking behavior decreases as CEOs become older, I document a negative relation between CEO age and stock return volatility. Further analyses reveal that older CEOs reduce firm risk through less risky investment policies. Specifically, older CEOs invest less in research and development, make more diversifying acquisitions, manage firms with more diversified operations, and maintain lower operating leverage. Further, firm risk and the riskiness of corporate policies are lowest when both the CEO and the next most influential executive are older and highest when both of these managers are younger. Although older CEOs prefer less risky investment policies, I document results suggesting that CEO and firm risk preferences tend to be aligned. Lastly, I find that a trading strategy that goes long in a portfolio of stocks consisting of firms managed by younger CEOs and short in a portfolio of stocks comprised of firms led by older CEOs would generate positive risk-adjusted returns. Overall, my results imply that CEO age can have a significant impact on risk-taking behavior and firm performance.

1. Introduction

Recent research suggests that CEO personal characteristics impact corporate policies. For instance, personal life experiences, overconfidence, and leverage preferences shape a CEO's financing decisions and attitudes towards risk (Cronqvist et al., 2012; Malmendier and Nagel, 2011; Malmendier et al., 2011). Yet, although CEO age is readily observable, there is surprisingly little evidence on how a CEO's age affects the CEO's corporate risk-taking behavior.

Prior theoretical work predicts that a CEO's age impacts his/her risk preferences and risk-taking behavior, but predictions are mixed. Specifically, models incorporating career concerns predict that younger CEOs are more risk-averse because they do not yet have reputations as high quality managers (Hirshleifer and Thakor, 1992; Holmstrom, 1999; Scharfstein and Stein, 1990; Zwiebel, 1995). As such, younger CEOs can be punished more harshly for poor performance through markedly reduced future career opportunities, which can induce them to adopt more conservative investment policies. In contrast, Prendergast and Stole (1996) develop a model that predicts that younger CEOs invest more aggressively and take greater risks to signal superior ability. In particular, younger CEOs overweight their personal beliefs and exaggerate their investment behavior to appear talented. Anecdotal evidence also generally portrays younger executives as risk takers. When 30-year-old Michael Reger, the CEO of Northern Oil and Gas, raised funds to drill for oil in unexplored areas, his actions were criticized as beyond the risk tolerances of older generations.[2] Also, Yahoo Japan hired a 44-year-old CEO along with seven other young managers, citing a need for an executive team that would not be afraid to take risks to remain competitive.[3]

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[2] See Spencer E. Ante and Joann S. Lublin, "Young CEOs: Are They Up to the Job? It's Creativity vs. Experience as a New Flock of Leaders Take Their Companies to Public Markets," *Wall Street Journal*, February 7, 2012.

[3] See Juro Osawa, "Yahoo Japan's Younger Look," *Wall Street Journal*, March 2, 2012.

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In this paper, I attempt to provide evidence on the relation between CEO age and risk-taking behavior. To do so, I study ExecuComp firms over the 1992 to 2010 period. Following prior work, I use a firm's stock return volatility as a measure of its overall risk (Cassell et al., 2012; Guay, 1999; Kini and Williams, 2012). Consistent with the prediction that CEOs take fewer risks as they age, I find a negative relation between stock return volatility and CEO age. This finding is robust to controlling for several CEO and firm characteristics known to impact firm risk, industry and year fixed effects, firm fixed effects, and to employing an instrumental variable approach. Moreover, the instrumental variable approach suggests a causal link from CEO age to firm risk.

To better understand how CEOs can affect firm risk, I next examine the relation between CEO age and four corporate policies through which CEOs can influence their firms' risk profiles. Prior work shows that firms that have lower research and development (R&D) expenditures, more diversified operations, lower operating leverage (i.e., a smaller change in earnings given a change in sales), and less financial leverage have lower overall firm risk.[4] Consistent with older (younger) CEOs making investments that lower (raise) firm risk, I document a negative relation between CEO age and both investment in R&D and operating leverage. I also find that firms managed by older CEOs are more diversified across business segments, and conditional on CEOs making acquisitions, older CEOs are more likely to make diversifying acquisitions.

Given that a CEO does not typically determine corporate policies alone but rather makes choices as a member of a team, the risk preferences of other senior executives could also contribute to the firm's overall risk profile. If an executive's age also affects risk preferences, then executives in a similar age group as the CEO should reinforce the risk-taking behavior of the CEO. Consistent with this prediction, stock return volatility, R&D expenditures, operating leverage, and financial leverage are lowest (highest) when both the CEO and the next most influential executive are older (younger). Also, the diversification of a firm's operations is highest (lowest) when the CEO and the next most influential executive are older (younger).

The results presented so far are consistent with CEOs reducing firm risk as they age. I next investigate whether firms appear to want older (younger) CEOs to take fewer (more) risks. First, I examine the relation between CEO age and the risk-taking incentives provided to the CEO. If firms want older (younger) CEOs to pursue low (high) risk strategies, then firms will award older (younger) CEOs with fewer (greater) risk-taking incentives. However, if firms want older (younger) CEOs to pursue high (low) risk strategies, then firms will award older (younger) CEOs with greater (fewer) risk-taking incentives. I measure these incentives with the CEO's stock option portfolio vega, which captures the sensitivity of the CEO's wealth to changes in stock return volatility (Chava and Purnanandam, 2010; Coles et al., 2006; Guay, 1999). I find that older CEOs have lower stock option portfolio vega. Second, if less (more) risky firms want older (younger) CEOs to take fewer (more) risks, then less (more) risky firms should hire older (younger) CEOs. I document that firms with lower stock return volatility and firms that are more diversified tend to hire older CEOs. Together, these results imply that less (more) risky firms want older (younger) CEOs to follow low (high) risk strategies and that firms try to match CEO and firm risk preferences.

While less (more) risky firms tend to hire older (younger) CEOs, firm and CEO risk preferences are unlikely to match perfectly. Thus, when younger (older) CEOs replace older (younger) CEOs, they may adjust firm risk to more closely match their own risk preferences. I find evidence consistent with this notion. Specifically, stock return volatility and financial leverage increase when firms hire CEOs that are much younger than incumbent CEOs. This finding is also consistent with firms that want to increase (reduce) their risk hiring younger (older) CEOs with higher (lower) risk preferences.

Lastly, I examine whether market participants incorporate the effect of CEO age on risk-taking into stock prices. First, I examine how differences in ages between successor CEOs and incumbent CEOs impact investors' responses to CEO succession announcements. If it is optimal for a low (high) risk firm to hire an older (younger) CEO so that the CEO's risk-preferences match those of the firm, then investors should respond negatively if the firm deviates from this optimal CEO-firm matching strategy. I find that when firms with lower stock return volatility or lower financial leverage hire a CEO that is younger than the incumbent CEO, these firms experience negative abnormal stock returns to succession announcements. Second, I compare long-run abnormal stock returns of portfolios grouped by CEO age. Assuming that stock returns are increasing in firm risk (French et al., 1987), if the market overestimates (underestimates) the risk that older (younger) CEOs will take, then the future stock returns of firms managed by older CEOs should be lower than the returns of firms led by younger CEOs. I find that portfolios consisting of firms with CEOs in the youngest age group generate higher risk-adjusted portfolio returns relative to portfolios consisting of firms with CEOs in the oldest age group.

The central contribution of this paper is that I identify CEO age as a factor that affects risk-taking behavior. Broadly, my study contributes to the literature that examines the determinants of CEO risk-taking. Prior work shows that stock option compensation induces CEOs to take greater risks (Coles et al., 2006; Rajgopal and Shevlin, 2002) but that pension benefits and deferred compensation incentivize CEOs to take fewer risks (Cassell et al., 2012). In addition, John et al. (2008) find that risk-taking is increasing in investor protection. These studies document ways that firms can overcome a CEO's natural risk preferences and encourage them to take a desired amount of risk. In contrast, I identify CEO age as a source of CEOs' innate risk preferences that affects their risk-taking behavior. Moreover, this notion that age affects behavior can also be applied to other settings. For example, CFO age could affect accounting choices or the age of board members may impact their monitoring abilities.

[4] For example, see Bhagat and Welch (1995), Kothari et al. (2002), Eberhart et al. (2004), Coles et al. (2006), Cassell et al. (2012), and Kini and Williams (2012) for R&D expenditures, Amihud and Lev (1981), May (1995), Tufano (1996), Mansi and Reeb (2002), and Duchin (2010) for business segment diversification, Lev (1974), Mandelker and Rhee (1984), and Chen et al. (2011) for operating leverage, and Coles et al. (2006) and Lewellen (2006) for financial leverage.

My findings also contribute to the stream of research investigating how managerial personal traits impact corporate policies. Prior research shows that CEO overconfidence affects investment and financing decisions (Malmendier and Tate, 2005; Malmendier et al., 2011), CEOs with industry expertise make better acquisitions (Custódio and Metzger, 2013), and overall, CEO fixed effects explain a significant portion of the variation in corporate policies (Bertrand and Schoar, 2003). In contrast to many previously identified CEO traits, CEO age is unique in that it is readily observable and measurable, applies to all CEOs, and changes over time.

In contemporaneous work, Yim (2013) finds that younger CEOs make more acquisitions because permanent increases in compensation following acquisitions incentivize younger CEOs to make more acquisitions earlier in their careers. In addition, by examining plant-level investment decisions, Li et al. (2011) show that younger CEOs follow a more active investment style, as younger CEOs are more likely to open and close plants. In contrast to these studies, I examine whether CEO age affects risk-taking and the corporate policies through which this occurs.

I also provide novel evidence that when top executives share similar personal characteristics as the CEO, the effect of CEO characteristics on corporate policies is more pronounced. Despite the fact that CEOs often make decisions as a member of an executive team, there is surprisingly little evidence on how the personal traits of other executives interact with those of CEOs.

Further, I contribute to the literature that investigates the matching between firms and CEOs. Previous work shows that firms and CEOs match according to their leverage preferences (Cronqvist et al., 2012), and firms hire outsiders following poor performance (Huson et al., 2001; Parrino, 1997). In addition, firms consider the traits of CEOs' previous employers and their prior work experiences when making hiring decisions (Chang et al., 2011; Ryan and Wang, 2011). My findings suggest that CEOs and firms may match according to their risk preferences.

Finally, my study also relates to the literature investigating how CEO traits impact firm stock market performance. For example, prior work finds that firms managed by founders earn higher risk-adjusted returns and that firms led by CEOs who win prestigious awards actually earn lower returns (Fahlenbrach, 2009; Malmendier and Tate, 2009). I contribute by showing that firms led by younger CEOs earn higher risk-adjusted portfolio returns than firms managed by older CEOs.

The remainder of this paper is organized as follows. Section 2 develops the study's principal hypothesis. Section 3 describes the data and presents summary statistics. Section 4 reports the empirical findings. Section 5 presents the results of robustness tests. Lastly, Section 6 concludes.

2. Hypothesis development

2.1. Age and risk-taking behavior

Prior theoretical and empirical work generates conflicting predictions and evidence with regard to how a manager's age impacts risk-taking behavior. The first strand of literature predicts that because younger managers face greater career concerns, they display more risk-aversion, which can lead to excessive conservatism in investment policies (Hirshleifer and Thakor, 1992; Holmstrom, 1999; Scharfstein and Stein, 1990).[5] Specifically, these studies argue that because younger managers do not have reputations as high quality managers, they face greater labor market scrutiny if they make a bad investment decision, which could significantly reduce future career opportunities. Zwiebel (1995) develops a model of how career and reputation concerns affect investment choices and shows that due to these concerns, younger managers will avoid innovative investments that differ from other firms and will undertake projects that are easier for the market to evaluate.

Consistent with these predictions, Chevalier and Ellison (1999) find that young mutual fund managers hold portfolios with less idiosyncratic risk and that deviate less from the sector weightings of funds within their objective class to reduce the likelihood of termination. Further, Hong et al. (2000) show that career concerns affect herding behavior among security analysts. Because younger analysts are punished more harshly for poor forecasting performance and forecast boldness, younger analysts herd more and forecast closer to consensus forecasts.

The second strand of literature predicts that younger managers make more, bolder, and riskier investments compared to older managers. Prendergast and Stole (1996) develop a managerial signaling model and argue that younger managers attempt to signal to the market that they are high quality managers with superior ability by pursuing riskier and more aggressive investment strategies. In particular, younger managers overweight their personal beliefs and exaggerate their investment behavior to appear talented. Further, older managers are reluctant to change their investment behavior because it may indicate that their previous investment decisions were incorrect.

In discussing the role that managerial backgrounds play in organizational outcomes, Hambrick and Mason (1984) posit three reasons why younger managers are generally associated with attempting the novel, unprecedented, and taking risks. First, older managers may be at a point in their lives where financial security and career security are more important. Second, older managers may have greater commitment to the status quo of the firm. Lastly, older executives may have less mental and physical stamina or are less able to grasp new ideas and learn new behaviors. In addition, older managers have a tendency to seek more information, to evaluate information in-depth, and take longer to make decisions (Taylor, 1975).

Based on these two strands of literature, it is unclear how CEO age empirically relates to risk-taking. If career concerns dominate, there should be a positive relation between CEO age and risk-taking. If the signaling explanation dominates, there should be a negative relation between CEO age and risk-taking. This leads to the study's principal hypothesis stated in alternative form.

[5] To the extent that younger executives have more to lose in the event of making a bad investment decision, firms can try to reduce these executives' risk aversion by providing them with an explicit employment agreement that would put the executive's terms of employment in writing (Gillan et al., 2009).

Hypothesis. *Older (younger) CEOs prefer less (more) risk.*

2.2. Empirical predictions

Prior studies use the volatility of a firm's stock returns as a measure of the overall riskiness of the firm, where greater volatility implies greater risk (Cassell et al., 2012; Guay, 1999; Kini and Williams, 2012). Thus, the hypothesis generates the empirical prediction that firms managed by older CEOs will have lower stock return volatility.

If CEOs affect firm risk, they must do so through channels that they have control over. Two of these channels are choices in the riskiness of investment and financial policies. I focus my analysis on three investment mechanisms through which CEOs can reduce the riskiness of their firms. First, CEOs can reduce R&D expenditures, as R&D expenditures are considered a riskier form of investment compared to capital expenditures due to their higher degree of uncertainty regarding future benefits (Bhagat and Welch, 1995; Cassell et al., 2012; Coles et al., 2006; Eberhart et al., 2004; Kini and Williams, 2012; Kothari et al., 2002). Second, CEOs can reduce firm-specific risk by diversifying their operations across multiple business segments and into different industries (Amihud and Lev, 1981; Duchin, 2010; Mansi and Reeb, 2002; May, 1995; Tufano, 1996). Third, CEOs can make investments that result in lower operating leverage, which is the percentage change in earnings for a percentage change in sales. Specifically, for a given level of sales and earnings, investments that reduce fixed costs result in lower operating leverage. Because the profits of firms with greater operating leverage are more sensitive to fluctuations in sales, firms with greater operating leverage are riskier (Chen et al., 2011; Lev, 1974; Mandelker and Rhee, 1984). Thus, this study's hypothesis generates the empirical predictions that CEO age is negatively related to R&D expenses and operating leverage and positively related to firm diversification.

CEOs can also reduce firm risk through more conservative financial policies. By maintaining lower leverage ratios, CEOs can reduce their firms' overall risk (Coles et al., 2006; Lewellen, 2006). Consequently, this study's hypothesis also generates the empirical prediction that CEO age is negatively related to financial leverage.

3. Sample selection, variable construction, and data description

3.1. Sample selection

The initial sample consists of all ExecuComp firm-years between 1992 and 2010.[6] Utilities (SIC 4900–4999) and financial firms (SIC 6000–6999) are excluded from the sample. I obtain financial statement data from the Compustat files, stock return data from the Center for Research in Security Prices (CRSP) files, and institutional ownership data from Thomson-Reuters Institutional Holdings (13F) Database. After merging the databases and removing observations with missing values, the sample consists of 20,973 firm-years, 2356 unique firms, and 4493 unique CEOs. Panel A of Table 1 presents summary statistics for the full sample. Panel B reports summary statistics by CEO age terciles. All continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars.

3.2. CEO age and measures of risk

The variable of interest in this paper is CEO age. I obtain CEO age from ExecuComp and use the natural logarithm of CEO age (*Log CEO Age*) in multivariate regressions. The mean (median) CEO is 55.22 (55.00) years old.

I use the annualized standard deviation of daily stock returns (*Total Risk*) and the annualized standard deviation of the residuals from the regression of daily stock returns on the Fama and French three factors (*Idiosyncratic Risk*) as two measures of overall firm risk. I calculate both measures from daily returns over the firm's fiscal year. The means (medians) of *Total Risk* and *Idiosyncratic Risk* are 45.88% (40.33%) and 39.86% (34.76%), respectively. In multivariate regressions, I use the natural logarithm of both measures.

The investment policies that I examine are R&D expenditures, operating leverage, and firm diversification. The financial policy is book leverage. Following Coles et al. (2006) and Kini and Williams (2012), I define *R&D Intensity* as firm R&D expenditures divided by book value of assets. If a firm does not report R&D expenses in a given year, I assume its value is zero. The mean (median) of *R&D Intensity* is 3.47% (0.38%).

I follow Mandelker and Rhee (1984) and Chen et al. (2011) and estimate total operating leverage as the elasticity of a firm's operating income with respect to its sales. Thus, *Operating Leverage* is the percentage change in operating income for a percentage change in sales and is estimated using Compustat quarterly data over a three-year window from year t to year $t + 2$. I require firms have at least eight quarters of non-missing data to construct this measure. I first define operating income as

[6] Duchin et al. (2010) document that corporate investment significantly declined following the onset of the credit crisis in 2007. To address the possibility that my results could be biased due to lower investment activity during the credit crisis, as a robustness test, I restrict the sample period to the years between 1992 and 2006. The study's main results and conclusions are robust to this restriction.

Table 1
Summary statistics. This table reports summary statistics for ExecuComp firms from 1992 to 2010. Financial and utility firms are excluded. Panel A reports summary statistics for the full sample. Panel B reports summary statistics by CEO age terciles. *CEO Age* is the age of the current CEO. *Younger CEO* is the youngest age tercile. *Middle-Aged CEO* is the middle age tercile. *Older CEO* is the oldest age tercile. The definitions of all variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. In Panel B, I test for significant differences in means between the oldest age tercile and the youngest age tercile using a t-test. The results of the test are reported next to the mean values for the oldest age tercile. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample summary statistics

	Obs.	Mean	Std. Dev.	P25	Median	P75
Measures of risk						
Total Risk	20,973	45.88	22.88	29.82	40.33	55.64
Idiosyncratic Risk	20,973	39.86	20.42	25.67	34.76	48.34
R&D Intensity	20,973	3.47	5.95	0.00	0.38	4.56
Segment HHI	20,973	0.78	0.27	0.52	1.00	1.00
Number of Segments	20,973	2.04	1.38	1.00	1.00	3.00
Operating Leverage	18,088	2.02	7.09	0.86	1.62	2.98
Book Leverage	20,973	21.82	17.80	5.75	20.57	33.10
Pct. Diversifying Acquisitions	2767	32.21	45.64	0.00	0.00	100.00
Pct. Spent on Diversifying Acquisitions	2767	32.10	45.87	0.00	0.00	100.00
CEO characteristics						
CEO Age	20,973	55.22	7.33	50.00	55.00	60.00
Tenure	20,973	7.36	7.11	2.50	5.06	9.76
Portfolio Delta	20,973	746.6	1731.9	99.2	251.9	657.0
Portfolio Vega	20,973	174.0	301.0	25.6	70.9	184.8
Awarded Vega	20,973	19.62	45.53	0.00	0.00	14.47
Firm characteristics						
Book Assets	20,973	5116	10,939	502	1308	4020
Market-to-Book	20,973	2.02	1.46	1.19	1.57	2.29
Return on Assets	20,973	3.56	12.42	1.66	5.24	8.90
Cash Holdings	20,973	14.66	17.09	2.25	7.50	21.38
Sales Growth	20,973	0.13	0.30	0.00	0.09	0.20
Blockholder	20,973	0.38	0.48	0.00	0.00	1.00
Stock Return	20,973	0.18	0.63	−0.16	0.10	0.38
Firm Age	20,973	24.38	15.95	11.00	20.00	38.00

Panel B: Summary statistics by CEO age terciles

	Older CEO		Middle-aged CEO		Younger CEO	
	Obs.	Mean	Obs.	Mean	Obs.	Mean
Measures of risk						
Total Risk	6889	42.02***	6705	44.99	7379	50.29
Idiosyncratic Risk	6889	36.42***	6705	38.90	7379	43.95
R&D Intensity	6889	2.67***	6705	3.31	7379	4.35
Segment HHI	6889	0.74***	6705	0.77	7379	0.83
Number of segments	6889	2.23***	6705	2.09	7379	1.82
Operating Leverage	6005	1.99	5741	1.96	6342	2.08
Book Leverage	6889	22.58***	6705	22.60	7379	20.40
Pct. Diversifying Acquisitions	848	33.77	856	32.82	1063	30.49
Pct. spent on diversifying acquisitions	848	33.39	856	32.60	1063	30.68
CEO characteristics						
CEO Age	6889	63.19***	6705	55.51	7379	47.53
Tenure	6889	10.37***	6705	6.48	7379	5.34
Portfolio Delta	6889	909.3***	6705	666.5	7379	667.4
Portfolio Vega	6889	189.6***	6705	184.7	7379	149.8
Awarded Vega	6889	19.17*	6705	22.27	7379	17.62
Firm characteristics						
Book Assets	6889	7429***	6705	6909	7379	4097
Market-to-Book	6889	1.90***	6705	1.97	7379	2.18
Return on Assets	6889	4.35***	6705	3.80	7379	2.61
Cash Holdings	6889	12.14***	6705	13.45	7379	18.10
Sales Growth	6889	0.11***	6705	0.12	7379	0.16
Blockholder	6889	0.36***	6705	0.37	7379	0.40
Stock Return	6889	0.17***	6705	0.17	7379	0.19
Firm Age	6889	27.52***	6705	25.72	7379	20.21

operating income after depreciation (*OIADPQ*) and run the following regression of *OIADPQ* on quarterly sales (*SALE*) for each firm over the three-year window.

$$OIADPQ_i = \alpha_i + \pi_i SALE_i + \varepsilon_i \quad (1)$$

I then calculate *Operating Leverage* as $\pi_i\left(\overline{SALE_i}/\overline{OIADPQ_i}\right)$, where $\overline{SALE_i}$ and $\overline{OIADPQ_i}$ denote the three-year average values of sales and operating income for firm *i*, respectively.

I measure financial leverage (*Book Leverage*) as the book value of long-term debt plus the debt in current liabilities divided by book value of assets (Coles et al., 2006; Kini and Williams, 2012).[7] The mean (median) of *Book Leverage* is 21.82% (20.57%).

I use two measures of firm diversification. First, following Coles et al. (2006), Cassell et al. (2012), and Kini and Williams (2012), *Segment HHI* is the business segment sales-based Herfindahl–Hirschman Index calculated by summing the squares of the ratios of individual segment sales to the firm's total sales. I obtain segment sales from Compustat's annual segment file. If a firm does not have data in the annual segment file in a given year, I assume that it derives all of its sales from a single business segment. *Segment HHI* is equal to one if a firm operates solely in one segment and decreases as the firm diversifies. The second measure is the total number of segments in which a firm operates (*Number of Segments*). The mean (median) firm operates in 2.04 (1.00) business segments. I use the natural logarithm of *Number of Segments* in multivariate regressions.

3.3. Control variables

Following Coles et al. (2006), Cassell et al. (2012), and Kini and Williams (2012), I include several CEO and firm characteristics that are potentially correlated with corporate policies and CEO age as control variables. I describe these variables below. *Tenure* is the number of years that the CEO has been CEO of the firm.[8] The mean (median) CEO has been CEO for 7.36 (5.06) years. The correlation between *CEO Age* and *Tenure* is 0.37.

Portfolio Delta is the CEO's total portfolio delta, where portfolio delta is the dollar increase in wealth (in thousands) for a 1% increase in stock price. *Portfolio Vega* is the CEO's total portfolio vega, where portfolio vega is the dollar increase in option-wealth (in thousands) for a one percentage point increase in stock return volatility. To measure portfolio delta and vega, I follow the methodology outlined in Core and Guay (2002) to calculate the CEO's portfolio delta for option and stock holdings and portfolio vega for option holdings. Following their methodology, stock option values and their sensitivity to stock price are based on the Black–Scholes formula adjusted for dividend payouts (Black and Scholes, 1973; Merton, 1973). The means (medians) of *Portfolio Delta* and *Portfolio Vega* are $746.6 ($251.9) and $174.0 ($70.9), respectively.

Book Assets is the book value of assets (in millions). The mean (median) firm has *Book Assets* of $5.12 ($1.31) billion. *Market-to-Book* is the market value of the firm divided by book value of assets. *Return on Assets* is income before extraordinary items divided by book value of assets. *Cash Holdings* is the book value of cash and short-term investments divided by book value of assets. The mean (median) firm has *Return on Assets* of 3.56% (5.24%) and has 14.66% (7.50%) of assets in cash. *Sales Growth* is the percentage increase in sales from year $t-1$ to year *t*. *Blockholder* is an indicator variable set to one if a firm has an institutional investor that owns at least 10% of the firm's outstanding shares and zero otherwise. The mean (median) firm has year-over-year sales growth of 13.03% (8.50%), and 38% of firms have at least one institutional owner that owns at least 10% of the firm. *Stock Return* is a firm's annual stock return during the fiscal year, and *Firm Age* is the number of years that a firm has had data available in Compustat. The means (medians) of *Stock Return* and *Firm Age* are 17.94% (9.50%) and 24.38 (20.00) years, respectively.

3.4. Descriptive statistics by CEO age terciles

Panel B of Table 1 presents descriptive statistics by CEO age terciles. I rank the age of every CEO into terciles with the top tercile representing the oldest CEOs. The age cutoffs for these three terciles are 29–52, 53–58, and 59–91. *Younger CEO* consists of CEOs whose ages are in the youngest age tercile, *Middle-Aged CEO* consists of CEOs whose ages are in the middle age tercile, and *Older CEO* consists of CEOs whose ages are in the oldest age tercile. I test for significant differences in means between the oldest age tercile and the youngest age tercile using a t-test and report the results of the test next to the mean values for the oldest age tercile.

The results show that firms managed by the oldest CEOs have lower return volatility, invest less in R&D, have more diversified operations, and have more debt outstanding. In addition, the oldest CEOs have longer tenures and receive more performance sensitive compensation. Lastly, firms managed by the oldest CEOs tend to be larger, have fewer growth opportunities, are more profitable but have lower stock returns, maintain lower cash reserves, are less likely to have a major institutional investor, and are more mature. In sum, with the exception of operating and book leverage, the univariate results are consistent with risk-taking behavior decreasing as CEOs age.

4. Empirical results

4.1. CEO age and overall firm risk

In this section, I examine the relation between CEO age and firm risk, as approximated by *Total Risk* and *Idiosyncratic Risk*. The hypothesis generates the prediction that CEO age is negatively related to firm risk. Thus, if older CEOs prefer less risk compared to younger CEOs, there should be a negative relation between CEO age and both *Total Risk* and *Idiosyncratic Risk*.

[7] All the results in the study are very similar if *Market Leverage*, defined as the book value of long-term debt plus the debt in current liabilities divided by market value of assets, is used instead of *Book Leverage*.

[8] I identify the first year of a CEO's tenure using the *BECAMECEO* variable in ExecuComp. This variable is missing for 3.14% of firm-years in the sample. In these instances or when tenure is a negative value, I set the year that the executive became CEO to the first year that the executive appears as CEO in ExecuComp. I do this for 5.86% of the sample. Results and inferences remain unchanged if I instead drop these observations from the sample.

Table 2 reports the findings of this analysis. Panel A of Table 2 presents results from pooled OLS regressions estimated with heteroskedasticity-robust standard errors clustered at the CEO-firm level to account for the correlation of residuals within CEO-firm pairs (Petersen, 2009). The dependent variable in Models 1–3 is the natural logarithm of *Total Risk*, and the dependent variable in Models 4–6 is the natural logarithm of *Idiosyncratic Risk*. In Models 1 and 4, I include year fixed effects and 2-digit SIC industry fixed effects to control for unobserved heterogeneity across years and industries. The results in Models 1 and 4 show a

Table 2
CEO age and overall firm risk. This table reports results from regressions relating CEO age to stock return volatility for ExecuComp firms from 1992 to 2010. Financial and utility firms are excluded. Panel A presents results from OLS regressions that include year fixed effects, industry fixed effects, the interactions of industry and year fixed effects, or firm fixed effects. Panel B presents results from 2-Stage Least Squares regressions. The dependent variable in Models 1–3 of Panel A and Model 2 of Panel B is the natural logarithm of *Total Risk*. The dependent variable in Models 4–6 of Panel A and Model 3 of Panel B is the natural logarithm of *Idiosyncratic Risk*. *Log CEO Age* is the natural logarithm of the age of the CEO. Model 1 of Panel B presents first-stage results obtained from regressing *Log CEO Age* on the instrumental variable *Log CPI at Birth* and other control variables. *Log CPI at Birth* is the natural logarithm of the Consumer Price Index in the year when the CEO was born. Models 2 and 3 of Panel B present second-stage results. Industries are defined at the 2-digit SIC level. Control variables include *Log Tenure*, *Log Portfolio Delta*, *Log Portfolio Vega*, *Log Book Assets*, *Market-to-Book*, *Book Leverage*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, and *Log Firm Age*. Tables showing all the estimated coefficients on control variables are in the Online Appendix. The definitions of all variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: OLS regressions

	Log Total Risk			Log Idiosyncratic Risk		
	(1)	(2)	(3)	(4)	(5)	(6)
Log CEO Age	−0.183***	−0.174***	−0.106***	−0.167***	−0.162***	−0.070**
	(−6.71)	(−6.55)	(−3.83)	(−5.93)	(−5.87)	(−2.54)
Log Tenure	0.019***	0.019***	0.017***	0.017***	0.018***	0.014***
	(3.93)	(4.06)	(3.76)	(3.53)	(3.72)	(3.07)
Log Portfolio Delta	−0.008**	−0.013***	−0.010***	−0.014***	−0.017***	−0.020***
	(−2.34)	(−3.89)	(−2.79)	(−3.84)	(−4.72)	(−5.46)
Log Portfolio Vega	−0.038***	−0.031***	−0.045***	−0.037***	−0.033***	−0.045***
	(−11.88)	(−9.82)	(−14.07)	(−11.34)	(−9.95)	(−13.79)
Log Book Assets	−0.049***	−0.053***	−0.058***	−0.068***	−0.070***	−0.085***
	(−13.51)	(−14.69)	(−8.26)	(−18.03)	(−18.68)	(−12.30)
Market-to-Book	0.004	−0.000	0.014***	−0.005	−0.007***	0.003
	(1.25)	(−0.15)	(5.37)	(−1.60)	(−2.65)	(1.31)
Book Leverage	0.001***	0.001***	0.001***	0.002***	0.002***	0.002***
	(5.57)	(5.87)	(5.24)	(7.29)	(7.36)	(6.77)
Return on Assets	−0.008***	−0.008***	−0.004***	−0.008***	−0.008***	−0.004***
	(−24.47)	(−23.94)	(−17.29)	(−23.55)	(−23.43)	(−16.76)
Cash Holdings	0.004***	0.004***	0.001**	0.004***	0.004***	0.000
	(15.71)	(16.57)	(2.31)	(15.40)	(16.15)	(0.82)
Sales Growth	0.091***	0.089***	0.037***	0.083***	0.081***	0.035***
	(11.64)	(11.29)	(5.66)	(10.54)	(9.95)	(5.29)
Blockholder	0.001	−0.001	−0.005	0.001	−0.001	−0.002
	(0.10)	(−0.23)	(−1.00)	(0.13)	(−0.19)	(−0.46)
Stock Return	0.027***	0.030***	0.003	0.038***	0.039***	0.016***
	(6.12)	(6.70)	(0.63)	(7.93)	(8.14)	(3.70)
Log Firm Age	−0.087***	−0.085***	−0.252***	−0.095***	−0.094***	−0.207***
	(−14.33)	(−14.43)	(−13.56)	(−15.31)	(−15.45)	(−11.65)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	No	Yes	Yes	No
Industry * Year Fixed Effects	No	Yes	No	No	Yes	No
Firm Fixed Effects	No	No	Yes	No	No	Yes
Observations	20,973	20,973	20,973	20,973	20,973	20,973
Adjusted R^2	0.624	0.412	0.754	0.622	0.643	0.758

Panel B: 2-Stage least squares regressions

	Log CEO Age	Log Total Risk	Log Idiosyncratic Risk
	(1)	(2)	(3)
Log CPI at Birth	−0.465***		
	(−99.07)		
Log CEO Age		−0.186***	−0.166***
		(−5.72)	(−4.95)
Control Variables	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	20,973	20,973	20,973
Adjusted R^2	0.765	0.624	0.623

negative relation between CEO age and firm stock return volatility. In terms of economic significance, the coefficient estimates in Models 1 and 4 imply that a 25% increase in CEO age leads to a decrease in total stock return volatility of 4.6% (= 0.183 * 0.25) and a decrease in idiosyncratic risk of 4.2% (= 0.167 * 0.25).

However, a potential concern is that an industry effect unique to specific industries during particular years is driving the negative relation between CEO age and firm stock return volatility. For example, older (younger) CEOs may tend to choose to work in industries with lower (higher) return volatility. To account for this potential issue, in Models 2 and 5, I also include as control variables the interactions of year and industry fixed effects. The inclusion of these industry-year fixed effects is equivalent to demeaning CEO age and all the other independent and dependent variables with respect to their averages by industry each year (Gormley and Matsa, forthcoming). Therefore, CEO age and the measures of risk should be comparable across industries in any given year. The results continue to show a negative relation between CEO age and return volatility, suggesting that an industry-year effect unlikely drives my findings.

A second potential concern is that low (high) risk firms select older (younger) CEOs or that older (younger) CEOs choose to work for low (high) risk firms. In this scenario, it is a firm effect that is driving the negative relation between CEO age and firm stock return volatility. To address this potential concern, in Models 3 and 6, I include as control variables firm fixed effects along with year fixed effects. The inclusion of these firm fixed effects is equivalent to demeaning CEO age and all the other independent and dependent variables with respect to their averages by firm. In other words, the inclusion of firm fixed effects implies that the results reflect average, within-firm changes in firm return volatility and CEO age. Further, the inclusion of firm fixed effects controls for all observed and unobserved time-invariant firm characteristics that may be correlated with firm return volatility and CEO age. The results continue to show a negative relation between CEO age and return volatility, suggesting that a time-invariant firm-level effect unlikely drives my findings.

In untabulated analyses, I also attempt to control for an industry or firm effect by rerunning Models 1 and 4 using industry-adjusted and firm-adjusted CEO age. I calculate industry-adjusted CEO age by subtracting the median CEO age of CEOs in the same 2-digit SIC industry as the firm in a given year and firm-adjusted CEO age by subtracting the median CEO age for the firm over the full sample period. The results from these tests are consistent with the findings using the industry-year and firm fixed effect approaches. In particular, firms managed by CEOs whose ages are higher than the median CEO age in their industry and firms managed by CEOs whose ages are higher than the median historical CEO age of their firm have lower stock return volatility.

Lastly, it is still possible that a time-variant omitted variable or a variable related to specific types of firms hiring CEOs of certain ages drives the negative relation between CEO age and firm stock return volatility. Using an instrumental variable approach is one identification strategy that can alleviate these endogeneity concerns. Panel B of Table 2 presents results from pooled 2-Stage Least Squares (2SLS) regressions estimated with heteroskedasticity-robust standard errors clustered at the CEO-firm level.[9] Model 1 presents first-stage results. In the first stage, I regress the natural logarithm of CEO age on the previously used set of control variables and a selected instrument. Admittedly, it is quite challenging to find a variable based on economic theory that predicts CEO age but not corporate policies. Nevertheless, I use the natural logarithm of the Consumer Price Index (CPI) in the year when the CEO was born (*Log CPI at Birth*) as an instrumental variable (Cline and Yore, 2012). In purely econometric terms, this variable likely meets the restrictions needed to be considered a valid instrument. First, the variable is highly correlated with CEO age. Specifically, higher values of the CPI correspond to later years. Because older CEOs have, on average, earlier birth years, there is a strong negative relation between the CPI in the year when the CEO was born and the CEO's current age. Second, there is no reason to believe that the CPI in the year when the CEO was born is correlated with current firm risk or any other firm policy, except through its relation with the CEO's age.[10] I then use the predicted values of *Log CEO Age* from the first-stage regression in second-stage regressions. Models 2 and 3 present second-stage results. The results continue to show a negative relation between CEO age and firm stock return volatility, which suggests a causal relation from CEO age to firm risk. Overall, the results in Table 2 are consistent with theoretical models predicting that risk-taking behavior decreases as CEOs become older.

4.2. CEO age and the riskiness of investment and financial policies

In this section, I examine the channels through which CEOs can influence overall firm risk. Specifically, I investigate whether CEO age impacts R&D expenditures, operating leverage, financial leverage, and firm diversification. Table 3 presents the results of this analysis. For each risk measure, I follow the empirical strategy outlined in the previous section. Specifically, Panels A, B, and C present results from pooled OLS regressions that include industry and year fixed effects, interactions of industry and year fixed effects, and firm and year fixed effects, respectively.[11] Panel D presents second-stage results from 2SLS regressions.

[9] In this panel and all the following tables, I do not tabulate the estimated coefficients on control variables to conserve space. However, tables showing all the estimated coefficients on control variables are in the Online Appendix.

[10] While I am unable to observe the true correlation between *Log CPI at Birth* and the risk measures after controlling for the full set of control variables, the correlation between *Log CPI at Birth* and the residuals from Model 1 in Panel A of Table 2 is 0.00093 (p-value = 0.890). This finding suggests that the instrument likely satisfies the exogeneity requirement.

[11] Similar to the analyses in the previous section, I rerun the regressions in Panel A using industry-adjusted and firm-adjusted CEO age. The results from these tests show that firms managed by CEOs that are older relative to the average CEO in their industry invest less in R&D, maintain lower operating leverage, and are more diversified across business segments. Further, I find that firms managed by CEOs that are older relative to the average CEO of their firm maintain lower operating leverage. Collectively, these findings are consistent with correcting for an industry or firm effect using the industry-year and firm fixed effects approaches.

Table 3
CEO age and the riskiness of investment and financial policies. This table reports the results from regressions relating CEO age to the riskiness of corporate policies for ExecuComp firms from 1992 to 2010. Financial and utility firms are excluded. Panel A presents results from OLS regressions that include industry and year fixed effects. Panel B presents results from OLS regressions that include the interactions of industry and year fixed effects. Panel C presents results from OLS regressions that include firm and year fixed effects. Panel D presents second-stage results from 2-Stage Least Squares regressions. First-stage results are obtained from regressing *Log CEO Age* on the instrumental variable *Log CPI at Birth* and other control variables. The dependent variables in Models 1-5 are *R&D Intensity*, *Operating Leverage*, *Book Leverage*, *Segment HHI*, and the natural logarithm of *Number of Segments*, respectively. *Log CEO Age* is the natural logarithm of the age of the CEO. Industries are defined at the 2-digit SIC level. Control variables include *Log Tenure*, *Log Portfolio Delta*, *Log Portfolio Vega*, *Log Book Assets*, *Market-to-Book*, *Book Leverage*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, and *Log Firm Age*. In Model 3, the control variable *Book Leverage* is replaced with *R&D Intensity*. The definitions of all variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Base regressions

	R&D Intensity	Operating Leverage	Book Leverage	Segment HHI	Log Number of Segments
	(1)	(2)	(3)	(4)	(5)
Log CEO Age	−1.104**	−1.040**	−1.845	−0.098***	0.212***
	(−2.21)	(−2.19)	(−1.03)	(−3.59)	(3.51)
Control Variables	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	20,973	18,088	20,973	20,973	20,973
Adjusted R^2	0.556	0.009	0.331	0.232	0.234

Panel B: Industry * year fixed effects regressions

	(1)	(2)	(3)	(4)	(5)
Log CEO Age	−1.180**	−1.092**	−1.775	−0.092***	0.194***
	(−2.35)	(−2.30)	(−0.99)	(−3.38)	(3.25)
Control Variables	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry * Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	20,973	18,088	20,973	20,973	20,973
Adjusted R^2	0.550	0.017	0.328	0.229	0.235

Panel C: Firm fixed effects regressions

	(1)	(2)	(3)	(4)	(5)
Log CEO Age	−0.628**	−1.549**	1.115	−0.041*	0.100*
	(−2.26)	(−2.35)	(0.79)	(−1.67)	(1.86)
Control Variables	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	20,973	18,088	20,973	20,973	20,973
Adjusted R^2	0.881	0.082	0.714	0.686	0.654

Panel D: 2-Stage least squares regressions

	(1)	(2)	(3)	(4)	(5)
Log CEO Age	−0.774	−1.545***	−2.593	−0.102***	0.187**
	(−1.28)	(−2.67)	(−1.19)	(−2.96)	(2.50)
Control Variables	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	20,973	18,088	20,973	20,973	20,973
Adjusted R^2	0.556	0.009	0.331	0.232	0.234

First, I examine the relation between CEO age and firm R&D expenditures and present the results in Model 1. Because R&D expenditures are considered a riskier form of investment due to their higher degree of uncertainty regarding future benefits, if older CEOs prefer less risk compared to younger CEOs, there should be a negative relation between CEO age and R&D expenditures. The dependent variable in Model 1 is firm R&D expenses divided by book value of assets. Overall, the results show a negative relation between CEO age and firm R&D expenditures. Given that the sample mean of R&D expenditures is 3.47%, the coefficient estimates in Model 1 of Panel A imply that a 25% increase in CEO age leads to a decrease in R&D expenditures of 8.0% ($=1.104 * 0.25/3.47$). In untabulated results, I include the ratio of a firm's capital expenditures to its book value of assets as an additional regressor to control for alternative forms of investment. The results remain very similar.

Next, I examine the relation between CEO age and firm operating leverage and present the results in Model 2. Firms with greater operating leverage are associated with greater risk. Therefore, if older CEOs prefer less risk compared to younger CEOs,

there should be a negative relation between CEO age and operating leverage. The dependent variable in Model 2 is operating leverage, defined as the percentage change in operating income for a percentage change in sales. Collectively, the results show a negative relation between CEO age and operating leverage. Given that the sample mean of operating leverage is 2.02, the coefficient estimates in Model 2 of Panel A imply that a 25% increase in CEO age leads to a decrease in operating leverage of 12.9% (= 1.040 * 0.25/2.02). Because operating leverage is measured over years t to $t + 2$, in instances when a firm replaces its CEO during this window, I attribute part of the successor CEO's investment behavior to those of the incumbent CEO. To correct for this potential problem, I rerun the analyses and restrict the sample to only those observations in which the CEO remains as CEO of the firm for the entire three-year window over years t to $t + 2$. The untabulated results continue to show a statistically negative relation between CEO age and operating leverage.

Third, because CEOs can also reduce risk through more conservative financial policies, I next analyze the relation between CEO age and firm financial leverage and report the results in Model 3.[12] Thus, if older CEOs prefer less risk compared to younger CEOs, there should be a negative relation between CEO age and financial leverage. The dependent variable in Model 3 is book leverage. The results show that CEO age is not significantly related to financial leverage.

Lastly, I examine the relation between CEO age and firm diversification and present the results in Models 4 and 5. Because CEOs can reduce firm-specific risk by diversifying their firms' operations across multiple business segments, if older CEOs prefer less risk compared to younger CEOs, there should be a positive relation between CEO age and firm diversification. The dependent variable in Model 4 is the segment sales-based Herfindahl–Hirschman Index (*Segment HHI*). A larger value of *Segment HHI* implies that a firm is less diversified and therefore riskier. The dependent variable in Model 5 is the natural logarithm of the number of segments in which the firm operates. The results in Models 4 and 5 show a positive relation between CEO age and firm diversification. Given that the sample mean of *Segment HHI* is 0.78, the coefficient estimates in Model 4 of Panel A imply that a 25% increase in CEO age leads to a decrease in *Segment HHI* of 3.1% (= 0.098 * 0.25/0.78). Similarly, the coefficient estimates in Model 5 of Panel A imply that a 25% increase in CEO age leads to a rise in the number of business segments of 5.3% (= 0.212 * 0.25).

Collectively, the results in Table 3 along with results in Table 2 suggest that older (younger) CEOs decrease (increase) their firms' risk by investing less (more) in R&D, making investments that lower (raise) operating leverage, and diversifying (focusing) their firms. However, the results also suggest that CEOs do not use financial leverage as tools to alter their firms' overall risk.

4.3. CEO age and diversifying acquisitions

To provide further insight on whether older (younger) CEOs reduce (increase) firm risk by diversifying (focusing) their firms, I examine the intensity at which CEOs make diversifying acquisitions. Conditional on making an acquisition, if older (younger) CEOs decrease (increase) firm risk through greater (lesser) firm diversification, then CEO age should be positively related to making diversifying acquisitions. I collect acquisition data from Thomson-Reuters SDC Spectrum Mergers and Acquisitions database. I only consider acquisitions in which the amount paid for the target is at least 5% of the acquirer's beginning of the fiscal year market value of equity because the CEO is most likely involved in these larger acquisition decisions. Given that Yim (2013) shows that older CEOs are less likely to make acquisitions, I correct for selection bias by applying a Heckman selection model that conditions on the likelihood that a CEO makes an acquisition.

In the first-stage model, whose results are reported in Table B1 of Appendix B, I model the choice of whether a CEO makes an acquisition in a given year. In this model, I measure all independent variables as of year $t - 1$ relative to the acquisition year. Following Bauguess and Stegemoller (2008), control variables in the first stage include *Log Book Assets* (a control for firm size), *Market-to-Book* (a proxy for growth opportunities), and *Book Leverage* (a proxy for access to external capital). Further, similar to Caprio et al. (2011), I also control for *Return on Assets* and *Cash Holdings* (measures for internal financial slack) and *Property, Plant, and Equipment* (a proxy for collateral that can be used to obtain debt financing). I also control for *R&D Intensity* (an additional proxy for growth opportunities), *Stock Return* (a proxy for stock market misvaluation), and *Industry Acquisition Expenditures* (a proxy for a firm's propensity to make acquisitions given the acquisition activity in its industry). Lastly, I also continue to control for *Log Tenure, Log Portfolio Delta, Log Portfolio Vega*, and *Log Firm Age*.[13] Consistent with the findings of Yim (2013), the first-stage results show that CEO age is negatively related to the likelihood of making acquisitions.

[12] When *Book Leverage* is the dependent variable in the second-stage regression of the 2SLS approach, the control variable *Book Leverage* is replaced with *R&D Intensity* in the first-stage regression. Thus, I obtain first-stage results by regressing *Log CEO Age* on *Log CPI at Birth*, *Log Tenure*, *Log Portfolio Delta*, *Log Portfolio Vega*, *Log Book Assets*, *Market-to-Book*, *R&D Intensity*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, *Log Firm Age*, year fixed effects, and 2-digit SIC industry fixed effects.

[13] As noted above, first-stage results are reported in Table B1 of Appendix B. Model 1 is the selection equation corresponding to Models 1 and 3 in Table 4. Model 2 is the selection equation corresponding to Models 2 and 4 in Table 4. To ensure identification of the Heckman models, I include the following variables in the selection equations but not in the second-stage regressions: (1) *Industry Acquisition Expenditures*, (2) *Return on Assets*, and (3) *Property, Plant, and Equipment*. These variables are assumed to affect the likelihood that a firm makes an acquisition in a given year. For instance, firms in industries that make more acquisitions may be more likely to make an acquisition. Further, because firms that are more profitable and firms with more tangible assets have more pledgable income and greater potential collateral, such firms have greater debt capacity and may find it easier to obtain financing for an acquisition (Caprio et al., 2011). However, similar to the findings of Caprio et al. (2011), I find that the estimated coefficient sign on asset tangibility is negative, which is opposite of the *ex-ante* prediction. To the extent that industry acquisition activity, firm profitability, and asset tangibility are themselves unrelated to the likelihood that an acquisition is diversifying rather than focused, these variables meet the exclusion restriction needed to ensure identification of the Heckman selection models.

Table 4 presents the second-stage results from the Heckman selection models. Conditional on a CEO making an acquisition in a given year, in the second-stage regressions, I model the intensity of making diversifying acquisitions using two proxies. First, in Models 1 and 2, the dependent variable is *Pct. Diversifying Acquisitions*, which is the ratio of the number of diversifying acquisitions made to the total number of acquisitions made during a fiscal year. An acquisition is considered diversifying if the acquirer and the target do not share the same 2-digit SIC industry. Second, in Models 3 and 4, the dependent variable is *Pct. Spent on Diversifying Acquisitions*, which is the ratio of the dollar amount spent on diversifying acquisitions to the dollar amount spent on all acquisitions during a fiscal year.

Control variables in the second-stage regressions are measured as of year $t-1$ relative to the acquisition year and include *Log Tenure*, *Log Portfolio Delta*, *Log Portfolio Vega*, *Log Book Assets*, *Market-to-Book*, *R&D Intensity*, *Book Leverage*, *Cash Holdings*, *Stock Return*, and *Log Firm Age*. To control for variation due to the characteristics of the deal (Fuller et al., 2002; Officer et al., 2009), I also include the fraction of acquisitions that are financed entirely with cash during a fiscal year (*Percent All Cash Deals*), the fraction of acquisitions made by a firm during a fiscal year that are at least partially financed with stock (*Percent Stock Deals*), the fraction of acquisitions in which the target is a publicly traded firm (*Percent Public Targets*), and the fraction of acquisitions in which the target is a private firm (*Percent Private Targets*). Lastly, I include the *Inverse Mills Ratio* from the first-stage regression. In 2755 out of 19,705 firm-years (14.0%), a firm makes at least one acquisition that is at least 5% of its beginning year market value of equity.

All four models in Table 4 show that CEO age is positively related to the likelihood of making diversifying acquisitions. Given that, on average, 32.2% of acquisitions are diversifying, the coefficient estimates in Model 1 imply that a 25% increase in CEO age leads to a rise in the fraction of diversifying acquisitions made of 18.9% ($=0.244 * 0.25/0.322$). Similarly, given that, on average, 32.1% of the money spent on acquisitions is used to finance diversifying acquisitions, the coefficient estimates in Model 3 imply that a 25% increase in CEO age leads to a rise in the fraction spent on diversifying acquisitions of 18.4% ($=0.236 * 0.25/0.321$). To control for industry-level shocks that may impact acquisition activity (Mitchell and Mulherin, 1996), in Model 2 (4), I estimate the same regression in Model 1 (3) with the inclusion of the interactions of industry and year fixed effects. The results remain very similar to those in Models 1 and 3. In sum, the results in Table 4 provide evidence that one way older (younger) CEOs decrease (increase) firm risk is by making more (fewer) diversifying acquisitions.

Table 4
CEO age and diversifying acquisitions. This table reports second-stage results from Heckman selection models using ExecuComp firms from 1992 to 2010. Financial and utility firms are excluded. First-stage results are reported in Table B1 of Appendix B. The dependent variable in the first stage is an indicator variable set to one if the firm makes an acquisition in a given year. Only acquisitions in which the amount paid for the target is at least 5% of the acquirer's beginning of the fiscal year market value of equity are considered. In Models 1 and 2, the dependent variable in the second stage is *Pct. Diversifying Acquisitions*, which is the ratio of the number of diversifying acquisitions made to the total number of acquisitions made during a fiscal year. An acquisition is considered a diversifying acquisition if the acquirer and the target do not share the same 2-digit SIC industry. In Models 3 and 4, the dependent variable in the second stage is *Pct. Spent on Diversifying Acquisitions*, which is the ratio of the dollar amount spent on diversifying acquisitions to the dollar amount spent on all acquisitions during a fiscal year. All firm variables are measured as of year $t-1$ relative to the acquisition year. *Log CEO Age* is the natural logarithm of the age of the CEO. Industries are defined at the Fama and French 12 industry level. Acquisition related control variables include *Percent All Cash Deals*, *Percent Stock Deals*, *Percent Public Targets*, and *Percent Private Targets*. *Inverse Mills Ratio* is from the first stage of the Heckman selection model. Other control variables include *Log Tenure*, *Log Portfolio Delta*, *Log Portfolio Vega*, *Log Book Assets*, *Market-to-Book*, *R&D Intensity*, *Book Leverage*, *Cash Holdings*, *Stock Return*, and *Log Firm Age*. The definitions of all variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Pct. Diversifying Acquisitions		Pct. Spent on Diversifying Acquisitions	
	(1)	(2)	(3)	(4)
Log CEO Age	0.244***	0.241***	0.236***	0.235***
	(2.86)	(2.65)	(2.75)	(2.58)
Percent All Cash Deals	−0.072****	−0.068***	−0.070***	−0.066***
	(−3.12)	(−2.81)	(−3.02)	(−2.72)
Percent Stock Deals	0.031	0.033	0.032	0.034
	(1.16)	(1.19)	(1.20)	(1.21)
Percent Public Targets	−0.156***	−0.159***	−0.154***	−0.156***
	(−6.66)	(−6.44)	(−6.56)	(−6.30)
Percent Private Targets	0.011	0.014	0.014	0.017
	(0.43)	(0.51)	(0.52)	(0.62)
Inverse Mills Ratio	−3.314***	−3.697***	−3.297***	−3.701***
	(−3.94)	(−3.94)	(−3.92)	(−3.95)
Other Control Variables	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Industry * Year Fixed Effects	No	Yes	No	Yes
Uncensored Observations	2755	2755	2755	2755
Observations	19,705	19,705	19,705	19,705
Adjusted R^2	0.097	0.143	0.096	0.142

4.4. Does the age of the second most influential executive impact CEO risk-taking behavior?

In this section, I investigate whether the risk preferences of the second most influential executive affect the risk-taking behavior of the CEO. Because a CEO does not typically determine corporate policies in isolation but rather makes decisions as a member of a team, the risk preferences of other senior executives could also contribute to the firm's overall risk profile. Besides the CEO, the second most influential executive should have the greatest impact. If executive age also affects risk preferences, then executives in a similar age group as the CEO will reinforce the risk-taking behavior of the CEO. I identify the second most influential executive as the executive (excluding the CEO) with the highest total compensation (*TDC1* in ExecuComp). Executives with greater responsibility and influence are likely to receive greater compensation. This bypasses the problem of ranking executives based on titles such as "President" or "Chief Operating Officer." The problem with using titles is that they do not have a definitive rank order of importance that all firms consistently follow. Moreover, the CEO and other executives often hold multiple titles.

To examine whether the risk-taking behavior of the CEO is reinforced when the second most influential executive is of a similar age, I categorize CEOs and the second most influential executives based on their respective median ages. I then create indicator variables for the four possible combinations of managerial age. I categorize managers based on their median ages to limit the possible combinations to a reasonable number. The median CEO is 55 years old while the median second most influential executive is 51 years old. *Young CEO & Young Executive* is an indicator variable set to one if the CEO is less than or equal to 55 years old and the second most influential executive is less than or equal to 51, and zero otherwise. *Young CEO & Old Executive* is an indicator variable set to one if the CEO is less than or equal to 55 years old and the second most influential executive is greater than 51, and zero otherwise. *Old CEO & Young Executive* is an indicator variable set to one if the CEO is greater than 55 years old and the second most influential executive is less than or equal to 51, and zero otherwise. Finally, *Old CEO & Old Executive* is an indicator variable set to one if the CEO is greater than 55 years old and the second most influential executive is greater than 51, and zero otherwise.

Table 5 reports the results from the regressions of each risk measure on the *Young CEO & Old Executive*, *Old CEO & Young Executive*, and *Old CEO & Old Executive* indicator variables and all previously used control variables. The *Young CEO & Young Executive* indicator variable is excluded from the models. Thus, the coefficients on each of the indicator variables represent incremental effects compared to when both managers are young. The results show that across all the models, the coefficient on the *Old CEO & Old Executive* indicator variable is always statistically significant, and the sign on this variable suggests that when both the CEO and the second most influential executive are both older, firm risk is lower than when both of these individuals are younger. Further, comparing the coefficient estimates on the three age indicator variables across all the models, it is seen that risk-taking behavior is decreasing as one moves from *Young CEO & Old Executive* to *Old CEO & Young Executive* and finally to *Old CEO & Old Executive*. For example, the coefficient estimates in Model 1 imply that compared to firms managed by both a younger CEO and a younger executive, firm stock return volatility is 3.6%, 4.4%, and 6.6% lower for firms managed by both a younger CEO

Table 5
Does the age of the second most influential executive impact CEO risk-taking behavior? This table reports results from OLS regressions relating CEO age and the age of the second most influential executive to firm risk and the riskiness of corporate policies for ExecuComp firms from 1992 to 2010. Financial and utility firms are excluded. The dependent variables in Models 1–7 are the natural logarithm of *Total Risk*, the natural logarithm of *Idiosyncratic Risk*, *R&D Intensity*, *Operating Leverage*, *Book Leverage*, *Segment HHI*, and the natural logarithm of *Number of Segments*, respectively. *Young CEO & Old Executive* is an indicator variable set to one if the CEO is less than or equal to 55 years old and the second most influential executive is greater than 51, and zero otherwise. *Old CEO & Young Executive* is an indicator variable set to one if the CEO is greater than 55 years old and the second most influential executive is less than or equal to 51, and zero otherwise. *Old CEO & Old Executive* is an indicator variable set to one if the CEO is greater than 55 years old and the second most influential executive is greater than 51, and zero otherwise. Industries are defined at the 2-digit SIC level. Control variables include *Log Tenure*, *Log Portfolio Delta*, *Log Portfolio Vega*, *Log Book Assets*, *Market-to-Book*, *Book Leverage*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, and *Log Firm Age*. In Model 5, the control variable *Book Leverage* is replaced with *R&D Intensity*. The definitions of all variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Log Total Risk	Log Idiosyncratic Risk	R&D Intensity	Operating Leverage	Book Leverage	Segment HHI	Log Number of Segments
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Young CEO & Old Executive	−0.036***	−0.038***	0.027	0.142	−0.099	−0.007	0.022
	(−4.69)	(−4.90)	(0.21)	(0.79)	(−0.22)	(−1.01)	(1.36)
Old CEO & Young Executive	−0.044***	−0.042***	−0.328**	−0.058	−0.490	−0.015*	0.038**
	(−5.30)	(−4.90)	(−2.29)	(−0.33)	(−0.95)	(−1.80)	(2.07)
Old CEO & Old Executive	−0.066***	−0.065***	−0.398***	−0.309*	−0.939*	−0.028***	0.064***
	(−7.88)	(−7.59)	(−2.86)	(−1.95)	(−1.75)	(−3.21)	(3.37)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,209	20,209	20,209	17,513	20,209	20,209	20,209
Adjusted R^2	0.623	0.624	0.550	0.009	0.330	0.231	0.232

and an older executive, an older CEO and a younger executive, and an older CEO and an older executive, respectively.[14] Overall, the results in Table 5 are consistent with the proposition that risk-taking behavior is lowest when both the CEO and the second most influential executive are older and highest when both of these managers are younger. The results in Table 5 also suggest that when both managers are older (younger), firm risk is lowest (highest) in part because the CEO decreases (increases) firm risk by implementing less (more) risky investment and financial policies.

4.5. Do less (more) risky firms want older (younger) CEOs to take fewer (more) risks?

The previous results, especially the findings from firm fixed effects and 2SLS regressions, are consistent with CEOs reducing firm risk and the riskiness of corporate policies as they age. In this section, I investigate whether firms appear to want older (younger) CEOs to take fewer (more) risks and in doing so, provide evidence on whether CEO and firm risk preferences are aligned.

4.5.1. CEO age and risk-taking incentives

First, I examine the risk-taking incentives provided to CEOs. If firms want older (younger) CEOs to pursue low (high) risk strategies, then firms will award older (younger) CEOs with fewer (greater) risk-taking incentives. However, if firms do not want older (younger) CEOs to pursue low (high) risk strategies, then firms will award older (younger) CEOs with greater (fewer) risk-taking incentives to raise (lower) the amount of risk that the CEO takes. Following prior research (Chava and Purnanandam, 2010; Coles et al., 2006; Guay, 1999), I use the CEO's portfolio vega, which measures how much the CEO's wealth changes for a one percentage point increase in stock return volatility, to proxy for risk-taking incentives. As a secondary proxy, I also use the vega of options that a firm awards its CEO during a fiscal year.

Table 6 presents the results of this analysis. I follow the empirical strategy outlined in the earlier sections. Specifically, I present results from pooled OLS regressions that include industry and year fixed effects, the interactions of industry and year fixed effects, and firm and year fixed effects. I also report second-stage results from 2SLS regressions.[15] The dependent variable in Models 1–4 is the natural logarithm of one plus the CEO's total portfolio vega. The dependent variable in Models 5–8 is the natural logarithm of one plus the CEO's vega of options granted during the fiscal year. The results show a consistently negative relation between CEO age and risk-taking incentives. The coefficient estimates in Model 1 imply that a 25% increase in CEO age leads to a decrease in portfolio vega of 18.7% ($=0.749 * 0.25$). Similarly, the coefficient estimates in Model 5 imply that a 25% increase in CEO age leads to a decrease in awarded option vega of 23.4% ($=0.935 * 0.25$). In sum, the results in Table 6 provide support for the proposition that less (more) risky firms want older (younger) CEOs to follow lower (higher) risk strategies, suggesting that CEO and firm risk preferences tend to be aligned.

4.5.2. The determinants of successor CEO age

I next examine whether firms appear to consider CEO age in the hiring process to provide further insight on whether firms want older (younger) CEOs to take fewer (more) risks. If less (more) risky firms want older (younger) CEOs to take fewer (more) risks, then less (more) risky firms should hire older (younger) CEOs. To test this prediction, I identify CEO turnovers using ExecuComp firms from 1992 to 2010. Financial and utility firms and turnovers due to mergers or spinoffs are excluded. I require that the incumbent CEO was in office for at least two years before the turnover and that the successor remains in office for at least two years after the turnover, resulting in 1384 turnovers. I then collect the age of the successor CEO and match it to firm characteristics measured at least one year before the date the successor enters office.

I also collect turnover related variables. I define *Outside Successor* as an indicator variable set to one if the successor was an employee of the firm for less than one year before becoming CEO. To identify forced departures, I use LexisNexis to search news articles and determine whether the firm forced the incumbent CEO out of office. Following Parrino (1997), I identify a turnover as forced if: (1) the news article specifically states that the firm forced the CEO out, or (2) the departing CEO is less than 60 years old and the departure is not due to poor health, death, or acceptance of a new position. If none of these criteria are met, I classify the turnover as voluntary. I then define *Forced Turnover* as an indicator variable set to one if a firm forces its CEO out of office and zero otherwise. Of the 1384 turnovers, a firm hires an outsider 455 times (32.9% of all appointments) and forces out the incumbent CEO 317 times (22.9% of all appointments).

[14] Although some of the coefficients on the *Young CEO* & *Old Executive* and *Old CEO* & *Young Executive* indicator variables in Models 3–7 are not significant, the results in these models are still consistent with risk-taking behavior decreasing as one moves from *Young CEO* & *Old Executive* to *Old CEO* & *Young Executive* and finally to *Old CEO* & *Old Executive*. It is also important to note that based on the assumption that CEOs have greater control than the other executive, irrespective of the age of the other executive, younger CEOs will display greater risk-taking behavior than older CEOs. From Table 5 results, one can also see that if the models in this table were rerun so that the *Young CEO* & *Young Executive* indicator variable was included in the models and the *Old CEO* & *Old Executive* indicator variable was excluded from the models, the results would show that risk-taking behavior is increasing as one moves from *Old CEO* & *Young Executive* to *Young CEO* & *Old Executive* and finally to *Young CEO* & *Young Executive*. For example, if this specification was used to rerun the regression in Model 1, the coefficient estimates on the three remaining indicator variables would imply that, compared to firms managed by both an older CEO and an older executive, firm risk is 2.2%, 3.0%, and 6.6% greater for firms managed by both an older CEO and a younger executive, a younger CEO and an older executive, and a younger CEO and a younger executive, respectively.

[15] When vega is the dependent variable in the second-stage regression of the 2SLS approach, I do not include *Log Portfolio Vega* in the first-stage regression. Thus, I obtain first-stage results by regressing *Log CEO Age* on *Log CPI at Birth*, *Log Tenure*, *Log Portfolio Delta*, *Log Book Assets*, *Market-to-Book*, *Book Leverage*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, *Log Firm Age*, year fixed effects, and 2-digit SIC industry fixed effects.

Table 6
CEO age and risk-taking incentives. This table reports results from OLS regressions relating CEO age to risk-taking incentives for ExecuComp firms from 1992 to 2010. Financial and utility firms are excluded. The dependent variable in Models 1–4 is the natural logarithm of one plus *Portfolio Vega*. The dependent variable in Models 5–8 is the natural logarithm of one plus *Awarded Vega*. *Log CEO Age* is the natural logarithm of the age of the CEO. Models 4 and 8 present second-stage results from 2-Stage Least Squares regressions that explain *Log CEO Age*. First-stage results are obtained from regressing *Log CEO Age* on the instrumental variable *Log CPI at Birth* and other control variables. Industries are defined at the 2-digit SIC level. Control variables include *Log Tenure*, *Log Portfolio Delta*, *Log Book Assets*, *Market-to-Book*, *Book Leverage*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, and *Log Firm Age*. The definitions of all variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Log Portfolio Vega				Log Awarded Vega			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log CEO Age	−0.749***	−0.702***	−0.814***	−0.543***	−0.935***	−0.919***	−1.436***	−0.582***
	(−6.57)	(−6.07)	(−7.33)	(−4.12)	(−8.94)	(−8.77)	(−10.78)	(−4.53)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Industry * Year Fixed Effects	No	Yes	No	No	No	Yes	No	No
Firm Fixed Effects	No	No	Yes	No	No	No	Yes	No
2-Stage Least Squares Regressions	No	No	No	Yes	No	No	No	Yes
Observations	20,973	20,973	20,973	20,973	20,973	20,973	20,973	20,973
Adjusted R^2	0.594	0.597	0.425	0.594	0.370	0.368	0.431	0.370

Table 7 presents the results from the analysis of whether proxies for firm risk predict the ages of successor CEOs. The dependent variable in all seven models is the natural logarithm of the age of the successor. Panel A presents results from OLS regressions that include CEO and turnover related control variables, year fixed effects, and industry fixed effects. In addition to

Table 7
The determinants of successor CEO age. This table reports results from OLS regressions relating firm risk measures to the age of the CEO that a firm hires. CEO turnovers are identified using ExecuComp firms from 1992 to 2010. Financial and utility firms and turnovers due to mergers or spinoffs are excluded. I require that the incumbent CEO was in office for at least two years before the turnover event and that the successor remains in office for at least two years after the turnover, resulting in 1384 turnovers. All firm variables are calculated at least one year before the date that the successor enters office. Panel A presents results from models that include a set of control variables related to the incumbent CEO and the turnover. Panel B presents results from models that include the full set of control variables. The dependent variable in Models 1–7 is the natural logarithm of the new CEO's age. The measures for firm risk in Models 1–7 are the natural logarithm of *Total Risk*, the natural logarithm of *Idiosyncratic Risk*, *R&D Intensity*, *Operating Leverage*, *Book Leverage*, *Segment HHI*, and the natural logarithm of *Number of Segments*, respectively. In this table, *Operating Leverage* is defined as the percentage change in operating income for a percentage change in sales and is estimated using quarterly data from year $t-3$ to year $t-1$ relative to the turnover year. The coefficient estimates in all models are multiplied by 100 for readability. Industries are defined at the 2-digit SIC level. CEO and turnover control variables include *Log Prior CEO Age*, *Log Prior CEO Tenure*, *Outside Successor*, and *Forced Turnover*. Other control variables include *Log Book Assets*, *Market-to-Book*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, and *Log Firm Age*. The definitions of all variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: OLS regressions including incumbent CEO and turnover related control variables

	Log Total Risk	Log Idiosyncratic Risk	R&D Intensity	Operating Leverage	Book Leverage	Segment HHI	Log Number of Segments
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Measure of Risk	−4.273***	−4.069***	−0.066	−0.024	0.019	−3.621***	1.643***
	(−4.14)	(−4.10)	(−0.94)	(−0.35)	(0.85)	(−2.90)	(2.93)
CEO and Turnover Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other Control Variables	No	No	No	No	No	No	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1384	1384	1384	1379	1384	1384	1384
Adjusted R^2	0.105	0.105	0.094	0.093	0.094	0.099	0.099

Panel B: OLS regressions including full set of control variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Measure of Risk	−2.590**	−2.477*	0.032	−0.053	−0.046*	−0.549	0.223
	(−1.98)	(−1.93)	(0.37)	(−0.84)	(−1.92)	(−0.42)	(0.38)
CEO and Turnover Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1384	1384	1384	1379	1384	1384	1384
Adjusted R^2	0.128	0.128	0.126	0.125	0.128	0.126	0.125

controlling for the type of turnover by including *Outside Successor* and *Forced Turnover* as regressors, I also control for characteristics related to the incumbent CEO. Specifically, to account for the possibility that firms have a preference for hiring a specific age group irrespective of the firm's risk profile, I also control for the natural logarithm of the prior CEO's age (*Log Prior CEO Age*) and the natural logarithm of the prior CEO's tenure (*Log Prior CEO Tenure*).[16] For example, if firms prefer to have long-tenured CEOs, they may hire younger CEOs who have a longer expected working life. Panel B presents the results from OLS regressions that also include the full set of firm control variables. The coefficient estimates in all models are multiplied by 100 for readability.

The results in Table 7 provide some evidence that less (more) risky firms tend to hire older (younger) CEOs so that CEO and firm risk preferences are aligned.[17] Specifically, the results from Panel A imply that firms with lower (higher) stock return volatility and greater (less) firm diversification tend to hire older (younger) CEOs. The coefficient estimates in Models 1, 2, 6, and 7 of Panel A imply that firms that are 50% less risky than the average firm hire CEOs that are 2.14% (=4.273 * 0.5), 2.03% (=4.069 * 0.5), 1.41% (=3.621 * 0.39), and 0.82% (=1.643 * 0.5) older, respectively.[18] The results in Panel B imply that after including the full set of control variables, only firms with lower (higher) stock return volatility and lower (higher) financial leverage tend to hire older (younger) CEOs.[19]

4.6. Changes in firm risk following CEO turnovers

Although the previous section documents some evidence consistent with less (more) risky firms hiring older (younger) CEOs, it is still likely that because firms are unable to exactly match the firm's risk to the risk preferences of the new CEO, successors alter firm risk to more closely match their own risk preferences. If CEOs adjust corporate policies so that firm risk matches their risk preferences, then when younger (older) CEOs replace older (younger) CEOs, there should be an increase (decrease) in firm risk following the turnover event. This prediction is also consistent with lower (higher) risk firms that want to increase (reduce) their firms' overall risk deliberately hiring younger (older) CEOs with higher (lower) risk preferences.

To test this prediction, I use the same turnover sample discussed in Section 4.5.2. I examine changes in each risk measure from year $t-1$ to year $t+2$ relative to the turnover year, resulting in a sample 1298 turnovers. Table 8 presents the results of this analysis. For this test, I measure changes in operating leverage using operating leverage calculated over the years $t-3$ to $t-1$ and operating leverage calculated over the years t to $t+2$. I calculate differences in ages between successors and incumbent CEOs. It is more common for younger CEOs to replace older CEOs. On average, successors are 9.2 years younger than incumbent CEOs. I group these age differences into terciles and create three indicator variables for each tercile. *Successor is Much Younger* is an indicator variable set to one if successors are 13 to 40 years younger than incumbents and zero otherwise. *Successor is Younger* is an indicator variable set to one if successors are 6 to 12 years younger than incumbents and zero otherwise. *Successor is Older* is an indicator variable set to one if successors are 5 years younger to 23 years older than incumbents and zero otherwise. I exclude the *Successor is Older* indicator variable from the models. Thus, the coefficients on each of the other two indicator variables represent incremental effects compared to when successors are 5 years younger to 23 years older than incumbents.

The results in Table 8 show that relative to when firms hire CEOs that are closer in age or older than incumbents, firm stock return volatility and financial leverage increase when firms hire CEOs that are much younger than incumbents. The coefficient estimates in Models 1 and 2 imply that relative to when firms hire CEOs that are closer in age or older than incumbents, when firms hire CEOs that are much younger than incumbents, total stock return volatility and idiosyncratic return volatility increase by 7.1% and 6.4%, respectively. In addition, given that the sample mean of book leverage is 21.82%, the coefficient estimates in Model 5 imply that when firms hire CEOs that are much younger than incumbents, book leverage increases by 10.5% (=2.298/21.82) relative to when firms hire CEOs that are closer in age or older than incumbents. Collectively, the results in Table 8 are consistent with successor CEOs adjusting firm risk to match their own risk preferences.

4.7. Successor CEO age and stock price reactions to CEO succession announcements

In this section, I examine how differences in ages between successor CEOs and incumbent CEOs impact investors' responses to CEO succession announcements to provide insight on whether markets incorporate the effect of CEO age on firm risk into stock prices. If it is optimal for low (high) risk firms to hire older (younger) CEOs so that the CEO's risk-preferences match those of the firm, then investors should respond negatively if the firm deviates from this optimal CEO-firm matching strategy. Specifically, if a low (high) risk firm hires a CEO that is younger (older) than the incumbent, then I should observe negative cumulative abnormal stock returns to the announcement of the appointment of such a successor.

To test this prediction, I use the same turnover sample discussed in Section 4.5.2. I collect CEO succession announcement dates (the date when the identity of the successor CEO is revealed) from press reports using LexisNexis and calculate cumulative abnormal

[16] I tabulate additional summary statistics for variables used in CEO turnover regressions and acquisition regressions in the Online Appendix.

[17] It is important to point out that Table 7 results only provide evidence on whether firms tend to consider CEO age at the time of a CEO's hiring, but they do not rule out the interpretation that CEO age itself affects firm risk.

[18] To calculate the economic significance of the coefficient estimate on *Segment HHI* in Model 6, I compute a 50% decrease in *Segment HHI* from its sample mean. Given that the sample mean of *Segment HHI* is 0.78, a 50% decrease implies a decline in *Segment HHI* of 0.39 (=0.78 * 0.5).

[19] Interestingly, the untabulated coefficient on *Log Prior CEO Age* in Model 1 of Panel A is 0.113 (p-value = 0.001), suggesting that firms have a tendency to hire CEOs of a similar age as the departing CEO. Further, the untabulated coefficient on *Log Prior CEO Tenure* in Model 1 of Panel A is −0.016 (p-value = 0.008), implying that firms that previously had a long-tenured CEO hire younger CEOs who can potentially work for a longer period of time. The coefficient estimates on these variables are similar across the models in Table 7.

Table 8
Changes in firm risk following CEO turnovers. This table reports results from OLS regressions relating age differences between successor CEOs and incumbent CEOs to changes in firm risk and the riskiness of corporate policies following a CEO turnover. CEO turnovers are identified using ExecuComp firms from 1992 to 2010. Financial and utility firms and turnovers due to mergers or spinoffs are excluded. I require that the incumbent CEO was in office for at least two years before the turnover and that the successor remains in office for at least two years after the turnover. The dependent variables in Models 1–7 are the change in the natural logarithm of *Total Risk*, change in the natural logarithm of *Idiosyncratic Risk*, change in *R&D Intensity*, change in *Operating Leverage*, change in *Book Leverage*, change in *Segment HHI*, and change in the natural logarithm of *Number of Segments*, respectively. Changes are calculated as the change in each risk measure from year $t-1$ to year $t+2$ relative to the turnover year. The change in *Operating Leverage* is measured using *Operating Leverage* calculated over the years $t-3$ to $t-1$ and *Operating Leverage* calculated over the years t to $t+2$. I calculate differences in ages between successor CEOs and incumbent CEOs. These age differences are grouped into terciles. *Successor is Much Younger* is an indicator variable set to one when the age difference is in the first tercile and zero otherwise. In the first tercile, successors are 13 to 40 years younger than incumbents. *Successor is Younger* is an indicator variable set to one when the age difference is in the second tercile and zero otherwise. In the second tercile, successors are 6 to 12 years younger than incumbents. In the last and excluded tercile, successors are 5 years younger to 23 years older than incumbents. Industries are defined at the 2-digit SIC level. Control variables include *Log Prior CEO Tenure*, *Outside Successor*, *Forced Turnover*, *Log Book Assets*, *Market-to-Book*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, and *Log Firm Age*. The definitions of all other variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Change in Log Total Risk	Change in Log Idiosyncratic Risk	Change in R&D Intensity	Change in Operating Leverage	Change in Book Leverage	Change in Segment HHI	Change in Log Number of Segments
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Successor is Younger	0.053**	0.045*	0.038	−0.120	1.562*	−0.005	0.009
	(2.16)	(1.81)	(0.23)	(−0.11)	(1.71)	(−0.39)	(0.30)
Successor is Much Younger	0.071***	0.064***	0.115	0.512	2.298**	0.010	−0.039
	(2.95)	(2.63)	(0.61)	(0.41)	(2.50)	(0.74)	(−1.22)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1298	1298	1298	1294	1298	1298	1298
Adjusted R^2	0.518	0.482	0.169	−0.016	0.095	0.032	0.044

returns (CARs) over the event window $(-1, +1)$, in which $t = 0$ is the announcement date. I calculate abnormal returns from a market model using the CRSP equally-weighted market returns, where parameters are estimated over the window $(-280, -61)$ relative to the announcement date. I require firms have 180 trading days of available return data over the estimation window. I then match each succession to firm characteristics in the fiscal year before the succession announcement date. This step leaves 1370 succession announcements remaining. Lastly, I partition the sample each year into samples with above and below median values of a particular risk measure to examine market responses conditional on the level of firm risk.

Table 9 presents the results of this analysis for the samples of firms with below median risk measures. The results show that when low risk firms, as measured by lower stock return volatility and greater firm diversification, hire CEOs that are younger than incumbents, the market reacts negatively. The coefficient estimates in Models 1, 2, 6, and 7 imply that when a firm with below median

Table 9
Successor CEO age and abnormal stock returns to successor CEO announcements. This table reports results from OLS regressions relating stock price reactions to the announcement of a successor CEO appointment for firms with below median risk measures. CEO turnovers are identified using ExecuComp firms from 1992 to 2010. Financial and utility firms and turnovers due to mergers or spinoffs are excluded. I require that the incumbent CEO was in office for at least two years before the turnover and that the successor remains in office for at least two years after the turnover. The dependent variable in Models 1–7 is *CAR* $(-1,+1)$. *CAR* $(-1,+1)$ is defined as cumulative abnormal returns in percentages calculated over the event window $(-1,+1)$, in which $t = 0$ is the announcement date. Abnormal returns are calculated from a market model using CRSP equally-weighted market returns. The parameters for the market model are estimated over the window $(-280, -61)$ relative to the announcement date. Risk measures are split based on whether a particular risk measure is above or below the sample median in a given year. *New CEO is Younger* is an indicator variable set to one if the successor CEO is younger than the incumbent CEO and zero otherwise. Industries are defined at the 2-digit SIC level. Control variables include *Log Prior CEO Tenure*, *Outside Successor*, *Forced Turnover*, *Log Book Assets*, *Market-to-Book*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, and *Log Firm Age*. The definitions of all other variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	CAR $(-1,+1)$						
	Below Median Total Risk	Below Median Idiosyncratic Risk	Below Median R&D Intensity	Below Median Operating Leverage	Below Median Book Leverage	Below Median Segment HHI	Above Median Number of Segments
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
New CEO is Younger	−1.957***	−1.618**	−0.824	−0.701	0.042	−1.737**	−1.685**
	(−2.65)	(−2.19)	(−0.81)	(−0.82)	(0.05)	(−2.10)	(−2.38)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	680	680	550	680	676	662	842
Adjusted R^2	0.032	0.005	0.055	0.027	−0.028	0.027	0.055

risk hires a CEO that is younger than the incumbent, the firm experiences −1.96%, −1.62%, −1.74%, and −1.69% three-day CARs to succession announcements, respectively.

For the samples of firms with above median risk measures, there is no significant market reaction when these high risk firms hire a CEO that is older than the incumbent. I do not tabulate these results to conserve space. This finding could imply that investors only recognize the effect of CEO age on risk when firm risk is low. When risk is high, there may be more important CEO characteristics that the market considers when assessing the impact that CEOs will have on firm value. In sum, the results in Table 9 provide some evidence that market participants incorporate the effect of CEO age on firm risk into stock prices.

4.8. CEO age and portfolio returns

The results in the previous section provide some evidence that market participants incorporate the effect of CEO age on risk-taking into stock prices. However, for most risk measures, the market does not respond to differences in ages between successors and incumbent CEOs. Further, it is unclear whether market participants correctly incorporate the effect of CEO age on risk-taking into stock prices. In this section, I examine whether CEO age matters for firm performance and whether market participants fully incorporate this information into stock prices. Assuming that stock returns are increasing in firm risk (French et al., 1987), if the market overestimates (underestimates) the risk that older (younger) CEOs will take, then the future stock returns of firms managed by older CEOs will be lower than the future stock returns of firms led by younger CEOs. I test this prediction by comparing long-run abnormal stock returns of portfolios grouped by CEO age. For this analysis, I use all ExecuComp firms (excluding financials and utilities) over the 1992 to 2010 period that report the age of their CEOs.[20]

Table 10 presents the results of this analysis. I create five CEO age portfolios by ranking CEOs into quintiles based on their ages. The age cutoffs for these five portfolios are ages less than or equal to 49, 50–53, 54–57, 58–61, and ages greater than or equal to 62. I calculate monthly portfolio returns using both equally-weighted and value-weighted monthly returns of all firms in each age quintile. For the value-weighted portfolio returns, I calculate monthly firm weights based on the firm's market value of equity at the beginning of the month. Monthly portfolio returns are in excess of the one-month Treasury bill rate. In Panels A and B, I examine abnormal portfolio returns using the three-factor model of Fama and French (1993) and the four-factor model of Carhart (1997), respectively. Panel A presents the results from regressions of monthly portfolio returns on *Market Return*, *SMB Return*, and *HML Return*, and Panel B present the results from the same regressions with *Momentum* included as an additional regressor. *Market Return* is the CRSP value-weighted market return less the risk-free rate. *SMB Return*, *HML Return*, and *Momentum* are the returns to zero-investment long-short portfolios formed from small cap stocks minus large cap stocks, high book-to-market stocks minus low book-to-market stocks, and high momentum stocks minus low momentum stocks, respectively. *Alpha* is the abnormal return in excess of passive investment in these factors. For the difference portfolio, I construct a long portfolio that consists of monthly returns of all firms that have CEOs in the youngest age group. I then construct a short portfolio that consists of monthly returns of all firms that have CEOs in the oldest age group. Each month, I subtract the return on the short portfolio from the return on the long portfolio.

The results show that in three out of the four difference portfolios, those consisting of firms managed by younger CEOs earn significantly higher risk-adjusted stock returns compared to portfolios consisting of firms led by older CEOs. Following this strategy and estimating equally-weighted portfolio returns using the three-factor model, I find evidence that suggests an investor would have earned an abnormal return of 43.8 basis points per month. Estimating value-weighted portfolio returns and using the three-factor model, I find that an investor would have earned an abnormal return of 34.5 basis points per month.[21] The results also show that in all four of the difference portfolios, those formed for the youngest age group have significantly higher market betas than portfolios formed for the oldest age group. This finding is consistent with risk-taking behavior decreasing as CEOs become older. In summary, although the results using value-weighted portfolio returns are weaker than those using equally-weighted portfolio returns, Table 10 results collectively suggest that firms managed by

[20] By not requiring a firm to have available data for the control variables used in the main empirical tests, the size of the sample used for this test increases from 20,973 to 24,102 CEO-firm years. I relax the data requirements to limit the potential concern that some of the previously used data restrictions potentially drop observations when a firm has very poor performance.

[21] Admittedly, the alphas across the five age portfolios using equally-weighted portfolio returns and the four-factor model are somewhat large. In particular, the alphas are significant at the 1% level in four out of five models and range from 25.5 to 82.3 basis points per month. To examine whether these results are potentially driven by the recent financial crisis, I rerun the portfolio regressions over the January 1992 to December 2006 period. The alphas over this period are significant at the 1% level in three out of five models and range from 8.5 to 84.2 basis points per month. Thus, dropping the financial crisis period only slightly weakens the equally-weighted portfolio return results. It may also be possible that the dot-com bubble in the later part of the 1990s could be affecting the results. Since riskier high-tech firms tend to be run by younger CEOs, sorting portfolios by CEO age could cause problems during the dot-com bubble because firms managed by younger CEOs could be more likely to have experienced large price run-ups. To investigate this possibility, I split the portfolio regressions into two equal sub-periods: (1) January 1992 to June 2001 and (2) July 2001 to December 2010. The alphas are significant at the 1% level in three out of five models and range from 3.0 to 106.9 basis points per month over the January 1992 to June 2001 period and are significant at the 1% level in all five models and range from 42.8 to 52.3 basis points per month over the July 2001 to December 2010 period. Overall, it does not appear that recent financial crisis or the dot-com bubble explain the large alphas for the equally-weighted portfolio returns.

Table 10
CEO age and portfolio returns. This table reports results from monthly three-factor and four-factor portfolio regressions for portfolios grouped by CEO age. CEOs are grouped into quintiles based on their ages. The age cutoffs for these five portfolios are ages less than or equal to 49, 50–53, 54–57, 58–61, and ages greater than or equal to 62. Panel A presents the results from three-factor portfolio regressions using both equally-weighted and value-weighted monthly portfolio returns of all firms in each age quintile. Panel B presents the results from four-factor portfolio regressions using both equally-weighted and value-weighted monthly portfolio returns of all firms in each age quintile. Returns are in percentages. *Alpha* is the abnormal return in excess of passive investment in the factors. *Market Return* is the CRSP value-weighted market return minus the risk-free rate. *SMB Return*, *HML Return*, and *Momentum* are the returns to zero-investment long-short portfolios formed from small cap stocks minus large cap stocks, high book-to-market stocks minus low book-to-market stocks, and high momentum stocks minus low momentum stocks, respectively. Standard errors are corrected for heteroskedasticity (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Fama and French three-factor regressions

	Equally-weighted monthly portfolio returns						Value-weighted monthly portfolio returns					
	Young	2	3	4	Old	Young–old	Young	2	3	4	Old	Young–old
Alpha	0.668***	0.386***	0.308**	0.083	0.230*	0.438***	0.512***	0.053	0.1985*	0.081	0.167*	0.345*
	(5.06)	(3.08)	(2.46)	(0.59)	(1.87)	(3.71)	(3.15)	(0.47)	(1.88)	(0.68)	(1.81)	(1.83)
Market Return	1.240***	1.128***	1.146***	1.154***	1.084***	0.155***	1.145***	1.046***	0.909***	0.877***	0.951***	0.194***
	(31.55)	(30.24)	(28.75)	(25.81)	(28.03)	(6.20)	(30.49)	(36.94)	(36.67)	(32.74)	(43.56)	(4.31)
SMB Return	0.697***	0.664***	0.519***	0.498***	0.504***	0.193***	0.114**	0.142***	0.001	−0.084	−0.148***	0.261***
	(10.85)	(9.15)	(8.11)	(5.95)	(6.82)	(4.62)	(2.03)	(3.61)	(0.03)	(−1.32)	(−3.98)	(4.20)
HML Return	−0.030	0.351***	0.300***	0.473***	0.476***	−0.505***	−0.543***	−0.023	−0.171***	0.085	0.029	−0.572***
	(−0.52)	(5.32)	(4.34)	(6.71)	(7.88)	(−13.68)	(−8.87)	(−0.53)	(−3.66)	(1.63)	(0.83)	(−7.48)
Adjusted R^2	0.914	0.897	0.883	0.861	0.892	0.642	0.867	0.883	0.887	0.795	0.895	0.510

Panel B: Carhart four-factor regressions

	Young	2	3	4	Old	Young–old	Young	2	3	4	Old	Young–old
Alpha	0.823***	0.558***	0.458***	0.255**	0.387***	0.436***	0.485***	0.077	0.156	0.092	0.192*	0.294
	(6.76)	(5.26)	(4.13)	(1.99)	(3.55)	(3.64)	(2.94)	(0.67)	(1.62)	(0.77)	(1.94)	(1.56)
Market Return	1.162***	1.0428***	1.071***	1.069***	1.006***	0.156***	1.158***	1.034***	0.923***	0.872***	0.939***	0.220***
	(35.98)	(33.72)	(33.49)	(31.57)	(31.06)	(5.71)	(28.28)	(33.69)	(35.46)	(29.62)	(37.83)	(4.58)
SMB Return	0.724***	0.694***	0.545***	0.528***	0.532***	0.192***	0.109*	0.147***	−0.004	−0.082	−0.143***	0.252***
	(13.78)	(12.08)	(10.31)	(8.07)	(9.14)	(4.56)	(1.88)	(3.62)	(−0.07)	(−1.31)	(−3.96)	(4.07)
HML Return	−0.87*	0.288***	0.245***	0.409***	0.418***	−0.505***	−0.533***	−0.032	−0.160***	0.081	0.020	−0.553***
	(−1.87)	(5.66)	(4.01)	(7.75)	(8.86)	(−13.91)	(−8.76)	(−0.71)	(−3.51)	(1.62)	(0.56)	(−7.53)
Momentum	−0.190***	−0.210***	−0.183***	−0.210***	−0.192***	0.002	0.033	−0.030	0.035*	−0.014	−0.031	0.063
	(−6.54)	(−8.57)	(−6.30)	(−6.48)	(−6.89)	(0.07)	(0.76)	(−1.03)	(1.73)	(−0.58)	(−0.99)	(1.42)
Adjusted R^2	0.933	0.928	0.908	0.894	0.923	0.641	0.867	0.884	0.888	0.794	0.896	0.515

older CEOs underperform firms headed by younger CEOs and that investors do not fully incorporate the effect of CEO age on risk-taking into stock prices.

5. Robustness tests

5.1. Alternative measure of CEO age

In addition to using the natural logarithm of CEO age in multivariate regressions in Tables 2, 3, 4, and 6, I also examine the robustness of these findings to using a discrete measure of CEO age. For the discrete measure, I rank CEO age into terciles with the top tercile representing the oldest CEOs. For these tests, I do not run 2SLS regressions. Collectively, the results are similar to my previous findings in that firms managed by the oldest CEOs have lower stock return volatility, invest less in R&D, maintain lower operating leverage, make more diversifying acquisitions, are more diversified across business segments, and award their CEOs fewer risk-taking incentives.

5.2. Propensity score matched sample analysis

As shown in Panel B of Table 1, there are substantial differences between firms managed by older CEOs and those headed by younger CEOs. If the linear controls used throughout the models do not adequately account for differences between firms with older CEOs and firms with younger CEOs, then CEO age could be picking up nonlinear firm characteristics on the measures of firm risk. Ideally, older CEOs and younger CEOs would be assigned to the exact same firm and differ only on CEO age so that differences in firm risk can be attributed to differences in CEO age.

An empirical approach to address the concern that differences in observable characteristics of firms managed by older versus younger CEOs are driving the finding that risk-taking behavior decreases as CEOs age is to create a propensity score matched sample (Dehejia and Wahba, 2002; Rosenbaum and Rubin, 1983). The procedure works as follows. I first eliminate observations from the main sample in which the CEO is in the middle age tercile, resulting in 14,268 remaining firm-years. Second, using a Probit model, I regress *Older CEO* on the previously used control variables and estimate the probability (i.e., the propensity score) that a firm is managed by a CEO in the oldest age tercile.[22] Third, each observation in which the CEO is in the oldest age tercile is matched to an observation in which the CEO is in the youngest age tercile and has the closest propensity score. I match without replacement and require the propensity scores for each matched pair be within ±5% of each other.[23] The resulting sample consists of 2235 firm-years when a CEO is in the oldest age tercile matched to 2235 firm-years when a CEO is in the youngest age tercile.

Panel A of Table 11 reports univariate results of the relation between CEO age and risk-taking behavior, and Panel B presents multivariate findings. Both univariate and multivariate results show that firms managed by older CEOs have lower stock return volatility, invest less in R&D, maintain lower operating leverage, and are more diversified across business segments. In addition, the only firm characteristic that is moderately different between firms managed by older CEOs and those led by younger CEOs is *Market-to-Book*, which confirms the success of the matching process. In sum, after using this propensity score matched sample to correct for any endogenous selection on observed variables, the results in Table 11 continue to imply that risk-taking behavior decreases as CEOs age.

5.3. Are the results driven by the horizon problem?

The horizon problem arises when managers near retirement sacrifice investment in long-term projects that are good for the firm's long-term performance in exchange for short-term projects that temporarily improve short-term performance (Antia et al., 2010; Cheng, 2004; Dechow and Sloan, 1991; Smith and Watts, 1982). The typical methods that CEOs use to temporarily inflate short-term performance are reducing R&D expenses and managing accruals. The horizon problem relates to this study in that the finding that older CEOs invest less in R&D to reduce firm risk could be explained away if the result is driven by older CEOs near retirement decreasing R&D expenditures to improve short-term performance rather than to reduce risk.

To account for the horizon problem, I rerun all the regressions in the study including an additional regressor that is either an indicator variable set to one if CEOs are in their last year in office, an indicator variable set to one if CEOs are in their last two years in office, or an indicator variable set to one if CEOs are in their last three years in office. All of the study's results are robust to these controls, suggesting that the horizon problem does not drive the finding that risk-taking behavior decreases as CEOs age.

[22] Control variables include *Log Tenure*, *Log Portfolio Delta*, *Log Portfolio Vega*, *Log Book Assets*, *Market-to-Book*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, *Log Firm Age*, year indicator variables, and 2-digit SIC industry indicator variables.

[23] I use the ±5.0% cutoff point so that matched firms are very similar. The results are robust to using a ±2.5%, ±10.0%, or ±25.0% cutoff point.

Table 11
Propensity score matched sample analysis of CEO age and the riskiness of corporate policies. This table reports results from a propensity score matched sample relating CEO age to firm risk and the riskiness of corporate policies for ExecuComp firms from 1992 to 2010. Financial and utility firms are excluded. Panel A presents univariate results. The ages of CEOs are determined and grouped into terciles. *Younger CEO* is the group of CEOs in the youngest age tercile. *Older CEO* is the group of CEOs in the oldest age tercile. Panel B presents multivariate results. In Panel A, I test for significant differences in means between the oldest age tercile and the youngest age tercile using a t-test. The results of the test are reported next to the mean values for the oldest age tercile. The dependent variables in Models 1–7 in Panel B are the natural logarithm of *Total Risk*, the natural logarithm of *Idiosyncratic Risk*, *R&D Intensity*, *Operating Leverage*, *Book Leverage*, *Segment HHI*, and the natural logarithm of *Number of Segments*, respectively. Industries are defined at the 2-digit SIC level. Control variables include *Log Tenure*, *Log Portfolio Delta*, *Log Portfolio Vega*, *Log Book Assets*, *Market-to-Book*, *Book Leverage*, *Return on Assets*, *Cash Holdings*, *Sales Growth*, *Blockholder*, *Stock Return*, and *Log Firm Age*. In Model 5, the control variable *Book Leverage* is replaced with *R&D Intensity*. The definitions of all variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Univariate results

	Older CEO		Younger CEO	
	Obs.	Mean	Obs.	Mean
Measures of risk				
Total Risk	2235	45.19***	2235	48.20
Idiosyncratic Risk	2235	39.46***	2235	42.19
R&D Intensity	2235	3.26***	2235	3.82
Operating Leverage	2235	1.80*	2235	2.21
Book Leverage	2235	21.53	2235	21.13
Segment HHI	2235	0.78***	2235	0.81
Number Segments	2235	2.01***	2235	1.89

Panel B: Multivariate results

	Log Total Risk	Log Idiosyncratic Risk	R&D Intensity	Operating Leverage	Book Leverage	Segment HHI	Log Number of Segments
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Older CEO	−0.056***	−0.053***	−0.405**	−0.467**	−0.016	−0.021**	0.041*
	(−5.04)	(−4.75)	(−2.17)	(−2.06)	(−0.02)	(−2.00)	(1.78)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4470	4470	4470	4470	4470	4470	4470
Adjusted R^2	0.606	0.599	0.567	0.010	0.311	0.212	0.223

6. Conclusion

In this paper, I provide evidence on whether a CEO's age impacts his/her risk-taking behavior. Consistent with the theoretical prediction that risk-taking behavior decreases as CEOs age, I find that CEO age is negatively related to firm stock return volatility. Next, I examine the channels through which CEOs can influence firm risk. Consistent with older (younger) CEOs reducing (increasing) firm risk through less (more) risky investment policies, I find that older CEOs invest less in R&D, manage firms with more diversified operations, make more diversifying acquisitions, and maintain lower operating leverage.

I also show that total firm risk and the riskiness of both investment and financial policies are lowest when both the CEO and the next most influential executive are older and highest when both of these managers are younger. These results are consistent with the explanation that when the risk preferences of other senior executives are similar to those of the CEO, other executives reinforce and support the CEO's risk-taking behavior.

Further, I find some evidence suggesting that firms appear to want older (younger) CEOs to take fewer (more) risks, which implies that CEO and firm risk preferences are aligned. Specifically, I document that firms award older (younger) CEOs less (more) risk-taking incentives and that less (more) risky firms tend to hire older (younger) CEOs. Lastly, I find that portfolios of firms managed by older CEOs earn lower risk-adjusted stock returns than portfolios of firms led by younger CEOs, suggesting that firms run by older CEOs underperform firms managed by younger CEOs. Overall, the results in this paper imply that risk-taking behavior decreases as CEOs age, lower risk is accomplished through more conservative investment policies, and CEO and firm risk preferences appear in most cases aligned.

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Appendix A. Variable definitions

Awarded Vega	The vega of awarded options during a fiscal year, where vega is the dollar increase in option-wealth (in thousands) for a one percentage point increase in stock return volatility.
Blockholder	An indicator variable set to one if the firm has an institutional investor that owns at least 10% of the firm's outstanding shares and zero otherwise.
Book Assets	The book value of assets (in millions).
Book Leverage	The book value of long-term debt plus the debt in current liabilities divided by book value of assets.
Cash Holdings	The book value of cash and short-term investments divided by book value of assets.
CEO Age	The age of the current CEO.
Firm Age	The number of years that a firm has had data available in Compustat.
Forced Turnover	An indicator variable set to one if a firm forces its CEO out of office and zero otherwise.
Idiosyncratic Risk	The annualized standard deviation of the residuals from the regression of daily stock returns on the Fama and French three factors estimated over the fiscal year.
Market-to-Book	The market value of the firm divided by book value of assets.
Number of Segments	The number of business segments in which the firm operates.
Operating Leverage	The percentage change in operating income for a percentage change in sales and is estimated using quarterly data from year t to year $t + 2$.
Outside Successor	An indicator variable set to one if a firm replaces its CEO with an individual that has worked for the firm for one year or less and zero otherwise.
Pct. Diversifying Acquisitions	The ratio of the number of diversifying acquisitions made to the total number of acquisitions made during a fiscal year.
Pct. Spent on Diversifying Acquisitions	The ratio of the dollar amount spent on diversifying acquisitions to the dollar amount spent on all acquisitions during a fiscal year.
Percent All Cash Deals	The fraction of acquisitions during a fiscal year that are financed entirely with cash.
Percent Private Targets	The fraction of acquisitions during a fiscal year in which the target is a private firm.
Percent Public Targets	The fraction of acquisitions during a fiscal year in which the target is a publicly traded firm.
Percent Stock Deals	The fraction of acquisitions during a fiscal year that are at least partially financed with stock.
Portfolio Delta	The CEO's total portfolio delta, where portfolio delta is the dollar increase in wealth (in thousands) for a 1% increase in stock price.
Portfolio Vega	The CEO's total portfolio vega, where vega is the dollar increase in option-wealth (in thousands) for a one percentage point increase in stock return volatility.
Prior CEO Age	The age of the departing (incumbent) CEO.
Prior CEO Tenure	The number of years that the prior CEO was CEO of the firm.
R&D Intensity	Firm R&D expenses divided by book value of assets.
Return on Assets	Income before extraordinary items divided by book value of assets.
Sales Growth	The percentage increase in sales from year $t - 1$ to year t.
Segment HHI	The business segment sales-based Herfindahl–Hirschman Index calculated by summing the squares of the ratios of individual segment sales to the firm's total sales.
Stock Return	The firm's annual stock return during the fiscal year.
Tenure	The number of years that the CEO has been CEO of the firm.
Total Risk	The annualized standard deviation of daily stock returns during the fiscal year.

Appendix B. Table B1: CEO age and diversifying acquisitions

This table reports first-stage results from Heckman selection models using ExecuComp firms from 1992 to 2010. Financial and utility firms are excluded. Second-stage results are reported in Table 4. The dependent variable in the first stage is an indicator variable set to one if the firm makes an acquisition in a given year. Only acquisitions in which the amount paid for the target is at least 5% of the acquirer's beginning of the fiscal year market value of equity are considered. Model 1 is the selection equation corresponding to Models 1 and 3 of Table 4. Model 2 is the selection equation corresponding to Models 2 and 4 of Table 4. The coefficient estimates in all models are multiplied by 100 for readability. All firm variables are measured as of year $t - 1$ relative to the acquisition year. *Log CEO Age* is the natural logarithm of the age of the CEO. *Industry Acquisition Expenditures* is the mean of Compustat reported acquisition related expenses divided by book value of assets for firms in the same 2-digit SIC industry. *Return on Assets* is income before extraordinary items divided by book value of assets. *Property, Plant, and Equipment* is net property, plant, and equipment divided by book value of assets. Industries are defined at the Fama and French 12 industry level. The definitions of all other variables are provided in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles and expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the CEO-firm level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Firm makes an acquisition	
	(1)	(2)
Log CEO Age	−7.829***	−7.766***
	(−3.31)	(−3.27)
Log Tenure	−0.191	−0.161
	(−0.46)	(−0.39)
Log Portfolio Delta	0.476	0.454

(continued on next page)

Appendix B (*continued*)

	Firm makes an acquisition	
	(1)	(2)
	(1.44)	(1.36)
Log Portfolio Vega	0.119	0.170
	(0.40)	(0.57)
Log Book Assets	0.444	0.427
	(1.52)	(1.45)
Market-to-Book	−1.372***	−1.419***
	(−5.33)	(−5.46)
R&D Intensity	−0.303***	−0.275***
	(−4.64)	(−4.17)
Book Leverage	0.000	0.004
	(0.01)	(0.25)
Cash Holdings	0.073***	0.066***
	(3.03)	(2.72)
Stock Return	0.020***	0.020***
	(4.29)	(4.16)
Log Firm Age	−2.040***	−2.119***
	(−4.08)	(−4.23)
Industry Acquisition Expenditures	0.185***	0.194**
	(3.43)	(2.48)
Return on Assets	0.100***	0.107***
	(4.64)	(4.87)
Property, Plant, and Equipment	−0.084***	−0.089***
	(−5.27)	(−5.50)
Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Industry * Year Fixed Effects	No	Yes
Observations	19,705	19,705
Adjusted R^2	0.024	0.026

Appendix C. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jcorpfin.2013.12.013.

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