Managerial Incentives to Increase Risk Provided by Debt,Stock, and Options

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Abstract

- We measure a manager's risk-taking incentives as the total sensitivity of the manager's debt, stock, and option holdings to firm volatility.

- We compare this measure with the option vega and with the relative measures used by the prior literature. Vega does not capture risk-taking incentives from managers' stock and debt holdings and does not reflect the fact that employee options are warrants. The relative measures do not incorporate the sensitivity of options to volatility.

- Our new measure explains risk choices better than vega and the relative measures and should be useful for future research on managers'risk choices.

1.1 Key indicators

Agency problem: CEO, Shareholder , Debt holders

⇩

Salary structure: Debt,Stock, and Options

⇩

Risk choices: Stock Volatility, Diversification…

$$Vega = \frac{\partial V}{\partial \sigma}$$

(Guay1999，Coles2006)

1.1 Key indicators

Jensen and Meckling (1976) : $\frac{\text{risk-reducing incentives}}{\text{risk-increasing incentives}}$

Relative Leverage Ratio = $\frac{\beta}{EquityValue_{Mgr}/EquityValue_{Firm}}$,

Sundaram and Yermack (2007)

Relative Incentive Ratio = $\frac{\beta}{Delta_{Mgr}/Delta_{Firm}}$,

Wei and Yermack (2011)

The sensitivity of the CEO’s stock and option portfolio to a 1% increase in stock price (the “delta”)

Relative Sensitivity Ratio = $\frac{-CEO\ Debt\ Sensitivity}{CEO\ Stock\ Sensitivity + CEO\ Option\ Sensitivity}$.

1.1 Key indicators

The total sensitivity=the debt sensitivities + the stock sensitivities + the option sensitivities

The debt sensitivities = $D' - D$

The option sensitivities = $M(W' - W)$

The stock sensitivities = $N(P' - P)$

Financing sensitivity： sum the values of the changes in debt, stock, and options and assume that the CEO does not sell stock or exercise options. (Book Leverage) (Lewellen's 2006)

1.2 Logical framework

公司敏感性 → CEO敏感性 → 样本和变量的描述性统计 → 敏感性与公司风险选择的相关性 → 稳健性检验

2. Definition of Incentive Measures

2.1. Sensitivity of Firm Capital Structure to Firm Volatility

$$V = Debt + Stock + Options = D + NP + MW. \quad (1)$$

$$V = D + NP. \quad (2)$$

$$-\frac{\partial D}{\partial \sigma_v} = N\frac{\partial P}{\partial \sigma_v}. \quad (4)$$

$$V = NP + MW. \quad (5)$$

$$-\frac{\partial P}{\partial \sigma_v} = \frac{M}{N}\frac{\partial W}{\partial \sigma_v}. \quad (6)$$

$$-\frac{\partial D}{\partial \sigma_v} = N\frac{\partial P}{\partial \sigma_v} + M\frac{\partial W}{\partial \sigma_v}. \quad (7)$$

2.1.1. Estimating Firm Sensitivities.

Table 1. Examples of Firm and CEO Sensitivities

Panel A: Example Firm—Sensitivity of debt, stock, and options to firm volatility ($ thousands)

Leverage (%) (1)	*Debt Sensitivity* ($) (2)	*Stock Sensitivity* ($) (3)	*Option Sensitivity* ($) (4)	*Equity Sensitivity* ($) (5)
0.01	0	(209)	209	0
4	0	(222)	222	0
14	(15)	(246)	260	15
25	(237)	(75)	313	237
50	(2,709)	2,237	472	2,709

Leverage (%) (1)	*Debt Sensitivity/ Debt Value* (%) (2)	*Stock Sensitivity/ Stock Value* (%) (3)	*Option Sensitivity/ Option Value* (%) (4)	*Equity Sensitivity/ Equity Value* (%) (5)
0.01	0.00	−0.01	0.44	0.00
4	0.00	−0.02	0.45	0.00
14	-0.01	−0.02	0.49	0.00
25	-0.05	−0.01	0.54	0.02
50	-0.20	0.16	0.64	0.18

2.2. Managers'Incentives from the Sensitivity of Firm Capital Structure to Firm Volatility

2.2.1. Total Incentives to Increase Firm Volatility.

$$\gamma M \frac{\partial W}{\partial \sigma_v} + \alpha N \frac{\partial P}{\partial \sigma_v} + \beta \frac{\partial D}{\partial \sigma_v}. \tag{8}$$

$$p\left(M \frac{\partial W}{\partial \sigma_v} + N \frac{\partial P}{\partial \sigma_v} + \frac{\partial D}{\partial \sigma_v}\right) = 0. \tag{9}$$

2.2.2. Vega Incentives to Increase Stock Volatility.

$$\gamma M \frac{\partial O}{\partial \sigma_s}. \tag{10}$$

2.2.3. Relative Incentives to Increase Volatility.

Jensenand Meckling (1976) suggest a scaled measure of incentives: the ratio of risk-reducing incentives to risk-increasing incentives. The ratio of risk-reducing to risk-increasing incentives in (8) is equal to the ratio of debt incentives (multiplied by −1) to stock and option incentives:

$$\frac{-\beta(\partial D/\partial\sigma_v)}{\alpha N(\partial P/\partial\sigma_v)+\gamma M(\partial W/\partial\sigma_v)}.^{5} \qquad (11)$$

the relative sensitivity ratio.

If the firm has no employee options(M =0), the stock sensitivity is always positive and the relative sensitivity ratio (11) becomes

$$\frac{\beta(\partial D/\partial\sigma_v)}{\alpha(\partial D/\partial\sigma_v)}=\frac{Debt_{Mgr}/Stock_{Mgr}}{Debt_{Firm}/Stock_{Firm}} \qquad (12)$$

the relative leverage ratio

2.2.5. Example of CEO Sensitivities

Panel B: CEO ($ thousands)

Leverage (%) (1)	*Debt Sensitivity ($)* (2)	*Stock Sensitivity ($)* (3)	*Option Sensitivity ($)* (4)	*Equity Sensitivity ($)* (5)	*Total Sensitivity ($)* (6)	*Vega ($)* (7)	*Relative Sensitivity Ratio* (8)	*Relative Leverage Ratio* (9)	*Relative Incentive Ratio* (10)
0.01	0	(4)	33	29	29	35	0.13	0.82	0.72
4	(0)	(4)	36	31	31	37	0.13	0.82	0.72
14	(0)	(5)	42	37	36	42	0.13	0.81	0.72
25	(5)	(2)	50	49	44	46	0.13	0.80	0.72
50	(54)	45	76	120	66	47	0.45	0.77	0.72

The example CEO owns 2% of the firm's debt, 2% of the firm's stock, and 16% of the firm's options.

(5)Equity sensitivity, which is the sum of the stock and option sensitivities.
(6)Total sensitivity,which is the sum of the debt,stock,and option sensitivities.
(8)The relative sensitivity measure in column (8) is calculated following (11).
(9)The relative leverage ratio is computed by dividing the CEO's percentage debt ownership (2%) by the CEO's ownership of total stock and option value (roughly 2.5%).
(10)The relative incentive ratio,which is similarly computed by dividing the CEO's percentage debt ownership (2%) by the CEO's own-ership of total stock and option delta (roughly 2.8%).

3. Sample and Variable Construction

3.1. Sample Selection

We use two samples of ExecuComp CEO data. Our first sample contains ExecuComp CEOs from 2006 to 2012, and our second sample, described in more detail in Section 4.4, contains ExecuComp CEOs from 1994 to 2012.

Following Coles et al.(2006) and Hayes et al. (2012), we remove financial firms (firms with Standard Industrial Classification (SIC) codes between 6000 and 6999) and utility firms (firms with SIC codes between 4900 and 4999). We merge the ExecuComp data with data from Compustat and CRSP. The resulting sample contains 8,600 CEO-year observations that have complete data.

3.2. Descriptive Statistics—Firm Size, Volatility,and Leverage

Table 2. Descriptive Statistics on Firm Characteristics

Variable	Mean	Std. dev	P1	Q1	Median	Q3	P99
Volatility of Stock Return (%)	43.8	17.8	16.6	30.6	40.6	53.1	98.4
Volatility of Asset Return (%)	36.4	17.2	11.2	23.7	32.8	45.9	91.2
Market Value of Stock ($)	7,104	19,330	45	547	1,441	4,545	113,798
Market Value of Debt ($)	1,730	4,135	0	18	292	1,308	23,625
Market Value of Employee Options ($)	130	304	0	11	35	106	1,686
Market Value of Assets ($)	9,158	23,624	69	723	1,967	6,443	145,562
Leverage (%)	18.5	19.8	0.0	1.7	13.4	28.0	86.1
Dividend Yield (%)	1.1	2.0	0.0	0.0	0.0	1.6	9.5

Notes. This table provides descriptive statistics on firm characteristics for the primary sample of 8,600 firm-year observations from 2006 to 2012. Dollar amounts are in millions of dollars. Stock-return volatility is monthly volatility for 60 months with a minimum of 12 months. We estimate the volatility of asset returns following Eberhart (2005). The market value of debt is calculated as the Black–Scholes–Merton option value of the debt. Employee options are valued as warrants following Abinzano and Navas (2013) using the end-of-year number of stock options outstanding and weighted average strike price and an assumed maturity of seven years. The market value of assets is the sum of the market value of stock, the market value of debt, and the warrant value of employee options. Leverage is the book value of debt divided by the market value of assets. The dividend yield is (ex-date) dividends over the year divided by the closing stock price. All variables are winsorized by year at the 1% tails.

3.3. Descriptive Statistics—CEO Incentive Measures

3.4. Descriptive Statistics—CEO Relative Incentive Measures

Table 3. Descriptive Statistics for Incentive Variables ($ Thousands)

Panel A: Descriptive statistics

Variable	Mean	Std. dev.	P1	Q1	Median	Q3	P99
Debt Sensitivity ($)	(4.01)	16.67	(74.98)	(0.97)	(0.00)	0.00	0.00
Stock Sensitivity ($)	5.95	35.80	(69.58)	(0.95)	(0.07)	2.48	171.33
Option Sensitivity ($)	59.53	86.44	0.00	8.02	27.33	72.55	445.07
Equity Sensitivity ($)	67.82	107.55	(24.31)	9.43	30.61	80.68	573.50
Total Sensitivity ($)	63.74	103.43	(43.06)	8.08	28.44	76.67	545.17
Vega ($)	51.47	77.30	0.00	5.85	21.82	62.23	386.93
Total Wealth ($)	106,548	255,175	1,065	14,630	34,940	86,352	1,601,269
Equity Sensitivity/Total Wealth (%)	0.135	0.119	−0.009	0.042	0.112	0.197	0.528
Total Sensitivity/Total Wealth (%)	0.125	0.116	−0.052	0.035	0.103	0.187	0.515
Vega/Total Wealth (%)	0.101	0.092	0.000	0.022	0.080	0.156	0.371
Relative Sensitivity Ratio	0.57	1.44	0.00	0.01	0.03	0.18	7.02
Relative Leverage Ratio	3.38	18.24	0.00	0.00	0.16	1.17	78.50
Relative Incentive Ratio	2.69	15.48	0.00	0.00	0.12	0.86	61.71

3.5. Correlations—CEO Incentive Measures

Panel B: Correlation between incentive variables

	Total Sens.	*Vega*	*Eq. Sens.*	*Total Wealth*	*Tot. Sens./ Tot. Wealth*	*Vega/ Tot. Wealth*	*Eq. Sens./ Tot. Wealth*	*Rel. Sens.*	*Rel. Lev.*	*Rel. Incent.*
Total Sensitivity	1.00									
Vega	0.72	1.00								
Equity Sensitivity	0.99	0.71	1.00							
Total Wealth	0.30	0.27	0.30	1.00						
Total Sensitivity/Total Wealth	0.34	0.19	0.32	−0.22	1.00					
Vega/Total Wealth	0.18	0.37	0.17	−0.23	0.63	1.00				
Equity Sensitivity/Total Wealth	0.31	0.17	0.32	−0.24	0.95	0.61	1.00			
Relative Sensitivity Ratio	−0.16	−0.23	−0.14	0.15	−0.34	−0.37	−0.29	1.00		
Relative Leverage Ratio	−0.03	0.01	−0.03	−0.03	−0.04	0.05	−0.04	−0.02	1.00	
Relative Incentive Ratio	−0.03	0.00	−0.04	−0.03	−0.05	0.02	−0.05	−0.01	0.99	1.00

3.6. Descriptive Statistics on the Difference Between Total Sensitivity and Vega

Panel C: Descriptive statistics on the difference between total sensitivity and vega

Variable	Mean (%)	Std. dev. (%)	Pearson correlation with: *Tot. Sens./Tot. Wealth*	Pearson correlation with: *Vega/Tot. Wealth*
Total Sensitivity/Total Wealth	0.125	0.116	1.00	0.63
Vega/Total Wealth	0.101	0.092	0.63	1.00
(Option Sensitivity – Vega)/Total Wealth	0.019	0.068	0.57	−0.12
Option Sensitivity/Total Wealth	0.120	0.108	0.90	0.78
Stock Sensitivity/Total Wealth	0.014	0.041	0.35	−0.27
Debt Sensitivity/Total Wealth	−0.010	0.032	0.04	0.03

3.7. Descriptive Statistics on Sources of Variation in CEO Sensitivities

Table 3. (Continued)

Panel D: Descriptive statistics on sources of variation in CEO sensitivities

				CEO Sens./Tot. Wealth			*CEO % Ownership*			*Firm Sens./Tot. Wealth*		
Sample	*N*	*Tot. Sens./ Tot. Wealth* (1)	*Vega/ Tot. Wealth* (2)	Options (3)	Stock (4)	Debt (5)	Options (6)	Stock (7)	Debt (8)	Options (9)	Stock (10)	Debt (11)
All	8,600	0.125%	0.101%	0.120%	0.014%	−0.010%	16.3%	2.0%	2.4%	1.6%	4.1%	−5.6%
Ranked by option sensitivity/total wealth												
Low	2,866	0.028	0.016	0.017	0.016	−0.007	12.5	5.0	2.5	0.5	3.7	−4.2
Medium	2,867	0.102	0.093	0.100	0.010	−0.007	19.4	0.9	3.0	1.2	1.9	−3.1
High	2,867	0.243	0.193	0.244	0.016	−0.015	17.1	0.3	1.7	3.0	6.6	−9.6
Diff (Hi – Lo)		0.215***	0.178***	0.227***	0.000	−0.009***	4.7***	−4.7***	−0.8	2.5***	2.9***	−5.4***
Ranked by stock sensitivity/total wealth												
Low	2,866	0.094	0.111	0.102	−0.006	−0.001	15.0	3.2	4.5	1.7	−1.5	−0.2
Medium	2,867	0.119	0.118	0.122	0.000	−0.003	16.0	1.1	2.3	1.6	0.1	−1.8
High	2,867	0.161	0.073	0.137	0.048	−0.025	18.0	1.8	0.5	1.4	13.6	−15.0
Diff (Hi – Lo)		0.066***	−0.039***	0.035***	0.054***	−0.025***	3.0***	−1.3***	−4.1***	−0.3**	15.1***	−14.8***
Ranked by debt sensitivity/total wealth												
Low	2,866	0.151	0.107	0.153	0.028	−0.0290	17.6	0.9	1.4	1.7	9.3	−11.0
Medium	1,548	0.100	0.099	0.101	0.000	−0.0001	14.1	1.9	4.8	1.9	−0.8	−1.0
High	4,186	0.115	0.097	0.105	0.010	0.0000	16.3	2.9	2.2	1.4	2.3	−3.7
Diff (Hi – Lo)		−0.036***	−0.010**	−0.048***	−0.017***	0.029***	−1.3**	2.0***	0.8	−0.3***	−7.0***	7.3***

4. Associations of Incentive Measures with Firm Risk Choices

4.1. Research Design

4.1.1. Unscaled Incentive Measures.

$$\begin{aligned} Firm_Risk_Choice_{it+1} &= \beta_1 Risk\text{-}taking_Incentives_{it} + \beta_2 Delta_{it} \\ &\quad + \sum_j \alpha_j Control_{ijt} + v_{it+1}. \end{aligned} \tag{13}$$

4.1.2. Scaled Incentive Measures.

$$\begin{aligned} Firm_Risk_Choice_{it+1} &= \beta_1 Risk\text{-}taking_Incentives/Wealth_{it} + \beta_2 Delta/Wealth_{it} \\ &\quad + \beta_3 Wealth_{it} + \sum_j \alpha_j Control_{ijt} + v_{it+1}. \end{aligned} \tag{14}$$

Dependent variables

(1) ln(Stock Volatility) measured using daily stock volatility over year t + 1;

(2) R&D Expense measured as the ratio of R&D expense to total assets;

(3) CAPEX measured as the ratio of capital expenditures less sales of property , plant, and equipment to total assets;

(4) The HerfindahlIndex, which captures revenue concentration across segments and is defined as the sum of the square of segment sales divided by the square of firm sales;

(5) Book Leverage measured as the book value of long-term debt to the book value of assets.

(6) ln(Asset Volatility) The natural logarithm of σ v, the variance of firm value, calculated using (A.3) in fiscal year t +1

4.2. Association of Level and Scaled Incentive Measures with Firm Risk Choices

Table 4. Comparison of the Association Between Vega and Sensitivity Measures and Future Risk Choices from 2006 to 2012

	ln(*Stock Volatility*) (1)	ln(*Asset Volatility*) (2)	*R&D Expense* (3)	*-CAPEX* (4)	*Herfindahl Index* (5)	*Book Leverage* (6)	ln(*Stock Volatility*) (7)	ln(*Asset Volatility*) (8)	*R&D Expense* (9)	*-CAPEX* (10)	*Herfindahl Index* (11)	*Book Leverage* (12)
Panel A: Vega												
Vega	−0.088***	0.001	0.136***	0.039***	0.009	−0.082***						
	(−3.80)	(0.05)	(4.68)	(2.94)	(0.38)	(−4.47)						
Vega/Total Wealth							0.047***	0.148***	0.257***	0.063***	0.077***	−0.050**
							(2.78)	(4.14)	(6.97)	(3.64)	(2.77)	(−2.05)
Observations	8,600	7,797	8,192	8,189	7,849	8,104	8,600	7,797	8,192	8,189	7,849	8,104
R^2	0.550	0.380	0.479	0.456	0.217	0.382	0.583	0.439	0.497	0.457	0.221	0.379
Panel B: Sensitivity												
Total Sensitivity	0.001	0.122***	0.108***	0.045***	0.032							
	(0.06)	(5.99)	(3.60)	(3.12)	(1.24)							
Financing Sensitivity						0.271***						
						(11.28)						
Tot. Sens./ Tot. Wealth							0.198***	0.276***	0.168***	0.065***	0.057**	
							(14.32)	(10.76)	(5.67)	(3.20)	(2.13)	
Fin. Sens./ Tot. Wealth												0.322***
												(2.85)
Observations	8,600	7,797	8,192	8,189	7,849	8,104	8,600	7,797	8,192	8,189	7,849	8,104
R^2	0.546	0.389	0.475	0.456	0.218	0.428	0.604	0.471	0.483	0.457	0.220	0.457
Diff. in coefficients	0.089***	0.120***	−0.028**	0.007	0.023	0.353***	0.151***	0.128***	−0.087***	0.002	−0.020	0.372***
t-statistic	(4.94)	(5.95)	(−2.27)	(0.52)	(1.15)	(10.12)	(7.07)	(2.97)	(−5.04)	(0.10)	(−0.92)	(3.45)
Avg. diff. in coeff. excluding *Fin. Sens.*					0.042***				0.034**			
t-statistic					(4.64)				(2.52)			
Avg. diff. in coeff. including *Fin. Sens.*					0.094***				0.091***			
t-statistic					(9.65)				(4.08)			

4.3. Association of Relative Ratios with Firm Risk Choices

Table 5. Comparison of the Association Between Relative Leverage and Sensitivity Measures and Future Risk Choices from 2006 to 2012

	ln(*Stock Volatility*) (1)	ln(*Asset Volatility*) (2)	*R&D Expense* (3)	*-CAPEX* (4)	*Herfindahl Index* (5)	*Book Leverage* (6)	ln(*Stock Volatility*) (7)	ln(*Asset Volatility*) (8)	*R&D Expense* (9)	*-CAPEX* (10)	*Herfindahl Index* (11)	*Book Leverage* (12)
Panel A: Relative leverage ratio												
-Relative Leverage	0.051***	0.051***	0.061***	−0.007	0.071***	0.168***						
	(3.41)	(3.68)	(3.81)	(−0.58)	(3.36)	(10.80)						
-ln(*Rel. Lev.*)							0.042**	0.093***	0.015	−0.006	0.020	0.343***
							(2.13)	(3.08)	(0.51)	(−0.32)	(0.65)	(16.05)
Observations	7,224	6,573	6,893	6,892	6,634	6,795	4,651	4,281	4,476	4,475	4,353	4,386
R^2	0.604	0.408	0.440	0.482	0.226	0.345	0.636	0.400	0.448	0.510	0.249	0.431
Panel B: Sensitivity scaled by total wealth												
Tot. Sens./ Tot. Wealth	0.214***	0.294***	0.168***	0.065***	0.052**		0.203***	0.281***	0.133***	0.041*	0.032	
	(17.22)	(11.65)	(5.57)	(2.98)	(2.01)		(11.38)	(11.23)	(2.96)	(1.85)	(1.03)	
Financing Sens./ Tot. Wealth						0.336***						0.345***
						(2.79)						(2.93)
Observations	7,224	6,573	6,893	6,892	6,634	6,795	4,651	4,281	4,476	4,475	4,353	4,386
R^2	0.628	0.454	0.454	0.484	0.224	0.410	0.659	0.439	0.458	0.511	0.249	0.434
Diff. in coefficients	0.163***	0.243***	0.106***	0.072***	−0.019	0.169	0.161***	0.188***	0.118***	0.048*	0.013	0.002
t-statistic	(10.48)	(7.96)	(3.21)	(2.68)	(−0.61)	(1.35)	(7.57)	(5.23)	(2.71)	(1.75)	(0.31)	(0.02)
Avg. diff. in coeff. excl. *Fin. Sens.*				0.122***					0.106***			
t-statistic				(4.41)					(4.56)			
Avg. diff. in coeff. incl. *Fin. Sens.*				0.130***					0.088***			
t-statistic				(5.49)					(3.63)			

4.4. Association of Vega and Equity Sensitivity with Firm Risk Choices—1994–2012

Table 6. Comparison of the Association Between Vega and Equity Sensitivity and Future Risk Choices from 1994 to 2012

	ln(*Stock Volatility*) (1)	ln(*Asset Volatility*) (2)	*R&D Expense* (3)	*-CAPEX* (4)	*Herfindahl Index* (5)	*Book Leverage* (6)	ln(*Stock Volatility*) (7)	ln(*Asset Volatility*) (8)	*R&D Expense* (9)	*-CAPEX* (10)	*Herfindahl Index* (11)	*Book Leverage* (12)
Panel A: Vega												
Vega	−0.013	0.066***	0.109***	0.035***	0.028	−0.070***						
	(−0.59)	(5.16)	(4.86)	(2.86)	(1.35)	(−4.76)						
Vega/Tot. Wealth							0.059***	0.145***	0.221***	0.061***	0.050**	−0.075***
							(4.38)	(6.84)	(9.39)	(4.97)	(2.49)	(−4.12)
Observations	18,829	17,155	18,065	18,038	17,328	17,762	18,829	17,155	18,065	18,038	17,328	17,762
R^2	0.520	0.469	0.449	0.407	0.228	0.347	0.570	0.533	0.467	0.408	0.231	0.347
Panel B: Equity sensitivity												
Equity Sensitivity	0.053***	0.140***	0.099***	0.023*	0.052***							
	(3.42)	(7.91)	(5.73)	(1.66)	(2.77)							
Eq. Financing Sens.						0.251***						
						(9.53)						
Eq. Sens./Tot. Wealth							0.242***	0.273***	0.148***	0.086***	0.041**	
							(16.31)	(12.50)	(6.82)	(5.76)	(2.15)	
Eq. Financing Sens./ Tot. Wealth												0.297***
												(6.66)
Observations	18,829	17,155	18,065	18,038	17,328	17,762	18,829	17,155	18,065	18,038	17,328	17,762
R^2	0.522	0.479	0.448	0.407	0.229	0.389	0.601	0.564	0.455	0.411	0.230	0.411
Diff. in coefficients	0.066***	0.074***	−0.010	−0.012	0.024	0.321***	0.183***	0.128***	−0.073***	0.025*	−0.009	0.373***
t-statistic	(4.22)	(3.47)	(−0.70)	(−1.28)	(1.60)	(9.45)	(13.26)	(5.51)	(−6.00)	(1.91)	(−0.61)	(6.39)
Avg. diff. in coeff. excl. *Eq. Fin. Sens.*				0.028***						0.051***		
t-statistic				(3.36)						(6.42)		
Avg. diff. in coeff. incl. *Eq. Fin. Sens.*				0.077***						0.105***		
t-statistic				(7.30)						(8.44)		

4.5. Robustness Tests 4.5.1. Endogeneity.

Table 7. Comparison of Two-Stage Least Squares Estimates of the Relation Between Vega and Sensitivity Measures and Future Risk Choices from 1994 to 2012

	ln(*Stock Volatility*) (1)	ln(*Asset Volatility*) (2)	*R&D Expense* (3)	*-CAPEX* (4)	*Herfindahl Index* (5)	*Book Leverage* (6)	ln(*Stock Volatility*) (7)	ln(*Asset Volatility*) (8)	*R&D Expense* (9)	*-CAPEX* (10)	*Herfindahl Index* (11)	*Book Leverage* (12)
					Panel A: Vega							
Vega	−0.010	0.039***	−0.004	0.021	−0.008	−0.039**						
	(−0.51)	(3.23)	(−0.19)	(1.35)	(−0.25)	(−2.04)						
Vega/Tot. Wealth							−0.215***	−0.150**	0.038	0.018	−0.004	−0.055
							(−3.69)	(−2.19)	(0.73)	(0.34)	(−0.06)	(−1.17)
Observations	18,829	17,155	18,065	18,038	17,328	17,762	18,829	17,155	18,065	18,038	17,328	17,762
Partial *F*-statistic for inclusion of instruments:												
Vega	87.88***	102.03***	80.30***	63.85***	42.85***	113.06***	6.48***	4.98***	7.29***	7.13***	18.46***	6.72***
Delta	24.79***	72.85***	55.94***	67.13***	192.07***	454.38***	27.26***	30.38***	40.89***	40.85***	96.02***	37.18***
Hansen *J*-statistic *p*-value	0.53	0.35	0.15	0.23	0.39	0.75	0.38	0.39	0.48	*NA*	0.86	0.69
					Panel B: Sensitivity							
Equity Sensitivity	0.032*	0.086***	−0.005	−0.014	0.045							
	(1.80)	(4.16)	(−0.20)	(−0.85)	(1.60)							
Eq. Financing Sens.						0.187***						
						(6.40)						
Eq. Sens./Tot. Wealth							0.293***	0.268***	0.027	0.049	0.014	
							(10.16)	(4.39)	(0.66)	(1.34)	(0.37)	
Eq. Financing Sens./ Tot. Wealth												0.199***
												(4.31)
Observations	18,829	17,155	18,065	18,038	17,328	17,762	18,829	17,155	18,065	18,038	17,328	17,762
Partial *F*-statistic for inclusion of instruments:												
Sensitivity	271.15***	87.88***	61.51***	60.95***	93.31***	63.21***	24.09***	19.27***	27.33***	27.26***	31.43***	56.82***
Delta	79.05***	24.79***	56.00***	55.11***	78.22***	60.18***	37.01***	42.38***	34.41***	34.24***	117.32***	42.1***
Hansen *J*-statistic *p*-value	0.71	0.60	0.21	0.24	0.52	0.52	0.44	0.39	0.56	0.73	0.95	0.72
Diff. in coefficients	0.042	0.047*	−0.001	−0.035	0.053	0.226***	0.508***	0.418***	−0.011	0.031	0.018	0.254***
t-statistic	(1.05)	(1.74)	(−0.02)	(−1.59)	(1.23)	(5.79)	(7.94)	(3.91)	(−0.12)	(0.41)	(0.22)	(3.10)
Avg. diff. in coeff. excl. *Fin. Sens.*				0.021						0.193***		
t-statistic				(1.33)						(5.36)		
Avg. diff. in coeff. incl. *Fin. Sens.*				0.055***						0.203***		
t-statistic				(3.69)						(6.15)		

4.5.2. Changes in Vega, Changes in Equity Sensitivity,and Changes in Firm Risk Choices.

Table 8. Comparison of the Association Between Changes in Vega and Changes in Equity Sensitivity Changes in Future Risk Choices Around the Introduction of SFAS 123R

	Δln(*Stock Volatility*) (1)	Δln(*Asset Volatility*) (2)	Δ*R&D Expense* (3)	-*CAPEX* (4)	Δ*Herfindahl Index* (5)	Δ*Book Leverage* (6)	Δln(*Stock Volatility*) (7)	Δln(*Asset Volatility*) (8)	Δ*R&D Expense* (9)	-*CAPEX* (10)	Δ*Herfindahl Index* (11)	Δ*Book Leverage* (12)
Panel A: Δ Vega												
Δ*Vega*	−0.021	0.128***	−0.007	0.068***	0.003	−0.124***						
	(−0.70)	(3.95)	(−0.36)	(2.90)	(0.09)	(−4.69)						
Δ*Vega/Tot. Wealth*							−0.072**	0.052	0.042	0.112***	−0.007	−0.091**
							(−2.14)	(1.39)	(1.08)	(3.15)	(−0.17)	(−2.30)
Observations	1,158	1,064	1,097	1,096	1,079	1,077	1,158	1,064	1,097	1,096	1,079	1,077
R^2	0.083	0.045	0.476	0.131	0.028	0.108	0.116	0.119	0.069	0.135	0.030	0.102
Panel B: Δ Equity sensitivity												
Δ*Equity Sensitivity*	−0.048	0.150***	0.010	0.070***	0.018							
	(−1.55)	(4.04)	(0.67)	(3.04)	(0.45)							
Δ*Eq. Financing Sens.*						0.206***						
						(6.37)						
Δ*Eq. Sens./Tot. Wealth*							0.056	0.216***	0.013	0.157***	−0.003	
							(1.58)	(5.04)	(0.35)	(4.23)	(−0.07)	
Δ*Eq. Fin. Sens./Tot. Wealth*												0.328***
												(10.40)
Observations	1,158	1,064	1,097	1,096	1,079	1,077	1,158	1,064	1,097	1,096	1,079	1,077
R^2	0.085	0.051	0.476	0.131	0.028	0.133	0.114	0.149	0.068	0.143	0.030	0.191
Diff. in coef.	−0.028	0.022	0.017	0.002	0.015	0.331***	0.128***	0.164***	−0.029	0.044	0.003	0.419***
t-statistic	(−1.20)	(0.61)	(1.27)	(0.10)	(0.49)	(7.55)	(4.32)	(3.52)	(−1.07)	(1.53)	(0.10)	(8.66)
Avg. diff. in coeff. excl. Δ*Eq. Fin. Sens.*				0.006						0.062***		
t-statistic				(0.44)						(3.79)		
Avg. diff. in coeff. incl. Δ*Eq. Fin. Sens.*				0.060***						0.121***		
t-statistic				(4.62)						(7.48)		

4.5.3. Convexity in Performance Vesting Awards.

We leave including the effects of p-v awards on risk incentives to future work but provide a robustness test that our finding of the superiority of our sensitivity measures to vega is not affected by this omission of p-v awards. To do this, we estimate the risk-taking incentives provided by p-v awards following the procedure described in Hayes et al. (2012, p. 186) and in their related Internet appendix (Hayes et al. 2011).

In untabulated results, we find that adding the p-v award incentives does not affect our inference. However, we caveat that our estimates likely are noisy due to our assumptions and because of noise in our data on p-v awards.

4.5.4. Other Robustness Tests

the expected present value of future cash pay can provide risk-reducing incentives (e.g.,John and John 1993, Cassell et al. 2012).By this argument, total risk-reducing incentives should include future cash pay as well as pensions and deferred compensation.To evaluate the sensitivity of our results, we estimate the present value of the CEO's debt claim from future cash pay as current cash pay multiplied by the expected number of years before the CEO terminates. Our calculations follow those detailed in Cassellet al. (2012).

we attempt to reduce measurement error in the estimates by using the mean estimate for a group of similar firms. To do this, we note that leverage and stock volatility are the primary observable determinants of the debt sensitivity.

We therefore sort firms each year into 10 groups based on leverage and then sort each leverage group into 10 groups based on stock volatility. For each leverage-volatility-year group, we calculate the mean sensitivity as a percentage of the book value of debt. We then calculate the debt sensitivity for each firm-year as the product of the mean percentage sensitivity of the leverage-volatility-year group multiplied by the total book value of debt.

4.5.4. Other Robustness Tests

Finally , our sensitivity estimates do not include options embedded in convertible securities. While we can identify the book value of convertible securities, the number of shares issuable upon conversion is typically not available on Compustat. Because the parameters necessary to estimate the sensitivities are not available, we repeat our tests excluding firms with convertible securities. To do this, we exclude firms that report convertible debt or preferred stock. In our main (secondary) sample, 21% (26%) of all firms have convertibles. When we exclude these firms, our inferences from Tables 4–6 are unchanged.

5. Conclusion

We examine the relation between our measure of incentives and firm risk choices and compare the results using our measure and those obtained with vega and the relative leverage ratio used in the prior literature. Our measure explains risk choices better than the measures used in the prior literature.

We also calculate an equity sensitivity that ignores debt incentives and find that it is 99% correlated with the total sensitivity. While we can only calculate the total sensitivity beginning in 2006, when we examine the equity sensitivity over the longer 1994–2012 period, we find consistent results.

As previously discussed,we caveat that if performance vesting (p-v) awards continue to displace traditional options and restricted `stock, eventually the sensitivity measures we develop in this paper will need to be augmented by a measure that includes the sensitivity of p-v awards to volatility.

Thanks !