Equity Vesting and Investment

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This paper links the CEO's concerns for the current stock price to reductions in real investment. We identify short-term concerns using the amount of stock and options scheduled to vest in a given quarter. Vesting equity is associated with a decline in the growth of research and development and capital expenditure, positive analyst forecast revisions, and positive earnings guidance, within the same quarter. More broadly, by introducing a measure of incentives that is determined by equity grants made several years prior, and thus unlikely driven by current investment opportunities, we provide evidence that CEO contracts affect real decisions. (*JEL* G31, G34, M12, M52)

Received May 12, 2015; editorial decision December 15, 2016 by Editor Andrew Karolyi.

This paper studies the link between real investment decisions and the CEO's short-term stock price concerns. We introduce a new measure of short-term incentives: the amount of stock and options scheduled to vest in a given quarter.[1] This measure is significantly correlated with CEO equity sales; it is also largely

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We are particularly grateful to two referees and the Editor (Andrew Karolyi) for insightful comments that significantly improved the paper. We also thank Kenneth Ahern, Ray Ball, Tom Bates, Taylor Begley, Brian Cadman, Jeff Coles, John Core, Francesca Cornelli, Pingyang Gao, Francisco Gomes, Jeff Gordon, Moqi Groen-Xu, Wayne Guay, Ole-Kristian Hope, Dirk Jenter, Wei Jiang, Marcin Kacperczyk, Ralph Koijen, Christian Leuz, Paul Ma, Joshua Madsen, Colin Mayer, Kevin Murphy, Clemens Otto, Zach Sautner, Haresh Sapra, Rui Silva, Jared Stanfield, Geoff Tate, Luke Taylor, Francesco Vallascas, Mike Weisbach, and seminar participants at Chicago, Columbia, CUHK, FIRS, HKUST, Imperial, LBS, Minnesota, NYU, Stockholm, Sydney, Toronto, UNSW, UTS, Wharton, the Bristol/Manchester Corporate Finance Conference, Edinburgh Corporate Finance Conference, Financial Research Association, Florida State/Sun Trust Beach Conference, Oxford/LSE Law and Finance Conference, Penn Law and Finance Conference, University of Washington Summer Finance Conference, Utah Winter Accounting Conference, and Western Finance Association. We thank Timur Tufail and Ann Yih of Equilar for answering numerous questions about the data, and Jayant Chaudhary, Elliott Quast, and Jianghua Shen for research assistance. Alex Edmans gratefully acknowledges financial support from European Research Council Starting Grant 638666, LBS's Deloitte Institute of Innovation and Entrepreneurship, Wharton's Jacobs Levy Equity Management Center for Quantitative Financial Research, and the Wharton Dean's Research Fund. Supplementary data can be found on *The Review of Financial Studies* web site. Send correspondence to Alex Edmans, London Business School, Regent's Park, London NW1 4SA, United Kingdom; telephone: +44-20-7000-8258. E-mail: aedmans@london.edu.

[1] Strictly speaking, options do not vest; they become exercisable. For brevity, we use the word "vest" to refer to options changing status from being unexercisable to exercisable.

doi:10.1093/rfs/hhx018 Advance Access publication March 27, 2017

driven by equity grants made several years prior, and thus unlikely to be related to current shocks to investment opportunities. We find that vesting equity is associated with reductions in the growth rates of research and development (R&D) and capital expenditure, positive analyst forecast revisions, and positive earnings guidance. These results suggest that vesting equity induces CEOs to reduce investment in long-term projects and increase short-term earnings, and more broadly that CEO contracts have a causal effect on real decisions.

One of the most fundamental principles of corporate finance is that managers should maximize firm value by trading off short-term and long-term cash flows based on shareholders' discount rates. This principle underlies almost all research on corporate investment and is a central premise in leading finance textbooks. However, the myopia models of Stein (1988, 1989) predict that stock price concerns will instead lead managers to overweight short-term cash flows and forgo value-increasing long-term investments.

Despite the importance of investment decisions in the research, teaching, and practice of corporate finance, there are very few tests of myopia, in part because short-term concerns are difficult to measure. Standard measures of CEO incentives (e.g., Jensen and Murphy 1990; Hall and Liebman 1998) quantify his overall level of equity holdings. However, short-term concerns arise not from overall equity, but from the amount of equity that the CEO expects to sell in the short term. Equity that the CEO plans to hold for the long term may deter myopia (Edmans et al. 2012). Using actual equity sales to measure short-term incentives would be problematic since they are endogenous choices of the CEO and thus likely correlated with omitted variables that also drive investment. For example, negative private information on firm prospects may cause him to sell equity and also cut investment. In addition, actual equity sales include unexpected liquidity sales (which will not affect investment) and so are a mismeasured proxy for anticipated sales.

We thus study neither total equity holdings nor actual equity sales, but the amount of equity that vests in a given quarter. As discussed earlier, vesting equity is largely driven by the schedule of equity grants made several years prior,[2] and is highly correlated with actual short-term equity sales: a one-standard-deviation increase in vesting equity is associated with a rise in same-quarter equity sales by $140,000, 16% of the average level. The amount of vesting equity is also known to the CEO in advance, so he is able to change investment in anticipation. We construct this measure using the Equilar database, which tracks the vesting status of equity grants on an annual basis, based on the Securities and Exchange Commission's (SEC) increased

2 Gopalan et al. (2014) show that most equity grants do not fully vest for three to five years, and vesting schedules are largely predetermined at the time of the grant. However, in some cases, vesting is based on accounting or stock performance, which may be correlated with current investment opportunities. We address this concern in Section 2.1.

disclosure requirements from 2006. By devising an algorithm that allows the estimation of vesting dates, we are able to calculate vesting equity on a quarterly (rather than only annual) basis, thus enabling more precise identification.

We find that vesting equity is associated with significant declines in the growth of five measures of investment, controlling for determinants of investment opportunities and the firm's ability to fund investment, other components of CEO compensation (unvested equity, already-vested equity, salary, and bonus), CEO characteristics (age, tenure, and an indicator for new CEO), as well as year, quarter, and firm fixed effects. A one-standard-deviation increase in vesting equity is associated with an annualized 0.2% decline in growth in R&D plus net capital expenditure (scaled by total assets), 11% of the average investment-to-assets ratio. The results continue to hold when removing grants with performance-based vesting provisions, considering only vesting stock or vesting options, using vesting equity as an instrument for equity sales in a two-stage least squares (2SLS) analysis, excluding controls, and using different algorithms to estimate vesting dates.

One interpretation of our results is that stock price concerns lead CEOs to forgo positive net present value (NPV) investments at the expense of long-run value (the myopia hypothesis). An alternative explanation is that the vesting-induced investment cuts are efficient: if CEOs have a general tendency to overinvest, a focus on the short-term stock price could curb overinvestment (the efficiency hypothesis). This explanation still implies that CEO contracts affect real decisions, but unlike the myopia hypothesis, the effect is not inefficient. A third explanation is that boards schedule vesting dates to coincide with declines in investment opportunities (the timing hypothesis). Indeed, Gopalan et al. (2014) show that the duration of executive compensation is longer for firms with more R&D investments and higher market-to-book ratios (which indicate more valuable long-term projects). This explanation requires that boards forecast quarter-level declines in investment opportunities several years in advance. Note that it is still consistent with myopia theories if boards believe that vesting equity exacerbates myopia and so try to ensure that equity does not vest while investment opportunities are strong.

Distinguishing between these alternative hypotheses is challenging, in particular because we can only observe the level of investment and not its efficiency. Nevertheless, we perform indirect tests to evaluate them. To investigate the timing hypothesis, we rerun our tests including only grants issued at least two years prior, which are less likely to be correlated with current investment opportunities; the results remain robust. To investigate the efficiency hypothesis, we study changes in contemporaneous operating performance. If vesting equity induces the CEO to act more efficiently, we might expect him to do so by not only cutting unproductive investments but also improving other dimensions of operating performance. However, we find no change in the ratio of the cost of goods sold to sales, the ratio of operating expenses to sales, or sales growth, suggesting that the investment cut is unlikely to be part of a general program to increase efficiency. Separately, we find that the link between vesting equity and investment growth is generally weaker in subsamples where the cost of myopia to the CEO is likely higher or its benefit lower, such as firms with more blockholders (who have incentives to analyze a firm's fundamental value rather than current earnings), younger CEOs (who have greater career concerns and thus suffer more from long-run value erosion), and smaller size and lower age (which indicate superior investment opportunities).

Next, we study how the reduction in investment, induced by vesting equity, might benefit the CEO by increasing his payoff from equity sales. A CEO may communicate the increased earnings that result from the investment cut to the market before the earnings announcement through earnings guidance, public disclosures, press releases, or interviews. We first use analyst forecast revisions to assess the extent and effectiveness of the CEO's overall communication. We find that vesting equity is positively and significantly related to the increase in analyst earnings forecasts within quarter q, the same time period in which the CEO sells equity. While forecast revisions measure the outcome of managerial communication, we also directly study one specific communication channel, earnings guidance. We find that vesting equity is associated with a higher likelihood that the firm issues positive earnings guidance during the same quarter, but not negative guidance. We also show that CEOs' equity sales are concentrated in a small window immediately following positive guidance, likely because guidance occurs just before a trading window in which insiders are allowed to sell. This suggests that CEOs are able to benefit from guidance by selling shares immediately afterwards. Finally, we find that vesting equity is positively related to the likelihood that the announced earnings exceed the analyst consensus forecast by a narrow margin, but not by a wide margin. This result is consistent with the CEO communicating a level of positive earnings news that allows him to maximize his benefit from the investment cuts without creating a large risk of missing the forecast.

This paper is related to a large literature on managerial myopia. In addition to Stein (1988, 1989), other theories include Miller and Rock (1985), Narayanan (1985), Bebchuk and Stole (1993), Bizjak, Brickley, and Coles (1993), Goldman and Slezak (2006), Edmans (2009), and Benmelech, Kandel, and Veronesi (2010). Empirically, Graham, Harvey, and Rajgopal (2005) provide survey evidence that 78% of executives would sacrifice long-term value to meet earnings targets. Using standard measures of incentives that capture the CEO's total equity holdings, Cheng and Warfield (2005), Bergstresser and Philippon (2006), and Peng and Roell (2008) find a positive association with earnings management, but Erickson, Hanlon, and Maydew (2006) find no link to accounting fraud. These conflicting results may arise because, theoretically, it is the sensitivity to the short-term stock price that induces myopia. In addition, total equity holdings are potentially endogenous, because they depend on the amount of equity a CEO has chosen to hold onto.

Our study is also related to papers that analyze the vesting horizon of the CEO's equity. Kole (1997) is the first to describe vesting horizons, but does not relate them to firm behavior.[3] Gopalan et al. (2014) are the first to undertake a systematic analysis of the horizon of a CEO's incentives, also using Equilar. They introduce a new "duration" measure of CEO incentives and show how it varies across industries and with firm characteristics. They also link this measure to accruals,[4] but do not investigate real outcomes because duration—unlike vesting equity—depends on current equity grants and is thus likely correlated with current shocks to investment opportunities.

A contemporaneous paper by Ladika and Sautner (2016) shows that the adoption of FAS 123R induced some firms to accelerate option vesting, which in turn led to a fall in investment. Our papers are complementary in that they employ different empirical strategies to analyze the relation between vesting and investment, and find consistent results. While Ladika and Sautner (2016) focus on a one-time shock, we study a panel of firms with vesting events distributed over time. This broader setting allows us to quantify the responsiveness of investment to vesting equity, rather than study the more specific question of how investment responded to a change in accounting rules.

Our paper also contributes to the broader literature on CEO compensation, beyond the specific topic of short-termism. Even though this literature is substantial, very few papers show that incentive contracts affect managers' behavior, that is, that CEO pay actually matters. The survey of Frydman and Jenter (2010) notes that "compensation arrangements are the endogenous outcome of a complex process … this makes it extremely difficult to interpret any observed correlation between executive pay and firm outcomes as evidence of a causal relationship." This paper takes a step toward addressing the identification challenge, by introducing a measure of CEO incentives—vesting equity—that is unlikely to be driven by the current contracting environment. Thus, our results suggest that compensation has real effects. Indeed, our identification using vesting equity has since been used in wider contexts. Gopalan, Huang, and Maharjan (2015) use vesting equity as an instrument for duration and examine its effect on CEO turnover; Salitskiy (2015) links it to lower risk-taking; and Edmans et al. (2017) show that CEOs reallocate news toward months in which their equity vests and away from adjacent months. Turning to alternative identification strategies, Shue and Townsend

[3] Some papers do not consider the horizon of equity incentives but do differentiate between unvested and vested equity. Johnson, Ryan, and Tian (2009) show that vested stock is related to corporate fraud. Burns and Kedia (2006) and Efendi, Srivastava, and Swanson (2007) find that large holdings of vested options, particularly those in the money, are positively related to managers' propensity to misreport.

[4] Unlike real activities such as changing investment, accruals management may not affect the firm's fundamental value. Separately, Cohen, Dey, and Lys (2008) document a significant shift from accruals management to changes in investment and other discretionary expenses after the passage of the Sarbanes-Oxley Act of 2002, suggesting that changes in investment are more relevant during our sample period. Graham, Harvey, and Rajgopal (2005) also find that "most earnings management is achieved via real actions as opposed to accounting manipulations" after Sarbanes-Oxley.

(Forthcoming) use multi-year grant cycles as an instrument for option grants to identify the effects of compensation contracts on CEO risk-taking; Flammer and Bansal (Forthcoming) conduct a regression discontinuity analysis of shareholder proposals to increase long-term compensation and find that such proposals improve long-run performance.

1. Data and Variable Measurement

1.1 Measuring short-term concerns

Our empirical approach is motivated by standard models of managerial myopia. In such models, the CEO's wealth in quarter q is typically given by:

$$W_q = S_q + \alpha_q \left[\omega_q P_q + \sum_{s=1}^{T-q} \omega_{q+s} E(P_{q+s}) \right], \tag{1}$$

where T is the number of periods, W_q is the manager's wealth, S_q is cash salary, P_q is the stock price in quarter q, and α_q is the manager's total number of shares, of which a fraction ω_q is sold in quarter q. We have $\sum_{s=0}^{T-q} \omega_{q+s} = 1$. The manager's short-term incentives in quarter q—his incentives to increase P_q by a given percentage—are given by $\mathrm{E}(\frac{dW_q}{dP_q} P_q) = \mathrm{E}(\alpha_q \omega_q P_q)$, that is, the value of shares that he plans to sell in quarter q. Standard measures of incentives instead capture $\alpha_q P_q$, that is, total dollar equity holdings. Using $\alpha_q \omega_q P_q$, the amount of equity actually sold in quarter q, to proxy for $\mathrm{E}(\alpha_q \omega_q P_q)$ is also problematic due to the endogeneity concerns discussed earlier.

We thus introduce a new measure of incentives to capture $\mathrm{E}(\alpha_q \omega_q P_q)$, the CEO's concerns for the short-term stock price in particular: the effective dollar value of equity scheduled to vest in quarter q, converting options to share-equivalents using their deltas. Vesting equity leads to stock price concerns because risk-averse, undiversified executives should sell some equity upon vesting. While most CEOs hold vested equity, this may be due to various explicit or implicit constraints (documented by Armstrong, Core, and Guay 2015). Vesting relaxes these constraints, allowing the CEO to reduce risk by selling equity.

A first constraint results from ownership guidelines: requirements to hold equity in excess of a given multiple of salary or percentage of shares outstanding. These guidelines are typically satisfied only by vested equity (Core and Larcker 2002), and so vesting allows the CEO to sell equity without violating the guidelines. Second, the CEO may hold vested equity voluntarily for control reasons—he wishes to maintain voting rights in excess of a particular threshold. Since unvested equity does not provide voting rights, vesting allows additional sales without falling below the threshold. Third, the CEO may hold a threshold level of vested equity to signal confidence in the firm. In addition to releasing constraints, vesting stock also imposes a tax charge on the CEO and so he may sell equity to pay the tax.[5] Consistent with these points, we show in Section 2 that equity sales are strongly related to vesting equity, controlling for holdings of already-vested equity. Note that our identification does not require the CEO to sell his entire equity upon vesting, only that equity vesting is significantly correlated with equity sales.

We calculate vesting equity using Equilar. The SEC's compensation disclosure requirements, implemented in 2006, mandate companies to disclose grant-level (rather than merely aggregate-level) information on each stock and option award held by a top executive in their proxy statements, including whether the award is vested or unvested. Equilar tracks this information for Russell 3000 firms, versus ExecuComp, which covers only S&P 1500 firms. We purchase this data for 2006–2010.

Equilar's variable "Shares Acquired on Vesting of Stock" directly gives the number of shares that vest in a given year, either from previously restricted stock or stock units, or long-term incentive plans. To calculate the number of vesting options, we use grant-by-grant information on a given CEO's newly awarded options in year t, and his unvested options at the end of years $t–1$ and t. We group these options by the strike price and expiry date. For a given price-date pair, we infer the number of vesting options using:

$$VESTINGOPTNUM_t = UNVESTEDOPTNUM_{t-1} + NEWOPTNUM_t - UNVESTEDOPTNUM_t, \quad (2)$$

where *VESTINGOPTNUM* is the number of vesting options, *UNVESTEDOPTNUM* is the number of unvested options, and *NEWOPTNUM* is the number of newly awarded options.

The above approach yields the number of securities that vest over a given year, because Equilar provides only annual data. To closely match the timing of vesting equity to the timing of investment, we calculate vesting equity at the quarterly level, since this is the highest frequency available for investment measures. To do so, we assign vesting equity in a year to a particular quarter based on the vesting date. For options, this is simple. Options vest and expire on the anniversary of a grant, and so we can use their expiry date to infer the vesting date.[6] For stock, there is no expiry date, and grant dates are only available for shares awarded after 2006 in Equilar. We thus use the following algorithm. We first attribute vesting shares to post-2006 awards for which we know the grant dates from Equilar. Cliff-vesting grants vest at the end of the vesting period. For graded-vesting grants, we assume that they vest annually on a straight-line basis, following Gopalan et al. (2014). We then attribute the

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[5] Restricted stock represents income and so taxation is triggered upon vesting, unless a Section 83(b) election (to pay tax on the grant rather than vesting date) is made, which is uncommon.

[6] Gopalan et al. (2014) similarly assume that options vest on grant anniversaries, and we have checked this assumption by manually investigating a subsample of proxy filings that provide the full vesting schedule.

remaining vesting shares to pre-2006 grants. To approximate their grant dates, we use all grant dates of the post-2006 awards that we observe in Equilar. Specifically, if we observe n different grant dates in Equilar, we allocate the inferred vesting from pre-2006 grants evenly across the n dates.[7] This step assumes that firms grant restricted stock in the same quarter(s) of the year; indeed, out of the 1,758 sample firms that granted restricted stock more than once post 2006, 83% have repeated grants in the same month. Section 5 verifies robustness to other assumptions.

Having identified the number of vesting securities, we calculate their delta: the number of shares a security is equivalent to, from an incentive standpoint. The delta of a share is 1; we calculate the delta of an option using the Black-Scholes formula.[8] We then sum across the deltas of all of the CEO's vesting stock and options. The aggregate delta measures the dollar change in vesting equity for a $1 change in the stock price, and reflects the effective number of vesting shares. To calculate the effective value of vesting equity in quarter q, we multiply the aggregate delta by P_{q-1}. We label the resulting measure *VESTING*, and it represents the dollar change in vesting equity for a 100% change in price. Appendix B gives a sample calculation for one CEO-quarter.

Our sample for the main analyses consists of 26,724 firm-CEO-quarters; see Table 1, Panel A, for the detailed sample selection procedure. As reported in Table 1, Panel B, vesting equity has a mean of $785,000, with a mean of $566,000 ($178,000) coming from vesting options (shares). Vesting equity is zero for 62% of the firm-quarters in our sample. The coefficient of variation (standard deviation divided by the mean) of *VESTING* is 2.2 when computed separately for each CEO and then averaged, suggesting significant within-firm variation. Even setting aside the variation due to price, the average coefficients of variation are still sizable for the number of vesting shares and the number of vesting options (2.2 and 2.3, respectively).

1.2 Measurement of investment

Our first measure of investment is the quarterly change in R&D (ΔRD), scaled by lagged total assets. R&D is generally expensed and thus immediately reduces

7 If the vesting equity, calculated from post-2006 grants with known vesting schedules, exceeds "Shares Acquired on Vesting of Stock," we decrease the amount of vesting equity from each grant proportionally. Of post-2006 grants, 6.8% have an unknown vesting schedule and vesting period in Equilar. We combine them with pre-2006 grants and apply our algorithm to the combination. Less than 1% of the grants vest only after CEO retirement; we exclude them.

8 For the Black-Scholes inputs of firm volatility, dividend yield, and risk-free rate, we use Equilar for consistency with our other compensation variables. For options that vest in year t, we use inputs as of the end of year t–1, and if unavailable, as of year t. If the data is missing in Equilar, we use year t–1's inputs from ExecuComp, and year t–1's inputs from Compustat, in that order. If absent from the three databases, we calculate volatility using the standard deviation of the firm's stock returns over the past three years using the CRSP daily files; the risk-free rate using the Treasury Constant Maturity Rate with the closest term to a given option; and the dividend yield using the average of the firm's dividend yield over the past five years using the Compustat annual files. If the expiry date is missing from Equilar (which occurs for 96 out of 29,948 unvested option grants), we delete the option.

Table 1
Sample selection and summary statistics

Panel A: Sample selection

Firm-CEO-years in Equilar for which we can calculate the price sensitivity of the vesting equity of quarter q, and that of unvested and already-vested equity in year *t–1* for the sample period of fiscal year 2007 to 2010	9,385
(–) Observations that cannot be matched to Compustat or CRSP	(320)
(–) Observations associated with financial firms (SICs between 6000 and 6999)	(2,010)
(–) Observations associated with utility firms (SICs between 4900 and 4949)	(325)
Number of firm-CEO-years	6,730
Converting firm-CEO-years to firm-CEO-quarters	26,920
(–) Observations missing quarterly controls	(196)
Number of firm-CEO-quarters in the final sample	26,724
Number of unique firms in the final sample	2,043

Panel B: Summary statistics

Variable	***N***	**5%**	**Mean**	**Median**	**95%**	**SD**
Dependent variables of the main specification: Change in investment						
ΔRD_q	26,724	−0.007	0.000	0.000	0.008	0.007
$\Delta CAPEX_q$	26,724	−0.013	0.000	0.000	0.013	0.010
$\Delta NETINV_q$	26,724	−0.026	0.001	0.000	0.029	0.025
$\Delta RDCAPEX_q$	26,724	−0.020	0.000	0.000	0.021	0.014
$\Delta RDNETINV_q$	26,724	−0.032	0.001	0.000	0.035	0.029
Key independent variables of the main specification: CEO incentives from vesting equity						
$VESTING_q$	26,724	0	785,139	0	4,457,005	2,321,968
$VESTINGSTOCK_q$	26,724	0	177,891	0	1,104,233	646,830
$VESTINGOPT_q$	26,724	0	566,498	0	3,359,160	1,863,655
Other independent variables of the main specification: Annual controls						
$UNVESTED_{q-1}$	6,730	0	5,656,486	1,835,151	25,000,000	10,200,000
$VESTED_{q-1}$	6,730	415,985	70,400,000	13,300,000	298,000,000	205,000,000
$SALARY_{q-1}$	6,730	265,000	670,194	600,000	1,300,000	336,489
$BONUS_{q-1}$	6,730	0	167,704	0	979,620	483,780
$CEOAGE_{q-1}$	6,730	42	54	54	67	8
$CEOTENURE_{q-1}$	6,730	0	7	5	22	7
$NEWCEO_q$	6,730	0	0.004	0	0	0.064
$FIRMAGE_{q-1}$	6,730	4	21	15	57	16
Other independent variables of the main specification: Quarterly controls						
Q_q	26,724	0.525	1.687	1.260	4.454	1.332
Q_{q-1}	26,724	0.527	1.711	1.282	4.523	1.352
MV_{q-1}	26,724	4.626	6.931	6.732	9.924	1.597
MOM_{q-1}	26,724	−0.312	0.029	0.007	0.448	0.237
$CASH_{q-1}$	26,724	0.006	0.199	0.116	0.681	0.217
$BOOKLEV_{q-1}$	26,724	0.000	0.215	0.174	0.640	0.215
$RETEARN_{q-1}$	26,724	−2.557	−0.200	0.162	0.726	1.404
ROA_{q-1}	26,724	−0.102	0.001	0.012	0.051	0.052
Endogenous variable of interest: Equity sold						
$EQUITYSOLD_q$	26,724	0	874,992	0	4,960,305	3,030,349
Other operating performance measures						
SGR_q	26,385	−1.371	−0.879	−0.933	−0.263	0.424
$\Delta COGS_q$	26,325	−0.093	−0.004	0.000	0.083	0.272
$\Delta OPEXP_q$	26,322	−0.169	−0.005	−0.002	0.147	0.376

Summary statistics of the main variables used in our multivariate analysis. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are in Appendix A.

earnings. However, the cash flows created by R&D typically only arise in the long term, and so it is difficult for even a forward-looking market to assess them immediately and incorporate them into the stock price. Consistent with this view, prior literature finds that managers use R&D cuts to increase short-run earnings.[9] Following Himmelberg, Hubbard, and Palia (1999), we set missing R&D values to zero. The results are robust to removing observations with missing R&D, despite a much smaller sample.

We also calculate the quarterly change in capital expenditure ($\Delta CAPEX$) and net investment (Δ*NETINV*), scaled by lagged total assets. While *CAPEX* is taken directly from the cash flow statement, *NETINV* is the change in Net Property, Plant, and Equipment from the balance sheet. The latter is net of accumulated depreciation while the former is not. Although capital expenditure is not expensed, it depresses earnings through raising depreciation. In addition, it is typically financed by reducing cash or increasing debt. This increases a firm's net interest expense, reducing earnings, and also worsens the firm's solvency ratios, which may enter into market valuations. As two additional measures, we consider the change in scaled R&D plus either measure of capital expenditure (Δ*RDCAPEX* and Δ*RDNETINV*). We use "investment" as an umbrella term to encapsulate the five different measures: *RD*, *CAPEX*, *NETINV*, *RDCAPEX*, and *RDNETINV*. The average scaled change in investment is very close to zero, as shown in Table 1, Panel B.

1.3 Control variables

Our first set of controls contains other components of CEO pay. For a given quarter *q* of year *t* in which we measure vesting, we calculate all controls at the end of quarter *q–1*, unless otherwise specified. When a control is not available at the quarterly level, we proxy for it using the annual variable. We include $VESTED_{q-1}$, the sensitivity of all stock and options that had vested by the end of year *t–1*, and $UNVESTED_{q-1}$, the sensitivity of unvested equity at the end of year *t–1* minus any equity scheduled to vest in year *t*.[10] The direction of any correlation between these two variables and investment is unclear. While already-vested equity could deter investment if the CEO intends to sell it in the short run, his decision to hold onto vested equity is endogenous. For example, if the CEO has positive private information on investment opportunities, he may retain vested equity and also increase investment. While unvested equity may decrease myopia if it is scheduled to vest far in the future, it may exacerbate

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9 Graham, Harvey, and Rajgopal (2005) report that 80% of managers would cut discretionary expenditure on R&D, advertising, and maintenance to meet earnings targets. Bushee (1998) finds that investors who trade on earnings induce managers to cut R&D to meet earnings targets. Roychowdhury (2006) shows that firms manipulate earnings through real activities, including cuts in discretionary spending, to avoid reporting losses. Bhojraj et al. (2009) find that firms that beat analyst consensus forecasts by reducing discretionary spending enjoy a short-term stock price gain that is reversed in the long run. Chan, Lakonishok, and Sougiannis (2001) provide evidence that R&D is underpriced by the market, suggesting that a cut in R&D could boost the short-term stock price. These results are inconsistent with the hypothesis that a cut in R&D signals poor investment opportunities (Bebchuk and Stole 1993). Any such effect would work against finding a negative association between R&D and vesting equity.

10 In very rare cases, vesting equity can exceed unvested equity at the end of year *t–1* because some unvested options have been canceled during the year, rather than being vested. We set *UNVESTED* to zero in such cases.

myopia if scheduled to vest shortly after q. Separately, Laux (2012) shows theoretically that unvested equity may exacerbate short-termism because the CEO takes actions to avoid being fired and forfeiting his unvested equity. Table 1, Panel B, shows that the mean amount of unvested equity is \$5,656,000, compared with the mean vesting equity of \$785,000. This puts a limit on the amount of value erosion—and thus investment cuts—that a rational CEO will undertake in order to boost the short-term stock price. We also include two other compensation components: $SALARY_{q-1}$ and $BONUS_{q-1}$, the CEO's salary and bonus in year *t–1*.

The second set of controls is CEO characteristics: $CEOAGE_{q-1}$ and $CEOTENURE_{q-1}$ (CEO age and tenure of year *t–1*) and $NEWCEO_q$ (a new CEO indicator coded for year *t*). We include these controls for a number of reasons. First, career concerns may deter myopia if it has negative long-run consequences (as we explore further in Section 3). Second, Pan, Wang, and Weisbach (2016) find that investment increases with tenure. Third, Gopalan, Huang, and Maharjan (2015) show that vesting equity leads to an increased probability of CEO turnover, and so any change in investment may result from such transitions.

Our final set of controls is at the firm level; most are taken from Asker, Farre-Mensa, and Ljungqvist (2015). The first five variables proxy for investment opportunities: Tobin's q at the end of quarter q and *q–1* (Q_q, Q_{q-1}), the compounded monthly market-adjusted stock return over quarter *q–1* (MOM_{q-1}), the log of market equity (MV_{q-1}), and firm age ($FIRMAGE_{q-1}$ measured for year *t–1*). Note that size and age also proxy for financial constraints (Hadlock and Pierce 2010). The remainder measure profitability and financial strength: cash and short-term investments ($CASH_{q-1}$), book leverage ($BOOKLEV_{q-1}$), retained earnings ($RETEARN_{q-1}$), and the return-on-assets ratio (ROA_{q-1}).

2. Investment

2.1 Equity vesting and investment

We run the following ordinary least squares (OLS) regression on a panel of firms, omitting the firm subscript for brevity:

$$\Delta INV_q = \alpha + \beta VESTING_q + \gamma CONTROLS_{q-1} + \varepsilon_q, \tag{3}$$

where ΔINV_q is the change in one of the five investment variables from quarter *q–1* to q.

We measure *VESTING* over quarter q, the same time period as ΔINV, because the CEO knows at the start of quarter q how much equity will vest over that quarter, and so may cut investment accordingly. Our hypothesis is that $\beta < 0$. The control variables *CONTROLS* are as discussed in Section 1.3. We use year fixed effects to control for common shocks to investment opportunities, quarter fixed effects to control for potential seasonalities in vesting and investment, and firm fixed effects to control for firm-level heterogeneity in investment opportunities, and we cluster standard errors at the firm level.[11] The inclusion of firm fixed effects means that our identification is based on within-firm variation in *VESTING*, which is sizable, as discussed in Section 1.1.

Table 2 shows that vesting equity is associated with declines in all five measures of investment growth, significant at the 1% level for four measures and the 5% level for the fifth. A one-standard-deviation increase in *VESTING* is associated with an annualized 0.2% decline in Δ*RDNETINV*, 11% of the average investment-to-assets ratio. This corresponds to a decline in investment of $1.8 million per year, based on the median total assets of $856 million. To our knowledge, these are the first results to link a measure of the CEO's short-term incentives to real investment decisions. These magnitudes are economically meaningful but also plausible: too large a decline may prompt the board to step in and block it; in addition, as noted earlier, the CEO's unvested equity will limit the amount of investment cuts that a rational CEO will undertake.

Turning to the other covariates, *UNVESTED* is insignificant in all specifications, consistent with the theoretical ambiguity discussed in Section 1.3. *VESTED* is negatively significant at the 10% level in two specifications and insignificant in the other three. These coefficients are difficult to interpret since the CEO's holdings of vested equity are endogenous, as discussed earlier. Investment growth is generally positively related to investment opportunities, as measured by Tobin's q and momentum, and negatively related to firm size. It is positively related to cash holdings and the negative of book leverage, two measures of the firm's ability to fund investment. The three CEO characteristics (age, tenure, and a new CEO indicator) are insignificant in all specifications.

Our use of vesting equity is motivated by it being determined by equity grants made several years prior. While true for grants with time-based vesting, performance-based vesting is becoming more common, and performance that triggers vesting may be correlated with investment opportunities. Bettis et al. (2010) find that 46% of performance-based vesting provisions are contingent on stock price thresholds, twice as frequent as the next category. Since high stock returns likely indicate good investment opportunities, stock-price-based vesting would yield a positive relationship between vesting equity and investment, contrary to Table 2; we also control for past stock returns. However, reverse causality may be a concern if the provision is contingent on accounting thresholds (23% of cases): investment cuts may increase earnings and trigger vesting.

We conduct two robustness checks to address this concern. First, we recalculate *VESTING* including only time-based vesting grants. We remove post-2006 grants labeled "performance-based," "contingent," or "accelerated;" post-2006 grants with unknown vesting schedule; and pre-2006 grants, and

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[11] Our results are robust to replacing firm fixed effects with CEO fixed effects to capture CEO preferences toward investment (e.g., from overconfidence or risk aversion), or to excluding firm fixed effects.

Table 2
Vesting equity and change in investment

	(1)	(2)	(3)	(4)	(5)
Dependent variables	ΔRD_q	$\Delta CAPEX_q$	$\Delta NETINV_q$	$\Delta RDCAPEX_q$	$\Delta RDNETINV_q$
$VESTING_q$	**−0.060*****	**−0.089*****	**−0.149****	**−0.159*****	**−0.224*****
	(0.021)	(0.025)	(0.067)	(0.039)	(0.079)
$UNVESTED_{q-1}$	−0.003	0.004	0.051	0.002	0.054
	(0.009)	(0.013)	(0.036)	(0.018)	(0.040)
$VESTED_{q-1}$	−0.001*	0.002	−0.006	0.001	−0.008*
	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)
$SALARY_{q-1}$	−0.341	−0.274	4.200	−0.662	3.952
	(0.618)	(0.996)	(2.765)	(1.387)	(3.040)
$BONUS_{q-1}$	−0.047	−0.189	−0.334	−0.281	−0.433
	(0.142)	(0.240)	(0.628)	(0.338)	(0.688)
$CEOAGE_{q-1}$	0.001	0.002	0.005	0.003	0.011
	(0.003)	(0.003)	(0.009)	(0.005)	(0.010)
$CEOTENURE_{q-1}$	−0.000	−0.001	−0.000	−0.001	−0.005
	(0.003)	(0.004)	(0.010)	(0.006)	(0.012)
$NEWCEO_q$	0.000	−0.000	−0.002	0.001	−0.002
	(0.001)	(0.001)	(0.003)	(0.002)	(0.004)
$FIRMAGE_{q-1}$	0.020	0.588***	0.013	0.669**	−0.005
	(0.079)	(0.226)	(0.740)	(0.299)	(0.787)
Q_q	0.000*	0.000	0.004***	0.001**	0.005***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Q_{q-1}	0.000	−0.000	−0.002***	0.000	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
MV_{q-1}	−0.001***	0.000*	−0.004***	−0.000	−0.005***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
MOM_{q-1}	0.000	0.002***	0.001	0.002***	0.001
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
$CASH_{q-1}$	0.004***	0.011***	0.041***	0.016***	0.048***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.003)
$BOOKLEV_{q-1}$	−0.001	−0.006***	−0.021***	−0.008***	−0.023***
	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)
$RETEARN_{q-1}$	0.000	−0.000**	0.000	−0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
ROA_{q-1}	0.014***	0.010***	−0.056***	0.027***	−0.036***
	(0.002)	(0.002)	(0.008)	(0.004)	(0.010)
Intercept	−0.004	−0.121***	0.013	−0.137**	0.017
	(0.015)	(0.044)	(0.144)	(0.058)	(0.153)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	26,724	26,724	26,724	26,724	26,724
Adjusted R^2	0.093	0.066	0.053	0.099	0.058

OLS regression results on the relationship between the CEO's vesting equity and the change in investment. Variable definitions are in Appendix A. *VESTING*, *UNVESTED*, *VESTED*, *SALARY*, and *BONUS* are in billions. *CEOAGE*, *CEOTENURE*, and *FIRMAGE* are in hundreds. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1% 5%, and 10% two-tailed levels, respectively.

we denote the resulting measure as *VESTING_TB*. Table 3, Panel A, reports results similar to those in Table 2, with the coefficient on *VESTING_TB* being negative and significant in all five specifications. Second, Gopalan et al. (2014) report that 35.3% of stock in the Equilar dataset exhibits performance-based vesting, compared with only 1.9% of options, and so the concern is significant for stock but not options. Table 1, Panel B, shows that the mean value of vesting options is over three times that of vesting stock, and so *VESTING*

Table 3
Time-based vesting vs. performance-based vesting

Panel A: Deleting performance-based vesting equity

	(1)	(2)	(3)	(4)	(5)
Dependent variables	ΔRD_q	$\Delta CAPEX_q$	$\Delta NETINV_q$	$\Delta RDCAPEX_q$	$\Delta RDNETINV_q$
$VESTING\_TB_q$	**−0.132*****	**−0.135*****	**−0.371*****	**−0.304*****	**−0.569*****
	(0.044)	(0.052)	(0.136)	(0.081)	(0.160)
$UNVESTED_{q-1}$	−0.004	0.003	0.051	0.001	0.053
	(0.009)	(0.013)	(0.036)	(0.017)	(0.040)
$VESTED_{q-1}$	−0.001*	0.002	−0.006	0.000	−0.008*
	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)
$SALARY_{q-1}$	−0.338	−0.286	4.219	−0.667	3.983
	(0.618)	(0.996)	(2.764)	(1.387)	(3.039)
$BONUS_{q-1}$	−0.040	−0.179	−0.315	−0.263	−0.405
	(0.143)	(0.240)	(0.628)	(0.338)	(0.688)
$CEOAGE_{q-1}$	0.001	0.002	0.005	0.003	0.011
	(0.003)	(0.003)	(0.009)	(0.005)	(0.010)
$CEOTENURE_{q-1}$	−0.000	−0.001	−0.000	−0.001	−0.005
	(0.003)	(0.004)	(0.010)	(0.006)	(0.012)
$NEWCEO_q$	0.000	−0.000	−0.002	0.001	−0.002
	(0.001)	(0.001)	(0.003)	(0.002)	(0.004)
$FIRMAGE_{q-1}$	0.019	0.587***	0.009	0.666**	−0.010
	(0.079)	(0.226)	(0.740)	(0.299)	(0.788)
Q_q	0.000*	0.000	0.004***	0.001**	0.005***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Q_{q-1}	0.000	−0.000	−0.002***	0.000	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
MV_{q-1}	−0.001***	0.000*	−0.004***	−0.000	−0.005***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
MOM_{q-1}	0.000	0.002***	0.001	0.002***	0.001
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
$CASH_{q-1}$	0.004***	0.011***	0.041***	0.016***	0.048***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.003)
$BOOKLEV_{q-1}$	−0.001	−0.006***	−0.021***	−0.008***	−0.023***
	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)
$RETEARN_{q-1}$	0.000	−0.000**	0.000	−0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
ROA_{q-1}	0.014***	0.010***	−0.056***	0.027***	−0.036***
	(0.002)	(0.002)	(0.008)	(0.004)	(0.010)
Intercept	−0.004	−0.121***	0.014	−0.136**	0.018
	(0.015)	(0.044)	(0.144)	(0.058)	(0.153)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	26,724	26,724	26,724	26,724	26,724
Adjusted R^2	0.093	0.066	0.053	0.099	0.058

OLS regression results on the relationship between the CEO's vesting equity and the change in investment. Variable definitions are in Appendix A. *VESTING_TB* includes only post-2006 time-based vesting grants. *VESTING_TB*, *UNVESTED*, *VESTED*, *SALARY*, and *BONUS* are in billions. *CEOAGE*, *CEOTENURE*, and *FIRMAGE* are in hundreds. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

is predominantly composed of options, for which performance-based vesting is rare. In addition, in Table 3, Panel B, we replace *VESTING* with the separate variables *VESTINGSTOCK* and *VESTINGOPT*. Both variables are negative in all specifications, with the former significant in two and the latter significant in four. Thus, the results remain strong for vesting options, for which performance-based vesting is a less significant concern.

Table 3
Continued

Panel B: Separating *VESTING* into *VESTINGSTOCK* and *VESTINGOPT*

	(1)	(2)	(3)	(4)	(5)
Dependent variables	ΔRD_q	$\Delta CAPEX_q$	$\Delta NETINV_q$	$\Delta RDCAPEX_q$	$\Delta RDNETINV_q$
$VESTINGSTOCK_q$	**−0.129****	**−0.217***	**−0.448**	**−0.030**	**−0.219**
	(0.065)	(0.112)	(0.282)	(0.145)	(0.307)
$VESTINGOPT_q$	**−0.102*****	**−0.079****	**−0.097**	**−0.210*****	**−0.240****
	(0.028)	(0.031)	(0.085)	(0.050)	(0.102)
$UNVESTED_{q-1}$	−0.003	0.004	0.051	0.002	0.054
	(0.009)	(0.013)	(0.036)	(0.018)	(0.040)
$VESTED_{q-1}$	−0.001*	0.002	−0.006	0.001	−0.008*
	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)
$SALARY_{q-1}$	−0.343	−0.271	4.198	−0.659	3.949
	(0.618)	(0.996)	(2.766)	(1.387)	(3.042)
$BONUS_{q-1}$	−0.043	−0.188	−0.332	−0.275	−0.426
	(0.142)	(0.240)	(0.628)	(0.338)	(0.688)
$CEOAGE_{q-1}$	0.001	0.002	0.005	0.003	0.010
	(0.003)	(0.003)	(0.009)	(0.005)	(0.010)
$CEOTENURE_{q-1}$	−0.000	−0.001	−0.000	−0.001	−0.005
	(0.003)	(0.004)	(0.010)	(0.006)	(0.012)
$NEWCEO_q$	0.000	−0.000	−0.002	0.001	−0.002
	(0.001)	(0.001)	(0.003)	(0.002)	(0.004)
$FIRMAGE_{q-1}$	0.016	0.588***	0.014	0.664**	−0.009
	(0.079)	(0.226)	(0.740)	(0.299)	(0.788)
Q_q	0.000*	0.000	0.004***	0.001**	0.005***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Q_{q-1}	0.000	−0.000	−0.002***	0.000	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
MV_{q-1}	−0.001***	0.000**	−0.004***	−0.000	−0.005***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
MOM_{q-1}	0.000	0.002***	0.001	0.002***	0.001
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
$CASH_{q-1}$	0.004***	0.011***	0.041***	0.016***	0.048***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.003)
$BOOKLEV_{q-1}$	−0.001	−0.006***	−0.021***	−0.008***	−0.023***
	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)
$RETEARN_{q-1}$	0.000	−0.000**	0.000	−0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
ROA_{q-1}	0.014***	0.010***	−0.056***	0.027***	−0.036***
	(0.002)	(0.002)	(0.008)	(0.004)	(0.010)
Intercept	−0.003	−0.121***	0.013	−0.135**	0.018
	(0.015)	(0.044)	(0.144)	(0.058)	(0.153)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	26,724	26,724	26,724	26,724	26,724
Adjusted R^2	0.093	0.066	0.053	0.099	0.058

OLS regression results on the relationship between the CEO's vesting equity and the change in investment. Variable definitions are in Appendix A. *VESTING*, *VESTINGSTOCK*, *VESTINGOPT*, *UNVESTED*, *VESTED*, *SALARY*, and *BONUS* are in billions. *CEOAGE*, *CEOTENURE*, and *FIRMAGE* are in hundreds. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

2.2 Equity sales and investment

The analysis in Section 2.1 shows a negative effect of vesting equity on investment. Our proposed mechanism is that vesting equity increases the CEO's equity sales and thus his concern for the current stock price. This section examines this economic mechanism directly by using vesting equity as an instrument for equity sales in a 2SLS analysis. Two of the properties of vesting equity discussed earlier—its high correlation with equity sales and its determination by equity grants several years prior—are analogous to the relevance criterion and the exclusion restriction for a valid instrument. We run the following 2SLS procedure:

$$EQUITYSOLD_q = \alpha_1 + \beta_1 VESTING_q + \gamma_1 CONTROLS_{q-1} + \varepsilon_{1q}, \quad (4)$$

$$\Delta INV_q = \alpha_2 + \beta_2 FIT\_EQUITYSOLD_q + \gamma_2 CONTROLS_{q-1} + \varepsilon_{2q}, \quad (5)$$

We calculate the number of shares sold by the CEO in a given quarter using Form 4 filed with the SEC and compiled by the Thomson Financial Insider Trading database. This database covers both standard sales and sales of shares acquired upon option exercises. We multiply the number of shares sold during quarter q by P_{q-1} to form $EQUITYSOLD_q$, the dollar value of equity sold. Similar to *VESTING*, *EQUITYSOLD* is zero for 68% of the firm-quarters in our sample.

The first column in Table 4 presents the first-stage results. The coefficient on *VESTING* is positive and significant at the 1% level. A one-standard-deviation increase in *VESTING* is associated with a rise in *EQUITYSOLD* by $140,000, 16% of the average level. The underidentification test strongly rejects the null of no correlation between our instrument and equity sales—the Cragg-Donald F-statistic is 53.03, significantly higher than the Stock and Yogo (2005) critical value of 16.38 for a 10% maximal bias of the instrumental variable estimator relative to OLS. The result that vesting equity is correlated with same-quarter equity sales is consistent with diversification motives, and also with Edmans et al.'s (2017) finding that CEOs typically sell equity in the vesting month.

The remaining columns show the second-stage results. The coefficients on instrumented equity sales (*FIT_EQUITYSOLD*) are negative and significant at the 1% level in three regressions and at the 5% level in two, consistent with the reduced-form regressions in Table 2. In terms of economic significance, an interquartile change in equity sales is associated with an annualized decline in $\Delta RDNETINV$ of 0.2%.[12] In untabulated results, this decline is insignificant and close to zero when conducting an OLS regression of investment growth on actual equity sales (and controls). This suggests that the main endogeneity issue with using actual sales is likely measurement error: actual sales are a mismeasured proxy for anticipated equity sales because they include unanticipated liquidity sales that are unlikely to drive investment.

12 The interpretation of economic significance in the 2SLS model is difficult because we do not observe the distribution of anticipated sales (our variable of interest). The dispersion of actual sales is likely larger than that of anticipated sales if actual sales contain an unanticipated component. To mitigate this issue, we use an interquartile range of actual sales rather than its standard deviation, as the latter would be more susceptible to outliers in unanticipated sales.

Table 4
Equity sales and change in investment: 2SLS analysis

	(1)	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)
Dependent variables	$EQUITY\_SOLD_q$	ΔRD_q	$\Delta CAPEX_q$	$\Delta NETINV_q$	$\Delta RDCAPEX_q$	$\Delta RDNETINV_q$
$VESTING_q$	**0.059***					
	(0.008)					
$FIT\_EQUITYSOLD_q$		**−1.032**	**−1.511***	**−2.546**	**−2.718***	**−3.826***
		(0.448)	(0.576)	(1.284)	(0.950)	(1.622)
$UNVESTED_{q-1}$	−0.004	−0.008	−0.003	0.040	−0.010	0.037
	(0.004)	(0.011)	(0.017)	(0.040)	(0.025)	(0.048)
$VESTED_{q-1}$	0.003***	0.002	0.006***	0.001	0.008**	0.002
	(0.000)	(0.001)	(0.002)	(0.005)	(0.003)	(0.006)
$SALARY_{q-1}$	0.846***	0.532	1.005	6.355**	1.638	7.191**
	(0.260)	(0.846)	(1.250)	(3.106)	(1.928)	(3.646)
$BONUS_{q-1}$	−0.090	−0.139	−0.324	−0.562	−0.525	−0.776
	(0.060)	(0.171)	(0.277)	(0.668)	(0.418)	(0.768)
$CEOAGE_{q-1}$	0.001	0.002	0.003	0.007	0.005	0.013
	(0.001)	(0.003)	(0.004)	(0.009)	(0.005)	(0.011)
$CEOTENURE_{q-1}$	0.005***	0.005	0.007	0.013	0.013	0.014
	(0.001)	(0.004)	(0.005)	(0.013)	(0.008)	(0.015)
$NEWCEO_q$	0.000	−0.000	−0.001	−0.003	−0.001	−0.004
	(0.000)	(0.001)	(0.001)	(0.003)	(0.002)	(0.004)
$FIRMAGE_{q-1}$	0.050	0.072	0.665***	0.141	0.806**	0.188
	(0.039)	(0.094)	(0.236)	(0.747)	(0.323)	(0.802)
Q_q	0.000***	0.001***	0.001***	0.005***	0.002***	0.006***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Q_{q-1}	0.000	0.000	−0.000	−0.002***	−0.000	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
MV_{q-1}	0.000***	−0.000	0.001***	−0.004***	0.000	−0.004***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
MOM_{q-1}	0.000*	0.000*	0.002***	0.001	0.003***	0.002
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
$CASH_{q-1}$	0.000	0.004***	0.011***	0.042***	0.017***	0.050***
	(0.000)	(0.001)	(0.001)	(0.003)	(0.002)	(0.004)
$BOOKLEV_{q-1}$	0.000	−0.001	−0.006***	−0.020***	−0.008***	−0.022***
	(0.000)	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)
$RETEARN_{q-1}$	0.000	0.000	−0.000*	0.000	−0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
ROA_{q-1}	0.001**	0.015***	0.011***	−0.054***	0.030***	−0.031***
	(0.001)	(0.002)	(0.003)	(0.008)	(0.004)	(0.010)
Intercept	−0.030	−0.005**	−0.007	0.003	−0.012	−0.004
	(0.022)	(0.002)	(0.011)	(0.014)	(0.012)	(0.016)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26,724	26,724	26,724	26,724	26,724	26,724
Adjusted R^2 (R^2)	0.246	0.093	0.066	0.053	0.099	0.057

Cragg-Donald F-statistic: 53.03. Stock-Yogo (2005) critical value for 10% maximal IV size: 16.38.

2SLS regression results on the relationship between the CEO's equity sales and the change in investment, using *VESTING* as an instrument for *EQUITYSOLD*. Variable definitions are in Appendix A. Column (1) presents the first-stage results associated with column (2.1), and columns (2.1)–(2.5) present the second-stage results for the five different investment measures. Variable definitions are in Appendix A. *FIT_EQUITYSOLD* is the fitted value of *EQUITYSOLD* from the first-stage regressions. *EQUITYSOLD*, *VESTING*, *UNVESTED*, *VESTED*, *SALARY*, and *BONUS* are in billions. *CEOAGE*, *CEOTENURE*, and *FIRMAGE* are in hundreds. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

3. Alternative Hypotheses

The results of Tables 2–4 show that vesting equity is significantly associated with declines in investment growth. One interpretation, consistent with our motivation, is that short-term stock price concerns lead the CEO to inefficiently reduce positive-NPV investments (the myopia hypothesis). However, the results also admit alternative explanations. One is the efficiency hypothesis: CEOs overinvest on average, and short-term stock price concerns induce them to cut wasteful expenditure, similar to the CEO restraint studied by Jacobsen (2014). Under this hypothesis, the reduction in investment is efficient; it increases rather than decreases long-run value. Note that this hypothesis is still consistent with a causal interpretation—that CEO contracts have real effects. A second is the timing hypothesis: boards design contracts so that equity vests when investment opportunities decline. This explanation requires that boards forecast quarter-level declines in investment opportunities several years in advance.

Although it is difficult to fully differentiate between these explanations, we conduct a number of tests to evaluate them. We first investigate the timing hypothesis. In Table 5, following Gopalan, Huang, and Maharjan (2015), we keep only equity grants made at least two years prior to the end of quarter q when calculating vesting equity; we call this measure *VESTING>2Y*. Since it is likely harder for boards to forecast investment opportunities two or more years in advance, the timing hypothesis suggests a weaker relation between *VESTING>2Y* and investment. To be conservative, we also remove all grants made prior to 2006, for which we cannot observe the grant date. Many of these grants will have been awarded more than two years before quarter q, and so removing them reduces power. Nevertheless, *VESTING>2Y* is negatively significant at the 1% level in two specifications, the 5% level in two, and the 10% level in one.

To examine the efficiency hypothesis, we investigate the link between vesting and contemporaneous changes in operating performance. If stock price concerns induce the CEO to increase efficiency, this is likely to manifest in not only the scrapping of inefficient investment projects, but also increases in efficiency in other dimensions—for example, higher sales and lower non-investment expenses. We calculate three measures to gauge the extent to which the CEO is improving efficiency more generally: *SGR*, sales growth from quarter *q–4* to q, the change in *COGS* (the ratio of the cost of goods sold to sales) from quarter *q–1* to q, and the change in *OPEXP* (the ratio of operating expenses to sales) from quarter *q–1* to q. Just as cuts in investment are not definitively an indicator of myopia (rather than efficiency), it is impossible to identify cuts in other expenses that are definitively an indicator of efficiency (rather than myopia). However, cuts in *COGS* and *OPEXP* are less likely to be at the expense of long-run value than cuts in investment, since many of these expenses do not improve long-term value—for example, overspending

Table 5
Keeping grants made at least two years ago

	(1)	(2)	(3)	(4)	(5)
Dependent variables	ΔRD_q	$\Delta CAPEX_q$	$\Delta NETINV_q$	$\Delta RDCAPEX_q$	$\Delta RDNETINV_q$
$VESTING{>}2Y_q$	**−1.379****	**−0.309*****	**−0.454***	**−0.430*****	**−0.596****
	(0.700)	(0.090)	(0.239)	(0.130)	(0.264)
$UNVESTED_{q-1}$	−0.005	0.002	0.048	−0.001	0.050
	(0.009)	(0.013)	(0.036)	(0.018)	(0.040)
$VESTED_{q-1}$	−0.001*	0.002	−0.006	0.000	−0.008*
	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)
$SALARY_{q-1}$	−0.364	−0.222	4.266	−0.609	4.023
	(0.619)	(0.996)	(2.766)	(1.386)	(3.040)
$BONUS_{q-1}$	−0.043	−0.198	−0.345	−0.291	−0.446
	(0.143)	(0.240)	(0.628)	(0.339)	(0.688)
$CEOAGE_{q-1}$	0.001	0.002	0.006	0.004	0.011
	(0.003)	(0.003)	(0.009)	(0.005)	(0.010)
$CEOTENURE_{q-1}$	−0.000	−0.001	0.000	−0.000	−0.005
	(0.003)	(0.004)	(0.010)	(0.006)	(0.012)
$NEWCEO_q$	0.000	−0.000	−0.002	0.001	−0.002
	(0.001)	(0.001)	(0.003)	(0.002)	(0.004)
$FIRMAGE_{q-1}$	0.021	0.586***	0.009	0.666**	−0.009
	(0.079)	(0.226)	(0.740)	(0.299)	(0.788)
Q_q	0.000*	0.000	0.004***	0.001**	0.005***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Q_{q-1}	0.000	−0.000	−0.002***	0.000	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
MV_{q-1}	−0.001***	0.000**	−0.004***	−0.000	−0.005***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
MOM_{q-1}	0.000	0.002***	0.001	0.002***	0.001
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
$CASH_{q-1}$	0.004***	0.011***	0.041***	0.016***	0.048***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.003)
$BOOKLEV_{q-1}$	−0.001	−0.006***	−0.021***	−0.008***	−0.023***
	(0.001)	(0.001)	(0.004)	(0.002)	(0.004)
$RETEARN_{q-1}$	0.000	−0.000**	0.000	−0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
ROA_{q-1}	0.014***	0.010***	−0.056***	0.027***	−0.036***
	(0.002)	(0.002)	(0.008)	(0.004)	(0.010)
Intercept	−0.004	−0.121***	0.014	−0.136**	0.017
	(0.015)	(0.044)	(0.144)	(0.058)	(0.153)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	26,724	26,724	26,724	26,724	26,724
Adjusted R^2	0.093	0.066	0.053	0.099	0.058

OLS regression results on the relationship between the CEO's vesting equity and the change in investment. Variable definitions are in Appendix A. *VESTING>2Y* includes only post-2006 grants that are awarded at least two years prior to the end of quarter q. *VESTING>2Y*, *UNVESTED*, *VESTED*, *SALARY*, and *BONUS* are in billions. *CEOAGE*, *CEOTENURE*, and *FIRMAGE* are in hundreds. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

on raw materials due to inefficient sourcing or production. Indeed, investors and analysts typically use the cost of goods sold and operating expense ratios to measure a firm's efficiency. We use the same controls as in Table 2.

Table 6 demonstrates no significant relationship between vesting equity and any of the three performance measures. While far from definitive, these results are not consistent with the hypothesis that vesting equity induces the CEO to engage in general improvements in efficiency.

Table 6
Vesting equity and change in operating performance measures

	(1)	(2)	(3)
Dependent variables	SGR_q	$\Delta COGS_q$	$\Delta OPEXP_q$
$VESTING_q$	**0.017**	**0.056**	**0.062**
	(0.030)	(0.065)	(0.068)
$UNVESTED_{q-1}$	−0.005	−0.046	−0.056
	(0.007)	(0.037)	(0.040)
$VESTED_{q-1}$	−0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
$SALARY_{q-1}$	−0.724**	0.055	0.350
	(0.335)	(0.542)	(0.646)
$BONUS_{q-1}$	0.014	−0.254	−0.270
	(0.096)	(0.176)	(0.179)
$CEOAGE_{q-1}$	0.013	−0.002	−0.002
	(0.013)	(0.013)	(0.023)
$CEOTENURE_{q-1}$	0.004	−0.011	0.007
	(0.013)	(0.022)	(0.039)
$NEWCEO_q$	0.120	−0.503	−1.176
	(0.404)	(0.386)	(0.803)
$FIRMAGE_{q-1}$	0.506	0.176	0.688
	(0.669)	(2.827)	(3.251)
Q_q	0.175	−0.425	−1.482
	(0.188)	(2.776)	(3.109)
Q_{q-1}	0.264	−0.505	−0.175
	(0.447)	(0.667)	(0.750)
MV_{q-1}	−0.218	−1.686	−2.860
	(0.513)	(2.574)	(3.056)
MOM_{q-1}	1.274	0.315	0.893
	(0.902)	(0.362)	(0.939)
$CASH_{q-1}$	−3.995	−1.835	−2.023
	(3.549)	(3.461)	(3.792)
$BOOKLEV_{q-1}$	−3.510	4.782	0.227
	(4.268)	(4.159)	(5.158)
$RETEARN_{q-1}$	0.730	−1.074	−5.262
	(0.935)	(1.599)	(3.280)
ROA_{q-1}	−2.934	30.935**	28.012*
	(4.789)	(12.100)	(15.567)
Intercept	−27.534	−2.095	−14.545
	(18.451)	(9.329)	(19.864)
Year fixed effects	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Observations	26,385	26,325	26,322
Adjusted R^2	0.234	0.023	0.039

OLS regression results on the relationship between the CEO's vesting equity and the change in operating performance. Variable definitions are in Appendix A. *VESTING*, *UNVESTED*, *VESTED*, *SALARY*, and *BONUS* are in millions. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

Next, we conduct three sets of cross-sectional analyses that shed further light on all three hypotheses. The first set of analyses split the sample based on firms' institutional ownership and block ownership. Our motivation is that, since institutions and blockholders have larger stakes than retail investors, they have stronger incentives to acquire and trade on information about long-run value rather than passively relying on short-term earnings numbers (as shown theoretically by Edmans 2009). Indeed, Aghion, van Reenen, and

Zingales (2013) find that institutional ownership has a positive causal effect on innovation. Thus, under the myopia hypothesis, investment cuts induced by vesting should decline with institutional or block ownership: since institutions and blockholders place greater weight on long-run value than short-term earnings when evaluating the firm, a CEO attempting to boost the stock price has less incentive to increase short-term earnings at the expense of long-run value. In contrast, the predictions under the efficiency hypothesis are more ambiguous: they depend on whether equity incentives and ownership have independent, complementary, or substitute effects on CEO behavior, and it is difficult to predict the direction of complementarity ex ante. For example, if blockholders complement the effects of equity incentives, we might see stronger vesting-induced efficiency improvements in high–block ownership firms.[13] The same ambiguity arises for the timing hypothesis: if blockholders and equity incentives are complements, equity incentives have greater effects in the presence of blockholders, and so it is more important for firms with blockholders to ensure that equity does not vest while investment opportunities are strong.

In Table 7, Panel A, we present our main investment regressions (similar to those in Table 2) with the two aggregate investment measures (Δ*RDCAPEX* and Δ*RDNETINV*) as the dependent variables, but estimated separately in subsamples split at the sample median based on the fraction of total institutional ownership (*IO*), the fraction of ownership held by all blockholders (*BLOCKO*), and the number of blockholders (*NBLOCK*). We define a blockholder as an investor who owns at least 1% of the outstanding equity.[14]

Based on both aggregate investment measures, the link between vesting equity and investment cuts is stronger in firms with lower institutional ownership, lower blockholder ownership, and fewer blockholders. For example, using Δ*RDNETINV*, the coefficient on *VESTING* is −0.437 in the low-*IO* sample (significant at the 1% level) and an insignificant −0.069 in the high-*IO* sample. A chi-squared test shows that the two coefficients are significantly different at the 5% level. We find similar results using *BLOCKO* and *NBLOCK*. An alternative methodology is to estimate the investment regressions in the full sample and include the ownership measures and their interactions with *VESTING* as additional regressors. Table OA1 in the Online Appendix finds consistent results: the interaction coefficients of vesting with ownership variables are positive and statistically significant. Overall,

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13 Blockholders may trade on information on the firm's fundamental value, and thus sell (buy more) shares if the firm is inefficient (efficient), affecting the current stock price (Edmans 2009). If the manager has vesting equity and thus expects to sell at the current stock price, he is more affected by blockholder trades.

14 While 5% is typically used as a threshold, Edmans and Holderness (2017) argue that this is because investors need to file a Schedule 13D/G when crossing 5%, rather than any theoretical justification. This threshold will miss many blockholders, particularly when analyzing large firms, for which a 1% stake will comprise a significant dollar holding. Since we obtain our ownership data from Thomson Reuters Section 13F holdings rather than Schedule 13D/G filings, we are not limited to the 5% threshold. The results continue to hold with a 5% threshold, although they are slightly weaker, consistent with this threshold leading to us missing some blockholders.

Table 7
Vesting equity and change in investment: Sample splits

Panel A: Sorting on raw values

	(1)	(2)	(3)	(4)
Dependent variables	$\Delta RDCAPEX_q$		$\Delta RDNETINV_q$	
	Low IO	*High IO*	*Low IO*	*High IO*
$VESTING_q$	**–0.268*****	**–0.077**	**–0.437*****	**–0.069**
	(0.067)	(0.071)	(0.136)	(0.123)
p-value of the χ^2 *test*	***0.01******		***0.02*****	
Observations	13,362	13,362	13,362	13,362
Adjusted R^2	0.122	0.128	0.090	0.078
	Low BLOCKO	*High BLOCKO*	*Low BLOCKO*	*High BLOCKO*
$VESTING_q$	**–0.229*****	**–0.063**	**–0.367*****	**–0.027**
	(0.053)	(0.082)	(0.109)	(0.151)
p-value of the χ^2 *test*	***0.03*****		***0.03*****	
Observations	13,362	13,362	13,362	13,362
Adjusted R^2	0.125	0.126	0.091	0.092
	Low NBLOCK	*High NBLOCK*	*Low NBLOCK*	*High NBLOCK*
$VESTING_q$	**–0.322*****	**–0.038**	**–0.465*****	**–0.024**
	(0.069)	(0.058)	(0.133)	(0.119)
p-value of the χ^2 *test*	***<0.01******		***<0.01******	
Observations	13,095	13,629	13,095	13,629
Adjusted R^2	0.132	0.141	0.094	0.094
	Low CEOAGE	*High CEOAGE*	*Low CEOAGE*	*High CEOAGE*
$VESTING_q$	**–0.101**	**–0.196*****	**–0.006**	**–0.397*****
	(0.089)	(0.047)	(0.146)	(0.107)
p-value of the χ^2 *test*	*0.21*		***0.01******	
Observations	13,270	13,454	13,270	13,454
Adjusted R^2	0.104	0.114	0.066	0.065
	Low MV	*High MV*	*Low MV*	*High MV*
$VESTING_q$	**–0.165**	**–0.135*****	**–0.045**	**–0.173****
	(0.199)	(0.040)	(0.385)	(0.084)
p-value of the χ^2 *test*	*0.87*		*0.38*	
Observations	13,362	13,362	13,362	13,362
Adjusted R^2	0.097	0.146	0.073	0.087
	Low FIRMAGE	*High FIRMAGE*	*Low FIRMAGE*	*High FIRMAGE*
$VESTING_q$	**–0.125**	**–0.145*****	**–0.032**	**–0.309*****
	(0.102)	(0.045)	(0.160)	(0.098)
p-value of the χ^2 *test*	*0.81*		***0.09****	
Observations	12,578	14,146	12,578	14,146
Adjusted R^2	0.093	0.122	0.064	0.061
Controls (all panels)	Yes	Yes	Yes	Yes
Year, quarter, and firm FE (all panels)	Yes	Yes	Yes	Yes

OLS regression results on the relationship between the CEO's vesting equity and the change in investment in subsamples split based on institutional ownership, block ownership, number of blockholders, CEO age, firm size, and firm age. Variable definitions are in Appendix A. *VESTING* is in billions. Robust standard errors are in parentheses. The coefficients on *VESTING* across subsamples are compared using a chi-squared test. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

we find that vesting induces stronger investment cuts in samples with low institutional or block ownership. This finding is consistent with the myopia hypothesis, but has less clear implications for the efficiency and timing hypotheses, as discussed earlier.

Table 7
Continued

Panel B: Sorting on the residual values after orthogonalizing with respect to *MV*

	(1)	(2)	(3)	(4)
Dependent variables	$\Delta RDCAPEX_q$		$\Delta RDNETINV_q$	
	Low IO	*High IO*	*Low IO*	*High IO*
$VESTING_q$	**–0.244*****	**–0.038**	**–0.341*****	**–0.048**
	(0.055)	(0.074)	(0.109)	(0.148)
p-value of the χ^2 *test*	***<0.01*****		***0.06****	
Observations	13,362	13,362	13,362	13,362
Adjusted R^2	0.122	0.118	0.088	0.085
	Low BLOCKO	*High BLOCKO*	*Low BLOCKO*	*High BLOCKO*
$VESTING_q$	**–0.235*****	**–0.033**	**–0.371*****	**0.005**
	(0.053)	(0.080)	(0.106)	(0.153)
p-value of the χ^2 *test*	***<0.01*****		***0.02*****	
Observations	13,362	13,362	13,362	13,362
Adjusted R^2	0.126	0.127	0.090	0.093
	Low NBLOCK	*High NBLOCK*	*Low NBLOCK*	*High NBLOCK*
$VESTING_q$	**–0.240*****	**–0.027**	**–0.364*****	**–0.070**
	(0.055)	(0.065)	(0.114)	(0.132)
p-value of the χ^2 *test*	***<0.01*****		***0.05*****	
Observations	13,362	13,362	13,362	13,362
Adjusted R^2	0.137	0.137	0.092	0.097
	Low CEOAGE	*High CEOAGE*	*Low CEOAGE*	*High CEOAGE*
$VESTING_q$	**–0.153***	**–0.166*****	**–0.106**	**–0.351*****
	(0.091)	(0.047)	(0.144)	(0.111)
p-value of the χ^2 *test*	*0.86*		***0.1****	
Observations	13,362	13,362	13,362	13,362
Adjusted R^2	0.111	0.109	0.070	0.064
	Low FIRMAGE	*High FIRMAGE*	*Low FIRMAGE*	*High FIRMAGE*
$VESTING_q$	**–0.048**	**–0.277*****	**0.032**	**–0.506*****
	(0.072)	(0.055)	(0.146)	(0.103)
p-value of the χ^2 *test*	***<0.01*****		***<0.01*****	
Observations	13,362	13,362	13,362	13,362
Adjusted R^2	0.101	0.136	0.067	0.089
Controls (all panels)	Yes	Yes	Yes	Yes
Year, quarter, and firm FE (all panels)	Yes	Yes	Yes	Yes

OLS regression results on the relationship between the CEO's vesting equity and the change in investment in subsamples split based on the residuals from orthogonalizing institutional ownership, block ownership, number of blockholders, CEO age, and firm age with respect to firm size. Variable definitions are in Appendix A. *VESTING* is in billions. Robust standard errors are in parentheses. The coefficients on *VESTING* across subsamples are compared using a chi-squared test. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

The second set of analyses splits the sample based on CEO age. CEO age is often used as a (negative) proxy for career concerns as younger CEOs are more likely to be concerned about their long-term labor market reputations (Gibbons and Murphy 1992). Under the myopia hypothesis, the investment growth cuts are inefficient and so may worsen the CEO's long-term reputation; thus, younger CEOs should be less likely to undertake them. If the investment cuts are efficient, it is less obvious why they should be less valuable to younger

CEOs. Under the timing hypothesis, there is no clear reason why the board's ability to time equity grants will depend on CEO age.

Consistent with the myopia prediction, our results are generally weaker in the subsample of younger CEOs. For example, based on Panel A of Table 7, using Δ*RDNETINV*, the coefficient on *VESTING* is significantly negative in the high-*CEOAGE* subsample and insignificant in the low-*CEOAGE* subsample. The two coefficients are significantly different at the 1% level. In our full sample test in Table OA1, the coefficient on the interaction between *VESTING* and *CEOAGE* is significantly negative at the 10% level in the Δ*RDNETINV* regression. The results are weaker using Δ*RDCAPEX*: the difference in coefficients on *VESTING* in the split tests and the interaction term in the full sample regression are both insignificant. Overall, this test provides some evidence that the tendency to reduce investment growth around vesting increases with CEO age.

Our third set of sample splits uses firm size and firm age, which can be interpreted as (negative) proxies for investment opportunities. Under this interpretation, younger and smaller firms might find it more costly to increase the short-term stock price by cutting investment growth.[15] This could be the case whether the investment cuts are myopic or efficient, so the test does not help us distinguish between the two explanations. However, the timing explanation suggests the opposite effect: if boards attempt to time vesting to coincide with declines in investment opportunities, this consideration is more important in firms with higher investment opportunities to begin with.

We find that investment growth is significantly negatively related to *VESTING* for larger and older firms, and the relation is generally insignificant for smaller and younger firms. The difference between the coefficients on *VESTING* is significant for the age split using Δ*RDNETINV*. The interaction between *VESTING* and firm age is significant in the full sample regressions using either investment measure. While the difference between the coefficients on *VESTING* is insignificant for the size split in Table 7, Panel A, the interaction between *VESTING* and size is significantly negative in the full sample regression in Table OA1. These results are consistent with the myopia and efficiency hypotheses but less consistent with the timing hypothesis.

Panel B of Table 7 repeats the subsample split analyses by orthogonalizing the splitting variables with respect to firm size (except for size itself), because most of these variables are likely to be highly correlated with firm size. All results continue to hold and become even stronger for some tests (for example, the coefficients are now significantly different in the firm age split).

A final way to shed light on the three alternative hypotheses is to study the link between *VESTING* and investment changes in future quarters. Under the myopia hypothesis, the CEO cuts (or delays the initiation of) value-creating

15 This may occur, for example, if investment opportunities are lumpy, or firms are capital constrained, and so the last investment taken by an (optimizing) firm is more valuable in a firm with better investment opportunities.

Table 8
Myopia vs. efficiency: Dynamic analysis

Panel A	(1)	(2)	(3)	(4)	(5)
Dependent variables	ΔRD_q	$\Delta CAPEX_q$	$\Delta NETINV_q$	$\Delta RDCAPEX_q$	$\Delta RDNETINV_q$
$VESTING_{q-1}$	**–0.036****	**–0.008**	**0.023**	**–0.048**	**–0.004**
	(0.015)	(0.026)	(0.067)	(0.035)	(0.074)
Controls	Yes	Yes	Yes	Yes	Yes
Year, quarter, and firm FE	Yes	Yes	Yes	Yes	Yes
Observations	26,719	26,719	26,719	26,719	26,719
Adjusted R^2	0.087	0.049	0.026	0.081	0.032
Panel B					
$VESTING_{q-2}$	**–0.001**	**0.038**	**0.177****	**0.033**	**0.170****
	(0.016)	(0.025)	(0.074)	(0.034)	(0.082)
Controls	Yes	Yes	Yes	Yes	Yes
Year, quarter, and firm FE	Yes	Yes	Yes	Yes	Yes
Observations	26,701	26,701	26,701	26,701	26,701
Adjusted R^2	0.087	0.059	0.029	0.087	0.034
Panel C					
$VESTING_{q-3}$	**0.062*****	**0.044***	**–0.036**	**0.111*****	**0.019**
	(0.020)	(0.025)	(0.075)	(0.037)	(0.085)
Controls	Yes	Yes	Yes	Yes	Yes
Year, quarter, and firm FE	Yes	Yes	Yes	Yes	Yes
Observations	26,667	26,667	26,667	26,667	26,667
Adjusted R^2	0.094	0.064	0.027	0.094	0.034

OLS regression results on the relationship between the CEO's vesting equity and the change in investment in future quarters. Variable definitions are in Appendix A. *VESTING* is in billions. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

investment projects in quarters with high vesting equity. Since these projects are value-creating, he may still initiate them in future quarters when *VESTING* is low. Under the efficiency hypothesis, the CEO cuts inefficient investment projects in a quarter with high *VESTING*. Since these projects are inefficient, he would be less likely to restart them in future quarters. Under the timing hypothesis, if the board schedules vesting to coincide with a quarter in which investment opportunities decline, the fall in investment growth should be permanent, unless the decline in investment opportunities is only in that quarter and subsequently rebounds.

Table 8 conducts this dynamic analysis. Panels A, B, and C regress investment growth in quarter *q* on *VESTING* in quarter *q–1*, *q–2*, and *q–3*, respectively. The results provide some evidence that the decline in investment growth reverses in each of the next three quarters, as suggested by the myopia hypothesis, although the coefficients are not consistently significant across all investment measures. The partial reversal of the investment declines documented in Table 8 suggests that vesting causes firms to delay investment to subsequent quarters. It is difficult to estimate how costly such delays are to shareholders, but the costs are likely higher for firms in growing or competitive industries in which investment opportunities change more quickly over time. Indeed, the Table 7 finding that vesting-induced investment declines are smaller in firms with strong investment opportunities may be because such declines are costlier, even if subsequently reversed.

4. Earnings Guidance and Earnings Announcements

4.1 Analyst forecast revisions

The results of Section 2 show that a CEO cuts investment in quarters in which large amounts of equity vest, and sells equity in the same quarters. Since the earnings of quarter q (which benefit from the investment cut) are announced after quarter-end, these results suggest that the CEO may be taking additional actions to communicate the expected earnings increase before the earnings announcement, to raise the stock price in quarter q itself and thus improve the conditions for quarter q equity sales. Examples of such actions include issuing earnings guidance, public disclosures, press releases, or interviews. We assess the extent and effectiveness of these actions by studying the increase in analyst consensus earnings forecasts within quarter q. We hypothesize that *VESTING* is positively associated with the revision in analyst forecasts over the same quarter.

We calculate three dependent variables: $ALYREV_q$ is the latest mean analyst consensus forecast prior to the end of quarter q minus the latest consensus forecast prior to the end of quarter *q–1*, scaled by the stock price at the end of quarter *q–1*; $ALYREV2_q$ is similar but uses the latest consensus forecast prior to the last equity sale in quarter q (rather than prior to the end of quarter q); and $ALYREV3_q$ uses the latest consensus forecast prior to the last equity sale in quarter q (or prior to quarter-end if there is no equity sale in quarter q). We require a firm to have at least five analysts to increase the likelihood of forecast revision. We continue to include compensation controls (unvested and vested equity, salary, and bonus), CEO characteristics (CEO age, tenure, and the new CEO indicator), year, quarter, and firm fixed effects, plus market equity, Tobin's q, and return on assets. We add three controls that have been shown to affect the manager's propensity to provide guidance to analysts (Chen, Matsumoto, and Rajgopal 2011): IO_{q-1}, the percentage of institutional ownership at the end of quarter *q–1*, $ANALYST_q$, the number of analysts following the firm in quarter q, and $ANDISP_q$, analyst forecast dispersion in quarter q, calculated as the standard deviation of analyst forecasts scaled by the absolute value of the mean consensus forecast. We also include *HORIZON*, the mean average forecasting horizon (the number of days between an analyst forecast and the earnings announcement), to measure forecast staleness.

Table 9 presents the results. All three measures of analyst forecast revisions are positively and significantly related to vesting equity at the 5% level. This suggests that vesting equity is associated with an increase in the market's earnings expectations within the same quarter, consistent with the

Table 9
Analyst forecast revisions

	(1)	(2)	(3)
Dependent variables	$ALYREV_q$	$ALYREV2_q$	$ALYREV3_q$
$VESTING_q$	**0.039****	**0.049****	**0.035****
	(0.017)	(0.022)	(0.017)
$UNVESTED_{q-1}$	−0.016	−0.024*	−0.013
	(0.011)	(0.013)	(0.011)
$VESTED_{q-1}$	−0.003**	−0.003	−0.003**
	(0.002)	(0.002)	(0.001)
$SALARY_{q-1}$	−0.007***	−0.007***	−0.007***
	(0.001)	(0.002)	(0.001)
$BONUS_{q-1}$	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)
$CEOAGE_{q-1}$	0.002	0.005	0.001
	(0.005)	(0.008)	(0.005)
$CEOTENURE_{q-1}$	−0.001	−0.003	−0.001
	(0.004)	(0.007)	(0.004)
$NEWCEO_q$	0.000	−0.002	0.000
	(0.001)	(0.002)	(0.001)
MV_{q-1}	0.006***	0.006***	0.005***
	(0.001)	(0.001)	(0.000)
Q_{q-1}	−0.001***	−0.001***	−0.001***
	(0.000)	(0.000)	(0.000)
ROA_{q-1}	0.040***	0.027***	0.039***
	(0.005)	(0.006)	(0.005)
IO_{q-1}	−0.001	0.000	−0.001
	(0.001)	(0.001)	(0.001)
$ANALYST_q$	−0.000***	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)
$ANDISP_q$	−0.000	−0.001**	−0.000*
	(0.000)	(0.000)	(0.000)
$HORIZON_q$	0.000***	0.000	0.000***
	(0.000)	(0.000)	(0.000)
Intercept	−0.039***	−0.046***	−0.036***
	(0.004)	(0.006)	(0.004)
Year fixed effects	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Observations	13,745	5,894	12,673
Adjusted R^2	0.343	0.480	0.348

OLS regression results on the relationship between the CEO's vesting equity and analyst forecast revisions. Variable definitions are in Appendix A. *VESTING*, *UNVESTED*, and *VESTED* are in billions. *SALARY* and *BONUS* are in millions. *CEOAGE* and *CEOTENURE* are in hundreds. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

myopia hypothesis: by communicating the earnings increase resulting from his investment cut within the same quarter, the manager can increase the payoff from his equity sales. The results are harder to reconcile with the timing hypothesis. Under this hypothesis, boards are able to forecast quarterly-level declines in investment opportunities several years in advance. If so, it is reasonable to believe that analysts will be aware of these declines (and the resulting earnings increases) by the start of the quarters in which they actually occur. Thus, there is no clear reason to expect increases in analyst earnings forecasts over the same quarters.

4.2 Earnings guidance

The advantage of studying analyst forecast revisions is that they are comprehensive: they capture various channels through which the manager may communicate earnings news to the market, such as earnings guidance, public disclosures, press releases, or interviews. However, analyst forecasts measure the outcome of managerial communication, rather than the actual act of communication. This section thus directly studies the usage of one specific communication channel—earnings guidance. We examine this action because it is a major avenue through which managers communicate earnings-related news to the market outside mandatory reporting (Healy and Palepu 2001) and guide analysts (Matsumoto 2002): indeed, Cotter, Tuna, and Wysocki (2006) find that 47% of analysts who issue a forecast at the start of a quarter revise it within five days of an earnings guidance event. In addition, it is a public event for which data is available in I/B/E/S. As a result, we can study whether the manager's equity sales are concentrated shortly after an earnings guidance event, as predicted by the myopia hypothesis.

We define four variables that measure the frequency of guidance events: *POSNEUEG*, *POSEG*, and *NEGEG* count positive or neutral, positive, and negative guidance events in quarter q, respectively, and *EG* counts all guidance events.[16] We use the same controls and fixed effects as in Table 9. Columns (1) and (2) of Table 10 show that *VESTING* is significantly positively related to the number of positive and neutral guidance events, and positive guidance events, respectively. Based on column (2), a one-standard-deviation increase in vesting equity is associated with a 0.04 increase in the number of positive guidance events in a quarter, compared with the average quarterly change of 0.07. As a falsification test, column (3) shows that *VESTING* is unrelated to the number of negative guidance events; similarly, column (4) shows that it is unrelated to the number of total guidance events. We separately find that positive guidance events are associated with an average 2.5% market-adjusted announcement return in the [–1, +1] window.[17]

Positive earnings guidance improves the conditions for equity sales if the CEO is able to sell equity shortly afterwards. Bettis, Coles, and Lemmon (2000) find that 78% of firms have blackout policies that restrict the CEO from trading within certain periods. If earnings guidance took place during these periods, the CEO would not be able to benefit by selling equity immediately afterwards. Table 11 thus investigates the extent to which the CEO's equity sales within a given quarter are concentrated shortly after positive guidance, thus allowing

[16] We define positive guidance as items coded by I/B/E/S as "Beat Consensus," "Match Consensus," or "Positive Sales Comparison," neutral guidance as items coded as "Announce Charge" (i.e., announcing the inclusion or exclusion of a charge), "Announce Gain" (i.e., announcing the inclusion or exclusion of a gain), or "Management Guidance," and negative guidance as items coded as "Earnings Shortfall," "Negative Sale Comparison," or "Restatement."

[17] Note that the 2.5% announcement return to positive guidance holds regardless of whether we exclude guidance events bundled with earnings announcements.

Table 10
Vesting equity and frequency of earnings guidance

	(1)	(2)	(3)	(4)
Dependent variables	$POSNEUEG_q$	$POSEG_q$	$NEGEG_q$	EG_q
$VESTING_q$	**0.161****	**0.142***	**−0.032**	**0.129**
	(0.078)	(0.076)	(0.050)	(0.086)
$UNVESTED_{q-1}$	0.039	0.029	0.017	0.056*
	(0.030)	(0.029)	(0.019)	(0.033)
$VESTED_{q-1}$	0.003	0.001	0.000	0.003
	(0.002)	(0.002)	(0.002)	(0.003)
$SALARY_{q-1}$	−4.797**	−3.616	5.588***	0.791
	(2.439)	(2.388)	(1.553)	(2.700)
$BONUS_{q-1}$	0.417	0.376	−0.117	0.300
	(0.509)	(0.499)	(0.324)	(0.564)
$CEOAGE_{q-1}$	1.052	0.979	−0.977	0.075
	(0.999)	(0.978)	(0.636)	(1.105)
$CEOTENURE_{q-1}$	2.231*	2.396**	0.088	2.320*
	(1.178)	(1.153)	(0.750)	(1.304)
$NEWCEO_q$	−0.412	−0.304	−0.023	−0.435
	(0.292)	(0.286)	(0.186)	(0.323)
MV_{q-1}	0.211***	0.241***	−0.210***	0.001
	(0.051)	(0.050)	(0.033)	(0.057)
Q_{q-1}	0.050*	0.041	0.053***	0.103***
	(0.027)	(0.026)	(0.017)	(0.029)
ROA_{q-1}	1.705***	1.734***	−0.978***	0.727
	(0.492)	(0.481)	(0.313)	(0.544)
IO_{q-1}	0.478***	0.411***	0.362***	0.840***
	(0.154)	(0.151)	(0.098)	(0.170)
$ANALYST_q$	−0.008	−0.004	0.056***	0.049***
	(0.007)	(0.007)	(0.005)	(0.008)
$ANDISP_q$	−0.016	−0.019	0.072***	0.057**
	(0.024)	(0.023)	(0.015)	(0.026)
$HORIZON_q$	−0.002*	−0.001	−0.003***	−0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Intercept	4.273	3.591	5.441***	9.714***
	(2.630)	(2.575)	(1.675)	(2.912)
Year fixed effects	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Observations	14,451	14,451	14,451	14,451
Adjusted R^2	0.526	0.526	0.339	0.601

OLS regression results on the relationship between the CEO's vesting equity and the frequency of earnings guidance. *VESTING*, *UNVESTED*, *VESTED*, *SALARY*, and *BONUS* are in ten millions. *CEOAGE* and *CEOTENURE* are in hundreds. Robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

him to benefit from it. Finding concentration would be consistent with two scenarios. First, the firm has a blackout policy, but schedules earnings guidance to fall within or just before a window that permits trading. Indeed, in our sample, 80% of guidance events are concurrent with earnings announcements,[18] and Bettis et al. (2010) find that the most common blackout policy allows executives to trade only within a [3,12] window after an earnings announcement. Second,

[18] It is well documented in the accounting literature that firms bundle earnings guidance with earnings announcements of the prior quarters. For example, Rogers and Van Buskirk (2013) note that bundled forecasts have evolved to become the most common type of earnings guidance, occurring 70–80% of the time (consistent with our finding).

Table 11
Equity sales following positive earnings guidance events

	(1)	(2)	(3)	(4)	(5)
Window	[0, +2]	[0, +5]	[0, +10]	[0, +15]	[0, +20]
(a) *EQUITYSOLD%*	11.5%	24.7%	39.6%	55.6%	67.0%
(b) Benchmark *EQUITYSOLD%*	6.2%	12.3%	22.6%	32.9%	43.2%
t-stat of testing (a) = (b)	9.48***	15.83***	17.85***	20.41***	19.95***

This table reports (a) *EQUITYSOLD%*, the average percentage of equity sold in vesting quarters over window [0, x], with day 0 being the announcement date of a positive earnings guidance event in I/B/E/S and x being the 2nd, 5th, 10th, 15th, or 20th trading day after the event, and how it compares to (b) a benchmark percentage calculated using the total number of trading days in a quarter and a random distribution of equity sales. The last row reports the t-statistics of testing whether *EQUITYSOLD%* equals the corresponding benchmark. We limit the sample to vesting quarters with at least one positive earnings guidance event and with equity sales. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

the firm does not have a blackout policy, and the CEO chooses to sell shortly after positive guidance. Our goal is to test whether the CEO is able to sell equity shortly after guidance, which could occur under either scenario. Regardless of whether any post-guidance sales are "voluntary" (due to the CEO choosing to sell after guidance) or "mechanical" (due to the opening of a trading window), the CEO is still able to benefit from the positive guidance event.

Table 11 calculates the proportion of total equity sales in a quarter that occur within a [0,2], [0,5], [0,10], [0,15], or [0,20] window around a positive guidance event. We find that these proportions are large: for example, 56% of equity sales occur within [0,15] and 67% of equity sales occur within [0,20]. To assess the magnitude of concentration, that is, whether the CEO sells more shortly after positive guidance than on other days, we compare these fractions to a hypothetical scenario in which quarterly sales were not concentrated but instead evenly distributed across trading days within a quarter. There are on average 1.3 positive guidance event dates per quarter. Thus, if sales were not concentrated, 33% of sales (i.e., 1.3 $\times$ 16/number of trading days in a quarter) should occur within a [0,15] window, significantly lower than 43%. For all five windows, the proportion of equity sales that occur within the window is significantly higher (at the 1% level) than if sales were not concentrated. Thus, CEO sales are concentrated shortly after positive guidance events, and so the CEO is able to benefit from positive guidance.

As a back-of-the-envelope calculation of how positive guidance increases the proceeds from equity sales shortly afterwards, the average equity sold within 20 trading days of a positive guidance event is $958,414. Multiplied by the 2.5% announcement return to positive guidance, this yields $23,960, in line with prior research that also finds modest gains can have a large effect on behavior, even for wealthy individuals such as CEOs and directors.[19] Moreover, this benefit only applies to earnings guidance, not other channels through which the CEO

19 Adams and Ferreira (2008) find that board meeting fees (which average $1,000) affect director attendance, even though preparing for and attending a meeting involves significant effort. Yermack (1997) finds that the median gain over 1992–94 from timing of option grants was $11,100 after 20 trading days and $15,600 after 50 trading

may communicate earnings information ahead of the announcement, and is only an average effect: some CEOs may not sell equity upon vesting if they do not have diversification concerns.

4.3 Earnings surprises

While Table 9 shows that vesting equity is associated with an increase in analyst earnings forecasts, we now study how close the revised forecast is to actual earnings. This analysis sheds light on how much of the earnings increase the manager communicates prior to the announcement. When the manager decides how much to communicate, he faces a trade-off. The benefit of increasing analyst earnings forecasts through positive communication is that it boosts the price at which he can sell equity in quarter q. The cost is that it will be harder to beat the forecast when he subsequently announces earnings. A large literature (see, e.g., the survey of Graham, Harvey, and Rajgopal 2005) shows that managers perceive a discontinuous cost when the firm moves from meeting to missing the forecast, such as a decline in the stock price and managerial reputation.

A potential implication of this trade-off is that managers with vesting equity tailor the level of pre-announcement communication to maximize their proceeds from equity sales in quarter q, while trying to ensure that they do not miss the analyst forecast. We thus hypothesize that vesting equity increases the frequency with which the manager narrowly beats the forecast at announcement. Missing the forecast would suggest that the manager communicated too much positive information; beating it by a wide margin would suggest that he could have communicated more and thus sold his equity at a higher price.

We define three variables to capture the manager's tendency to beat analyst consensus forecasts. $BEAT_q$ is one for quarters in which the firm's reported earnings per share (EPS; from I/B/E/S) beats the consensus and zero otherwise; $BEATBELOW1_q$ equals one if the firm beats it by one cent or less; and $BEATABOVE1_q$ equals one if the firm beats it by more than one cent. As before, we require a firm to have at least five analysts. For each analyst, we take the latest forecast before the announcement. Here, we measure vesting equity from the start of quarter q to the actual earnings announcement date (rather than the end of quarter q) because the earnings of quarter q are not announced until after quarter-end. As in Table 9, we control for other compensation components, CEO characteristics, year and quarter fixed effects, plus *MV*, *Q*, *ROA*, *IO*, *ANALYST, ANDISP*, and *HORIZON*. We follow the literature (e.g.,

days. In 2008 terms (the midpoint of our sample period), these figures become \$16,549 and \$23,258. Lie (2005) subsequently found that such timing results from illegal backdating (and so a high benefit should be needed to bear the legal risk of grant timing), while investment cuts are legal. Meulbroek (1992) reports a median per-security gain to illegal insider trading of \$17,628 over 1980–89, i.e., \$35,267 in 2008 terms. Thus, the gains calculated above are in line with those from backdating and illegal insider trading; since they are not illegal, the risk-adjusted returns are likely higher.

Table 12
Vesting equity and likelihood of beating analyst consensus forecasts

	(1)	(2)	(3)
Dependent variables	$BEAT_q$	$BEAT\_BELOW1_q$	$BEAT\_ABOVE1_q$
$VESTING_q$	**15.474*****	**8.119***	**7.225**
	(4.326)	(4.496)	(4.459)
	[5.642***]	[1.471*]	[2.862]
$UNVESTED_{q-1}$	3.013	2.313	1.356
	(2.027)	(1.421)	(0.833)
$VESTED_{q-1}$	−0.035	0.001	−0.029
	(0.086)	(0.075)	(0.052)
$SALARY_{q-1}$	0.035	0.058	0.015
	(0.071)	(0.061)	(0.043)
$BONUS_{q-1}$	0.009	−0.030	0.024
	(0.027)	(0.027)	(0.025)
$CEOAGE_{q-1}$	−0.424*	−0.243	−0.276*
	(0.230)	(0.207)	(0.150)
$CEOTENURE_{q-1}$	−0.023	−0.021	−0.005
	(0.268)	(0.231)	(0.124)
$NEWCEO_q$	0.019	−0.262	0.123
	(0.174)	(0.234)	(0.171)
MV_{q-1}	0.074***	−0.024	0.072***
	(0.018)	(0.017)	(0.017)
Q_{q-1}	−0.022*	0.062***	−0.056***
	(0.012)	(0.011)	(0.014)
ROA_{q-1}	1.852***	1.435***	1.099***
	(0.275)	(0.318)	(0.201)
IO_{q-1}	0.080	−0.024	0.085*
	(0.055)	(0.053)	(0.044)
$ANALYST_q$	0.001	0.004	−0.001
	(0.003)	(0.003)	(0.002)
$ANDISP_q$	−0.124***	−0.097***	−0.092***
	(0.010)	(0.016)	(0.011)
$HORIZON_q$	−0.001**	0.001***	−0.002***
	(0.000)	(0.000)	(0.000)
Intercept	0.027	−1.133***	−0.252*
	(0.178)	(0.165)	(0.143)
Year fixed effects	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Observations	16,764	16,764	16,764
Adjusted R^2	0.040	0.040	0.040

Probit regression results on the relationship between the CEO's vesting equity and the likelihood of beating the quarterly analyst consensus forecast. Variable definitions are in Appendix A. *VESTING*, *UNVESTED*, and *VESTED* are in billions. *SALARY* and *BONUS* are in millions. *CEOAGE* and *CEOTENURE* are in hundreds. Robust standard errors are in parentheses. For *VESTING*, the marginal effects are displayed below the standard errors. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

McVay, Nagar, and Tang 2006) by estimating probit regressions with Fama-French 12-industry fixed effects; we do not use firm fixed effects due to the incidental parameters problem. (The results of Tables 9 and 10 hold using either firm or industry fixed effects.)

Column (1) of Table 12 shows that vesting equity is positively associated with the likelihood of beating analyst forecasts, and significant at the 1% level. Columns (2) and (3) show that vesting equity is positively related to the likelihood of beating the analyst forecast by up to one cent (significant at the 10% level), and positively but not significantly related to beating by more than one cent. A one-standard-deviation increase in vesting equity is associated with a four-percentage-point increase in the likelihood of beating the analyst forecast by up to one cent, compared with the unconditional likelihood of 11.1%. These results are consistent with the CEO communicating a level of positive earnings news that allows him to maximize his benefit from the investment cuts without creating a large risk of missing the forecast.

5. Robustness Tests

This section describes robustness tests for our headline result in Table 2. We first rerun the regressions in Table 2 excluding controls. Table OA2 shows that the coefficient on *VESTING* remains negative and significant at least at the 5% level in all five specifications, and that the point estimates are economically similar.

We next turn to robustness tests on the calculation of *VESTING*. Our main specifications convert options to share equivalents using their deltas, which depend on the options' time-to-maturity. However, if CEOs exercise their options shortly after they vest, their effective horizons are shorter. In Table OA3, Panel A, we instead use intrinsic values: we assign a delta of one to all in-the-money options and zero to all out-of-the-money options, because only the former would be exercised immediately upon vesting. The results are unchanged. We use deltas in our main specification as even if an option is out of the money at the start of the quarter (when we calculate our deltas), it may become in the money later in the quarter when it vests, and the delta captures this likelihood. In Panel B, we calculate option deltas assuming that all options have the same (short) maturity of one year, and again obtain consistent results.

Another concern is that $VESTING_q$ is correlated with P_{q-1} and thus investment opportunities at the start of quarter q. Such correlation could stem from two sources. First, *VESTING* is the delta of vesting equity multiplied by P_{q-1}. The multiplication is necessary to obtain an incentive measure that reflects the CEO's wealth gain from increasing the stock price by a percentage (rather than dollar) amount. Second, the delta of vesting options is itself increasing in the stock price and thus investment opportunities. Such a channel will lead to a positive correlation between *VESTING* and investment, the opposite of what we find. In addition, we already include the price-based controls Q_q, Q_{q-1} MV_{q-1}, and MOM_{q-1}. To address any residual correlation, rather than using an option's actual delta, Panel C assumes a delta of 0.7, which is the mean delta in our sample. In Panel D, we assume that all options are at the money, which removes the dependence of the estimated delta on the current stock price, but still allows for deltas to vary across firms with other inputs. The results are unchanged.

The next set of robustness tests concerns the assumptions made to estimate the vesting dates of stock. Our first alternative methodology defines a variant of *VESTING* using only time-based post-2006 awards (as opposed to all post-2006 awards) in the first step. Our second alternative methodology uses only time-based post-2006 awards in the first step and only grant dates of performance-based post-2006 awards in the second step. Table OA4, Panels A and B, report results using the two variants of *VESTING*, which are barely affected. Further, as shown in Table 3, Panel B, the results are robust to using only vesting options, which have expiry dates that we can use to infer vesting dates precisely.

In Table OA5, we add as an additional control *VEGA*, the dollar change in the CEO's wealth for a 100% change in stock return volatility, to control for the CEO's incentives to take risky investments. The results remain robust.

Finally, Table OA6 uses the level of, rather than change in, investment as the dependent variable. The coefficients are negative in all specifications, and significant at the 5% level in one and the 10% level in another. The stronger results for changes in investment may arise because it is likely less costly for a firm to reduce the growth rate than the level of investment. Reducing the level of R&D typically involves laying off employees or scaling down research programs that are already under way; reducing the growth rate may be achievable by lowering the rate of new hires or new R&D program initiations (but not necessarily turning it negative). Reducing the level of capital expenditure would be similarly costly if capital expenditures (e.g., building a new plant) are part of multi-quarter programs.

6. Conclusion

This paper studies the link between real investment decisions and the CEO's short-term concerns. Myopia theories predict that short-term stock price concerns may induce the CEO to reduce positive-NPV investments to boost earnings and thus the stock price. Such theories are difficult to test, partly due to the difficulty in measuring myopic incentives. The standard proxies for CEO incentives measure a CEO's overall level of equity holdings, rather than his concern for the short-term stock price in particular. Moreover, they depend on the amount of equity that a CEO has chosen to hold onto, which is an endogenous decision.

We introduce a new measure of the CEO's short-term concerns: the amount of equity scheduled to vest in a given quarter. We show that vesting equity is significantly negatively related to the growth in five measures of investment. The results continue to hold when removing all equity granted within the last two years, suggesting that they are not driven by boards timing equity to vest in the quarter when investment opportunities decline. Vesting equity is unrelated to reductions in other expenses or improvements in operating performance, providing suggestive evidence that the reductions in investment are myopic rather than part of a general program to increase efficiency. Under either interpretation, our results suggest that CEO contracts affect real decisions, and thus contribute more broadly to the general literature on executive compensation. We also find that vesting equity is significantly positively related to analyst forecast revisions and positive earnings guidance, consistent with the CEO's attempts to benefit from equity sales in the same quarter.

While the lack of a relationship between vesting equity and improvements in other measures of operating performance is less supportive of the efficiency hypothesis, it is difficult to rule it out conclusively. Moreover, even if the reduction in investment induced by the CEO's contract is inefficient, this does not mean that his contract is inefficient overall. Boards of directors may recognize that short-vesting equity leads to underinvestment, but trade this off against the costs of longer-term contracts. Such contracts may expose the manager to risks outside his control, and cause him to demand a risk premium.

If the link between vesting equity and investment growth results from myopia, our results have implications for CEO contract design. Policymakers often focus on the level of pay: for example, Dodd-Frank requires firms to disclose the ratio of CEO to median employee pay. However, it is the structure of pay, rather than its level, that is critical in determining managerial incentives. Our results point to the vesting horizon as an important element of pay structure, particularly when incentivizing long-term investment decisions such as R&D. Most directly, our paper suggests that investors and boards take note of vesting schedules and scrutinize CEO decisions when large amounts of equity are vesting. It also implies that boards might consider extending the vesting horizon of equity, potentially beyond retirement,[20] and spreading vesting dates equally across the four quarters of a year rather than concentrating them on the grant anniversary.

More broadly, our measure of short-term incentives—vesting equity—is relatively easy to construct, and potentially usable in wider contexts than investment decisions. In addition, in future research it may be interesting to extend the analysis of short-term incentives to include other contracting components, such as bonuses tied to a firm's accounting performance (Li and Wang 2016) and turnover risk (Cziraki and Groen-Xu 2016).

[20] For example, the U.K. government's November 2016 Green Paper on corporate governance reform proposes replacing bonuses based on financial targets with restricted share awards with long vesting periods.

Appendix A: Definition of Variables

This appendix describes the calculation of variables used in the core analysis. Underlined variables refer to variable names within Compustat. t indexes the year to which quarter q belongs.

Variable	Definition
CEO incentives from equity holdings	
$VESTING_q$	The dollar change in the value of vesting equity in quarter q for a 100% change in the stock price, calculated as *VESTINGSTOCK* (the number of vesting shares in quarter $q \times$ stock price at the end of quarter *q–1*) plus *VESTINGOPT* (aggregated delta of vesting options in quarter $q \times$ stock price at the end of quarter *q–1*).Vesting options are assigned to quarter q based on expiry dates, and vesting shares are assigned to quarter q based on grant dates. The delta of an option is calculated using the Black-Scholes formula. For options that vest in quarter q of year t, the inputs (i.e., dividend yield, risk-free interest rate, and volatility) to the Black-Scholes formula are those associated with a firm's newly awarded options in year *t–1* from Equilar, and if unavailable, replaced with those associated with a firm's newly awarded options in year t from Equilar, followed by year *t–1*'s inputs from ExecuComp (or year t's if year *t–1*'s are missing), and by year *t–1*'s inputs from Compustat (or year t's if year *t–1*'s are missing), in that order.
$VESTING\_TB_q$	Similar to $VESTING_q$, except that it includes only post-2006 time-based vesting grants.
$VESTING{>}2Y_q$	Similar to $VESTING_q$, except that it includes only post-2006 grants that are awarded at least two years prior to the end of quarter q.
$UNVESTED_{q-1}$	The dollar change in the value of unvested equity in year *t–1* for a 100% change in the stock price, calculated as the sum of max[*UNVESTEDSTOCK* (the total number of unvested shares including unvested long-term incentive plan shares × stock price, both at the end of year *t–1*) – *VESTINGSTOCK* (the total number of vesting share including unvested long-term incentive plan shares in year $t \times$ stock price at the end of year *t–1*), 0] and max[*UNVESTEDOPT* (aggregated delta of unvested options × stock price, both at the end of year *t–1*) – *VESTINGOPT* (aggregated delta of vesting options in year t × stock price at the end of year *t–1*), 0]. Delta is calculated similarly as above.
$VESTED_{q-1}$	The dollar change in the value of already-vested equity in year *t–1* for a 100% change in the stock price, calculated as *VESTEDSTOCK* (the number of already-vested shares × stock price, both at the end of year *t–1*) plus *VESTEDOPT* (aggregated delta of already-vested options × stock price, both at the end of year *t–1*).Delta is calculated similarly as above.
Equity sold	
$EQUITYSOLD_q$	The number of shares sold in quarter $q \times$ stock price at the end of quarter *q–1*.
Change in investment	
ΔRD_q	Change in R&D expenditure (XRDQ) from quarter *q–1* to q, scaled by total assets (ATQ) at the end of quarter *q–1*. Missing R&D expenditure is set to zero.
$\Delta CAPEX_q$	Change in capital expenditure (inferred from CAPXY) from quarter *q–1* to q, scaled by total assets at the end of quarter *q–1*. Missing capital expenditure is set to zero;
$\Delta NETINV_q$	Change in net capital expenditure from quarter *q–1* to q, calculated as ($PPENTQ_q - PPENTQ_{q-1}$) – ($PPENTQ_{q-1} - PPENTQ_{q-2}$), scaled by total assets at the end of quarter *q–1*. Missing net capital expenditure is set to zero.
$\Delta RDCAPEX_q$	Change in the sum of R&D expenditure and capital expenditure from quarter *q–1* to q, scaled by total assets at the end of quarter *q–1*. Missing R&D expenditure and capital expenditure are set to zero.
$\Delta RDNETINV_q$	Change in the sum of R&D expenditure and net capital expenditure from quarter *q–1* to q, scaled by total assets at the end of quarter *q–1*. Missing R&D expenditure and net capital expenditure are set to zero.
Control variables	
$SALARY_{q-1}$	CEO's salary in year *t–1*.
$BONUS_{q-1}$	CEO's cash bonus in year *t–1*.
$CEOAGE_{q-1}$	CEO's age in year *t–1*.
$CEOTENURE_{q-1}$	CEO's tenure in year *t–1*.
$NEWCEO_q$	An indicator variable to denote new CEO in year t to which quarter q belongs;
$FIRMAGE_{q-1}$	Firm's age in year *t–1*, approximated by the number of years listed on Compustat;

(*continued*)

Variable	Definition
Q_q	Tobin's q at the end of quarter q, calculated as [market value of equity (*PRCCQ* × *CSHPRQ*) plus liquidating value of preferred stock (*PSTKQ*) plus book value of debt (*DLTTQ* + *DLCQ*) minus balance sheet deferred taxes and investment tax credit (*TXDITCQ*)] divided by total assets at the end of quarter *q–1*.
Q_{q-1}	Tobin's q at the end of quarter *q–1*.
MV_{q-1}	Natural logarithm of market value of equity at the end of quarter *q–1*.
MOM_{q-1}	Compounded market-adjusted monthly stock returns over the three months in quarter *q–1*, with market-adjusted monthly stock return calculated as the firm's monthly raw stock return minus the corresponding monthly return on the CRSP value-weighted index.
$CASH_{q-1}$	Cash and short-term investments (*CHEQ*) at the end of quarter *q–1* divided by total assets at the end of quarter *q–1*.
$BOOKLEV_{q-1}$	Book value of debt at the end of quarter *q–1* divided by total assets at the end of quarter *q–1*.
$RETEARN_{q-1}$	Balance sheet retained earnings (*REQ*) at the end of quarter *q–1* divided by total assets at the end of quarter *q–1*.
ROA_{q-1}	Return-on-assets ratio, calculated as net income (*NIQ*) during quarter *q–1* divided by the average total assets of quarter *q–1*.
Operating performance measures	
SGR_q	Sales growth, calculated as sales (*SALEQ*) in quarter q divided by sales in quarter *q–4* minus one.
$\Delta COGS_q$	Change in ratio of cost of goods sold to sales (*COGSQ*/*SALEQ*) from quarter *q–1* to q.
$\Delta OPEXP_q$	Change in ratio of operating expenses to sales (*XOPRQ*/*SALEQ*) from quarter *q–1* to q.
Cross-sectional variables	
IO_{q-1}	The total percentage of shares owned by institutional investors at the end of quarter *q–1*.
$BLOCKO_{q-1}$	The total percentage of shares owned by blockholders, defined as those who hold 1% or more, at the end of quarter *q–1*.
NBLOCKq–1	The number of blockholders, defined as those who hold 1% or more, measured at the end of quarter *q–1*.
Additional variables used in the analyst revision analysis	
$ALYREV_q$	The latest mean analyst consensus forecast prior to the end of quarter q minus the latest mean analyst consensus forecast prior to the end of quarter *q–1*, scaled by the stock price at the end of quarter *q–1*.
$ALYREV2_q$	The latest mean analyst consensus forecast prior to the last equity sales in quarter q minus the latest mean analyst consensus forecast prior to the end of quarter *q–1*, scaled by the stock price at the end of quarter *q–1*.
$ALYREV3_q$	The latest mean analyst consensus forecast prior to the last equity sales in quarter q (or prior to the end of quarter q if there is no equity sale in the quarter) minus the latest mean analyst consensus forecast prior to the end of quarter *q–1*, scaled by the stock price at the end of quarter *q–1*.
$ANALYST_q$	The number of analysts following the firm in quarter q.
$ANDISP_q$	Analyst forecast dispersion, calculated as the standard deviation of analyst forecasts scaled by the absolute value of the mean analyst consensus forecast.
$HORIZON_q$	The mean average forecasting horizon, with forecasting horizon being the number of days between an analyst forecast date and earnings announcement date.
Additional variables used in the earnings guidance analysis	
$POSNEUEG_q$	The instances of positive and neutral management earnings guidance issued in quarter q. Positive guidance events include those coded by I/B/E/S as "Beat Consensus," "Match Consensus," or "Positive Sales Comparison." Neutral guidance events include those coded as "Announce Charge" (i.e., announcing the inclusion or exclusion of a charge), "Announce Gain" (i.e., announcing the inclusion or exclusion of a gain), or "Management Guidance."
$POSEG_q$	The instances of positive management earnings guidance issued in quarter q. Positive guidance events are as defined above.

(*continued*)

Variable	Definition
$NEGEG_q$	The instances of negative management earnings guidance issued in quarter q. Negative guidance events include those coded by I/B/E/S as "Earnings Shortfall," "Negative Sale Comparison," or "Restatement."
EG_q	The total instances of management earnings guidance issued in quarter q.
$EQUITYSOLD\%_q$	The percentage of equity sold in quarter q within window $[0, x]$, with day 0 being the announcement date of a positive earnings guidance event as tracked in I/B/E/S and x being the 2nd, 5th, 10th, 15th, and 20th trading day after the event.
Additional variables used in the earnings surprise analysis	
$BEAT_q$	An indicator variable that equals one if the reported EPS is more than or equal to the latest mean analyst consensus forecast prior to the earnings announcement of quarter q and zero otherwise.
$BEATBELOW1_q$	An indicator variable that equals one if the reported EPS falls between the latest mean analyst consensus forecast prior to the earnings announcement of quarter q and that plus one cent in a given quarter.
$BEATABOVE1_q$	An indicator variable that equals one if the reported EPS exceeds the latest mean analyst consensus forecast prior to the earnings announcement of quarter q plus one cent in a given quarter.

Appendix B: A Numerical Example

This appendix illustrates the calculation steps to derive equity incentives for a sample CEO, along with the company's disclosure tables retrieved from Equilar for the two fiscal years on which the calculations are based. As an example, we use James McCann, CEO of 1-800-Flowers.com, Inc. and calculate the price sensitivity of his vesting equity for the four quarters of the fiscal year ending on June 30, 2009 (*VESTING*), his unvested equity for the fiscal year ending on June 30, 2008 (*UNVESTED*), and his vested equity for the fiscal year ending on June 30, 2008 (*VESTED*).

VESTING for Q1–Q4 of the fiscal year ending on June 30, 2009

We calculate *VESTING* in two steps. First, we obtain option data from Equilar for James McCann:

B.1 Outstanding options as reported in Equilar

	Equity type	Number of securities	Strike price	Expiry date
	As of June 30, 2009			
(1)	Unexercisable options	10,000	$ 8.45	12/2/14
(2)	Unexercisable options	20,000	$ 6.52	10/13/15
(3)	Unexercisable options	224,109	$ 3.11	5/5/16
(4)	Exercisable options	39,810	$ 12.44	12/17/09
(5)	Exercisable options	82,730	$ 11.58	8/2/11
(6)	Exercisable options	200,000	$ 12.87	1/11/12
(7)	Exercisable options	200,000	$ 6.42	9/23/12
(8)	Exercisable options	170,148	$ 6.70	3/24/13
(9)	Exercisable options	29,852	$ 6.70	3/24/13
(10)	Exercisable options	40,000	$ 8.45	12/2/14
(11)	Exercisable options	30,000	$ 6.52	10/13/15
	As of June 30, 2008			
(12)	Unexercisable options	20,000	$ 8.45	12/2/14
(13)	Unexercisable options	30,000	$ 6.52	10/13/15
(14)	Exercisable options	39,810	$ 12.44	12/17/09
(15)	Exercisable options	82,730	$ 11.58	8/2/11
(16)	Exercisable options	200,000	$ 12.87	1/11/12
(17)	Exercisable options	200,000	$ 6.42	9/23/12
(18)	Exercisable options	170,148	$ 6.70	3/24/13
(19)	Exercisable options	29,852	$ 6.70	3/24/13
(20)	Exercisable options	30,000	$ 8.45	12/2/14
(21)	Exercisable options	20,000	$ 6.52	10/13/15

B.2 Newly granted options as reported in Equilar

	Grant date	Number of securities	Strike price	Expiry date
(22)	5/5/09	224,109	$ 3.11	5/5/16

To calculate the number of vesting options for fiscal year 2009, we match and group the outstanding options by strike price and expiry date. We then infer the number of vesting options from the following relationship, for a given price-date pair:

$$VESTINGOPTNUM_q = UNVESTEDOPTNUM_{q-1} + NEWOPTNUM_q - UNVESTEDOPTNUM_q \quad \text{(A1)}$$

After identifying vesting options in fiscal year 2009 at the grant level (show in Table B.3), we assign them to the four quarters of the year based on the grants' expiry dates. The 10,000 options vesting from the grant expiring on December 2, 2014, and the 10,000 options vesting from the grant expiring on October 13, 2015, are both assigned to Q2 of fiscal year 2009 (which runs from October 1, 2008 to December 31, 2008). We then input into the Black-Scholes formula the risk-free rate, volatility, and dividend yield from Equilar and calculate each option's delta, grant by grant.

B.3 Calculated number and delta of vesting options as of June 30, 2009

Calculated number of vesting options	Number of Securities	Strike price	Expiry date	Term as of prior quarter end	*Z*	Delta
(12) – (1)	10,000	$ 8.45	12/2/14	6.17	0.803	7,891
(13) – (2)	10,000	$ 6.52	10/13/15	7.04	1.017	8,455
(22) – (3)	0	$ 3.11	5/5/16			
						∑Delta=16,345.46

To calculate the price-sensitivity measures of vesting options, we multiply the deltas calculated above by the closing stock price of $6.02 at the end of Q1 of fiscal year 2009. James McCann's *VESTINGOPT* for the four quarters of fiscal year 2009 is therefore calculated as $16{,}345.46 \times 6.02 = 98{,}399.67$ for Q2, and 0 for Q1, Q3, and Q4.

Second, we obtain share data from Equilar for James McCann:

B.4 Shares held as reported in Equilar

Shares acquired on vesting of stock for the year ending on June 30, 2009 (a)	Total unvested shares for the year ending on June 30, 2008 (b)	Total unvested IP shares for the year ending on June 30, 2008 (c)	Unvested shares for the year ending on June 30, 2008 = (b) + (c)	Shares held for the year ending on June 30, 2008 (d)	Options exercisable within 60 days of proxy date for the year ending on June 30, 2008 (e)	Already-vested shares for the year ending on June 30, 2008 = (d) – (e)
67,434	33,000	277,677	310,677	36,775,359	792,540	35,982,819

B.5 Newly granted shares as reported in Equilar

	Grant date	Number of securities	Vesting schedule	Vesting period	Performance?
(23)	10/27/08	37,500	Cliff	3	N/A
(24)	5/5/09	112,055	Graded	3	N/A

The total number of vesting shares in fiscal year 2009 is 67,434. Since neither of the grants awarded post 2006 vests in fiscal year 2009 (the first grant vests on October 27, 2011, and the second grant vests annually starting May 5, 2010), we allocate 67,434 evenly between Q2 (based on grant date of October 27) and Q4 (based on grant date of May 5) of fiscal year 2009. James McCann's *VESTINGSTOCK* for the four quarters of fiscal year 2009 is therefore calculated as 33,717 × 6.02 (the closing stock price at the end of Q1) = 202,976.34 for Q2, 33,717 × \$2.07 (the closing stock price at the end of Q3) = 69,794.19 for Q4, and 0 for Q1 and Q3.

Finally, we sum the sensitivity measures of options and shares to construct the quarterly *VESTING* we use in the main specification:

B.6 Quarterly *VESTING* in fiscal year 2009

Q1	*Q2*	*Q3*	*Q4*
0	301,376.01	0	69,794.19

UNVESTED for the fiscal year ending on June 30, 2008

We similarly calculate the price sensitivity of James McCann's unvested equity for the fiscal year ending on June 30, 2008 (net of his vesting equity in fiscal year 2009), *UNVESTED*. We first calculate the aggregate delta of his unvested options:

B.7 Calculated number and delta of unvested options as of June 30, 2008

Calculated number of unvested options	Number of securities	Strike price	Expiry date	Term as of June 30, 2008	*Z*	Delta
(12)	20,000	\$ 8.45	12/2/14	6.4275	0.865	16,128
(13)	30,000	\$ 6.52	10/13/15	7.2904	1.072	25,746
						∑Delta=41,874

We then multiply the aggregated delta by the closing stock price of \$6.45 at the end of fiscal year 2008. James McCann's *UNVESTEDOPT* at the end of fiscal year 2008 is therefore calculated as $41,874 \times 6.45 = 270,087.3$. His *UNVESTEDSTOCK* at the end of fiscal year 2008 is calculated as 310,677 (from Table B.4) $\times 6.45 = 2,003,866.65$. Finally, we calculate *UNVESTED* = max (*UNVESTEDOPT—VESTINGOPT*, 0) + max (*UNVESTEDSTOCK—VESTINGSTOCK*,0) = $\max(270,087.3 - 107,366.7, 0) + \max(2,003,866.65 - 434,949.3, 0) = 1,731,637.95$. Note that *VESTINGOPT* at the annual level is calculated using the term and price as of June 30, 2008, to be consistent with *UNVESTEDOPT*. *VESTINGSTOCK* at the annual level is also calculated using the price as of June 30, 2008, to be consistent with *UNVESTEDSTOCK*.

VESTED for the fiscal year ending on June 30, 2008

To calculate the price sensitivity of James McCann's vested equity for the fiscal year ending on June 30, 2008, *VESTED*, we first calculate the aggregate delta of his vested options:

B.8 Calculated number and delta of vested options as of June 30, 2008

Calculated number of vested options	Number of securities	Strike price	Expiry date	Term as of June 30, 2008	Z	Delta
(14)	39,810	$ 12.44	12/17/09	1.4659	–0.266	15,724
(15)	82,730	$ 11.58	8/2/11	3.0904	0.242	49,266
(16)	200,000	$ 12.87	1/11/12	3.5344	0.243	119,174
(17)	200,000	$ 6.42	9/23/12	4.2356	0.825	159,041
(18) + (19)	200,000	$ 6.70	3/24/13	4.7342	0.844	160,152
(20)	30,000	$ 8.45	12/2/14	6.4275	0.865	24,192
(21)	20,000	$ 6.52	10/13/15	7.2904	1.072	17,164
						∑Delta = 544,714

We then multiply the aggregated delta by the closing stock price of $6.45 at the end of fiscal year 2008. James McCann's *VESTEDOPT* at the end of fiscal year 2008 is therefore calculated as 544,714 × 6.45 = 3,513,405.3. His *VESTEDSTOCK* at the end of fiscal year 2008 is calculated as 35,982,819 (from Table B.4) × 6.45 = 232,089,182.55. James McCann's *VESTED* for the fiscal year ending on June 30, 2008, is therefore 235,602,587, the sum of his *VESTEDOPT* and *VESTEDSTOCK*.

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