Short-Horizon Incentives and Stock Price Inflation *

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Abstract

We develop a dynamic algorithm that estimates the time horizon of equity-based incentives. Motivated by recent theories, we then test whether incentive horizon affects stock returns. We find that firms with short-horizon CEO incentives experience stock price inflation followed by reversal. Short-horizon CEOs exploit the price inflation by selling more stock and making greater abnormal profits than long-horizon CEOs do. The stock price inflation is partly explained by greater earnings surprises and more positive investor reaction to the surprises. To sustain the inflated price, short-horizon firms are more likely to employ income-increasing discretionary accruals. The findings are consistent with recent theories linking short-horizon incentives to stock price inflation and shed light on the role earnings management plays in the process.

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1 Introduction

An essential tool to mitigate the agency problem are equity-based incentives, usually in the form of stock or stock option grants. The incentives are intended to align the interests of the agent with the interests of the shareholders. The incentive design comprises two dimensions: incentive size and incentive horizon. That is, *how much* incentives to provide and *how soon* to allow the agent to cash out payoffs. Once vested, a stock or stock option grant can be sold by the agent, severing the interest alignment between the agent and the shareholders. While the literature on incentive size is extensive, significantly less is understood about incentive horizon. One hindrance to a better understanding is that incentive horizon is not readily observable. Even if a researcher observes the vesting schedule of a particular grant, the *actual* incentive horizon of the agent depends on 1) the vesting schedules of the agent's previous grants, 2) when those grants were awarded, and 3) the agent's past *and future* sale decisions about vested grants. Our first contribution is to develop an algorithm that estimates a dynamic incentive horizon measure – a measure that incorporates vesting schedules of overlapping grants that were awarded at different points in time *and* the agent's intertemporal sale decisions about vested grants. For any given year, our algorithm can estimate the incentive horizon of any executive in the ExecuComp database.

Our second objective is to examine whether incentive horizon has capital-market consequences. Although the literature has long recognized that short-horizon managers are prone to myopic behaviors (e.g., Dechow and Sloan, 1991), it is not clear, even theoretically, whether these behaviors have any real capital-market consequence. For example, in the signal-jamming model of Stein (1989), short-horizon managers cannot fool investors, yet the managers continue their myopic behaviors because investors already anticipate and discount these behaviors. Thus, short-horizon managers will attempt to, but will be unable to, inflate stock prices. Recent theories, however, suggest that short-horizon managers will attempt to inflate stock prices and can succeed in doing so (e.g., Goldman and Slezak, 2006; Bolton, Scheinkman, and Xiong, 2006; and Peng and Röell, 2014). Thus, the unsettled question in the literature is not whether short-horizon managers will attempt to inflate stock price, which they clearly have incentive to do, but rather whether the attempts will succeed. With the dynamic incentive horizon measure in hand, we aim to provide empirical evidence on whether short-horizon managers succeed in stock price inflation. In the theoretical models that predict stock price inflation (e.g., Bolton et al., 2006), managers must fool at least a subset of investors into overvaluing the stock, and informed short sellers who might otherwise correct the overvaluation must face short-sale constraints. Thus, we focus our tests on firms with high short-sale constraints, and hereafter, describe results for them.[1]

We find that firms exhibit stock price inflation as their CEOs' incentive horizon becomes shorter. During the 12 months prior to CEO horizon dropping below one year, the abnormal returns are 62 basis points monthly, or 7.44% annually. The inflated price is sustained in the first half of the short-horizon year. In the second half, however, the inflation reverses – abnormal returns turn to a significantly negative 65 basis points per month. A contemporaneous portfolio of firms with long-horizon CEOs does not exhibit this pattern of positive abnormal returns and the later reversal. Over the longer term from months +13 to +36, short-horizon firms underperform long-horizon firms by 52 basis points per month, or 6.24% per year. The positive abnormal returns and the later reversal is consistent with the hypothesis that short-horizon CEOs

[1] Although we do not discuss the results in this introduction section, we report and discuss later that, as expected, abnormal stock returns are generally statistically insignificant for firms with low short-sale constraints. Results for other tests in the paper are also generally insignificant for firms with low short-sale constraints.

inflate stock price when they have more stock options and shares vested that are available to exercise and sell, respectively.

Given the evidence of stock price inflation followed by reversal, we then examine whether short-horizon CEOs exploit the stock price inflation. We employ a propensity score approach to match firms with short-horizon CEOs with firms with long-horizon CEOs on many different characteristics. We find that short-horizon CEOs sell significantly more stock in the short-horizon year compared to long-horizon CEOs in the same year. A key question, however, is whether these CEOs earn abnormal profits through such sales. We find that they do. Following the method of Jagolinzer, Larcker, and Taylor (2011) to compute abnormal insider trading profits, we show that short-horizon CEOs earn significantly positive abnormal trading profits.

How does a short-horizon CEO inflate stock price? The literature has documented a myriad of myopic actions that a short-horizon CEO can potentially take, but the ultimate objective is to convince investors that the firm should be valued higher. No other corporate events that occur on a regular basis are more information-intensive and value-relevant than earnings announcements (e.g., Beaver, 1968; Landsman and Maydew, 2002; and Bartov, Givoly, and Hayn, 2002). Earnings announcements are often accompanied by conference calls with investors, which give CEOs an opportunity to influence investors' interpretation of the earnings and the company's future prospects. If a CEO intends to influence investors' valuation of the firm's stock, earnings announcements should be an opportune venue to do so. Thus, we examine whether short-horizon firms provide greater earnings surprises and whether investors react differently to earnings surprises in the relevant periods. We find that short-horizon firms have significantly greater standardized unexpected earnings (SUEs) than matched long-horizon firms in the year leading up to the short-horizon year. Moreover, we find that investors react more strongly to SUEs for short-horizon firms than for long-horizon firms. The larger SUE and larger investor response partly explains the stock price inflation for short-horizon firms.

Are the positive earnings surprises of short-horizon firms accomplished through managing discretionary accruals? The relation between CEO incentive *level* and earnings management has been widely studied, but the literature has yet to reach a consensus on whether there is a reliable relation (e.g., Armstrong, Jagolinzer, and Larcker, 2010). Again here, we employ a propensity score approach that matches firms with short-horizon CEOs with firms with long-horizon CEOs on many different characteristics. Given our focus on the *horizon* of CEO incentives, in all our matching tests we also match on the *level* of equity-based incentives.

We find that short-horizon firms do not exhibit abnormal discretionary accruals prior to the short-horizon year; but they do *during* the short-horizon year. Thus, earnings management is not deployed to generate greater SUEs and inflate stock price, but rather to sustain the inflated price. Armstrong et al. (2010) discuss hidden bias and the resulting endogeneity challenge when testing the effect of CEO incentives on earnings management. They introduce to the accounting literature a diagnostic tool for potential endogeneity – the sensitivity analyses developed by Rosenbaum (2002). Rosenbaum (2011) introduces new sensitivity tests that substantially increase the power from Rosenbaum (2002). Based on Rosenbaum's (2011) sensitivity tests, we conclude that the relation between CEO incentive horizon and income-increasing discretionary accruals is unlikely to be driven by endogeneity (Rosenbaum $\Gamma \geq 4.94$).

Taken together, the results on earnings surprises and earnings management shed light on the pattern of CEO behavior and investor reactions around short incentive horizon years. To be successful, attempts to inflate stock price need to be credible and undetectable to at least a subset of investors, and our findings show that positive earnings surprises that are not based on accruals management accomplish this. After the stock price inflation and possibly after other methods to attempt stock price inflation are exhausted, CEOs resort to standard accrual management to sustain the inflation. That accrual management is not the first choice of manipulation tool is consistent with recent empirical evidence that arbitrageurs such as hedge funds have increasingly exploited the accrual anomaly. As a result, the accrual anomaly has slowly dissipated over time and mostly disappeared in recent years (e.g., Richardson et al., 2010; Green et al., 2011; Dechow et al., 2011)

In summary, our results are consistent with recent theoretical models in which CEOs with short-horizon incentives pursue strategies to attempt to fool some investors into overvaluing the firm, and suggest that some CEOs are successful in these attempts and exploit their success by earning abnormal profits on stock sales. Although firms with short CEO incentive horizons are significantly more likely to employ income-increasing discretionary accruals during the short-horizon year, these strategies at best sustain overvaluation for a period while insiders sell their positions.

To estimate incentive horizon is a challenging task. Our first contribution is to introduce a dynamic and comprehensive measure of equity-based incentive horizon. Earlier studies on managerial horizon and its effects often focus on retiring CEOs because horizons for younger CEOs are difficult to measure (e.g., Dechow and Sloan, 1991; Cassell et al., 2013). Xu (2013) hand-collects CEO contract terms and expands the horizon study to younger CEOs. Extending this literature, our algorithm of estimating *incentive* horizon can be easily implemented for all executives covered by ExecuComp and provides a dynamic horizon measure that incorporates all forms of equity incentives (stock, option, vested, unvested, newly granted, and previously granted incentives).

To the best of our knowledge, we provide the first empirical evidence of a link between CEO incentive horizon, stock price overvaluation, and the exploitation of that overvaluation through CEOs' stock sales at inflated prices. The evidence illustrates how the temporal structure of managerial incentives can have important capital market effects, and complements the large literature that studies the various economic outcomes of managerial horizon and incentive structures (e.g., Dechow and Sloan, 1991; Cadman and Sunder, 2014). We also provide robust evidence that short CEO incentive horizon is associated with income-increasing discretionary accruals to *sustain* inflated stock prices.

Our paper also adds to the body of work that focuses on the determinants of managerial incentive horizons. For example, Bhattacharyya and Cohn (2010) perform a theoretical analysis on how an optimal temporal structure of compensation balances an agent's efforts and risk aversion. Cadman et al. (2013) and Gopalan et al. (2014) empirically study the determinants of vesting horizons of new grants. We hope to highlight the fact that a manager's incentive horizon is a function of not only new grants but also existing grants. In this aspect our paper calls for further understanding of how horizons of new grants are affected by the horizon of existing grants.

In the next section we describe our measure. Section 3 formulates our hypotheses. Section 4 describes our data and methods. Section 5 contains our results, and Section 6 concludes.

2 Incentive horizon measure

The literature has long recognized that managerial horizon is an important element of agency conflict. Earlier papers on managerial short-termism or myopia utilize measures such as retiring CEOs (Cassell et al., 2013), contract terms (Xu 2013), or the size of restricted stock holdings (Johnson et al., 2009). Recent studies utilize data on grant-level vesting schedule to measure horizon, e.g., Cadman et al. (2013), Gopalan et al. (2014), and Edmans et al. (2015). However, as we mentioned earlier, a manager's incentive horizon is determined by new grants and existing grants, as well as the vesting schedule and exercising or sale decision on previously awarded and vested grants. Thus, while identifying vesting schedule of new grants is fairly straightforward, keeping track of previous grants and sale decisions on previous grants are tricky and can require grant and sale data going back many years. Plus, it is not easy to track when an executive sells stocks, which grant he sells from, and thus complicating the tracking of vesting schedule of overlapping grants. Our first objective is to develop a comprehensive horizon measure that encompasses new and existing grants and previous sale decisions.

We describe our horizon measure below. Since our following tests will focus on CEOs, we will describe the horizon measure in the context of a CEO, but note that the measure can be computed for any executive in the ExecuComp database.

We need a measure that captures the horizons of CEOs' vested stock and stock options, which technically have a horizon of zero, and their unvested stock and stock options, which may have varying horizons depending on the original vesting schedule and when they were granted. The ideal measure would also capture the relative size of the incentives at each horizon. Unfortunately, there is not a machine readable database containing such a measure for a large sample of firms. Thus, we construct an approximation of the CEO incentive horizon based on a refined version of the algorithm first developed by Chi and Johnson (2009) and Chi, Gupta, and Johnson (2011).[2] We describe details of their algorithm next.

[2] Note that we need the horizon of incentives from new stock and stock option grants, as well as the horizon of incentives from existing stock and stock option holdings held by the CEO in a particular year. While data for the former are in firms' Form 4 filings, data on the latter are not.

We infer the vesting period for restricted stock as follows. For each CEO for each firm-year, we use the data in ExecuComp to calculate the numbers of restricted shares that vest in each of the subsequent three years. The number of restricted shares that vest in a particular year is computed by the accounting identity as the number of restricted shares that the executive had at the prior year-end plus newly granted restricted shares minus the number of restricted shares at current year-end. We then compute a time-weighted average of the numbers of shares that vested across the three years. For example, the proportion of shares that vests in year one is multiplied by one; the proportion that vests in year two is multiplied by two, and so on. Remaining shares not vested by year three are assumed to vest in year four. The computation produces a horizon measure in units of years. We adjust for stock dividends and stock splits in this calculation. This algorithm approximates the number of years that it takes the initial unvested holdings of shares in a given firm-year to vest. If no shares vest during the three years, we assume somewhat arbitrarily that the vesting horizon is four years. The censoring at four years should help to capture cases when incentives are subject to cliff vesting because Cadman et al. (2013) find that only 1% of grants cliff vest beyond five years. We perform a parallel computation for unvested stock options to approximate the vesting horizon for stock options.[3]

A numerical example illustrates the algorithm. Suppose CEO A has 300 shares of restricted stock at year 0, and 100 shares vest at the end of each of the next three years. CEO B also has 300 restricted shares, but the 300 shares vest all at once at the end of year 3. Even though both CEOs have all their shares vest in three years, CEO A's effective incentive horizon is shorter than CEO B's. Our algorithm captures the difference in the two effective incentive

[3] If a CEO leaves the company within three years, her unvested incentives may cliff vest. This may produce an *ex post* horizon measure that is shorter than the *ex ante* horizon. For this reason, we exclude all firm-year observations that see the CEO departing within the following three years. This exclusion also means that our findings are different from and compliment the earlier findings on retiring CEOs (e.g., Dechow and Sloan, 1991; Cassell et al., 2013).

horizons – the estimated incentive horizon for CEO A is 2 years (computed as 1*100/300 + 2* 100/300 + 3*100/300), and for CEO B is 3 years (computed as 1*0/300 + 2*0/300 + 3* 300/300).

In practice, some firms specify performance vesting, which is when the vesting of stock options or shares depends on achieving specified accounting-based or other targets (see e.g., Bettis et al., 2010 and 2015). Performance vesting is an important issue because there could be reverse causality between vesting and the outcome variables that we are examining. For example, a CEO could inflate the stock price to a threshold that triggers future vesting. We would observe a relation between short CEO incentive horizon and the abnormal stock return preceding the short-horizon period, but the causality would run from stock return to the incentive horizon instead of vice versa. For firms that employ performance vesting, there is no obvious way to compute an *ex ante* vesting horizon based on the vesting rules they specify. Our algorithm determines the vesting horizon based on how many shares *actually* vest over time for each executive. Thus, our algorithm should produce reasonable ex ante estimates of performance-based vesting horizons under the assumption that managers and investors have unbiased expectations about the relevant future performance outcomes that determine the vesting. In the empirical test section later, we perform robustness tests and show that our main findings are unlikely to be driven by performance testing.

Unrestricted stock holdings and vested stock options technically have vesting horizon lengths of zero. We recognize that implicit or explicit expectations by a board of directors may prevent a CEO from selling her entire unrestricted stock or vested option holdings even though those holdings have no vesting restriction.[4] Indeed, across the CEOs in our sample, less than 1%

[4] Cai and Vijh (2007) present several arguments for why managers cannot freely sell even unrestricted shares.

of them sell unrestricted stock and vested option holdings down to zero during their employment periods. We use the observed minimum incentives over a CEO's time series as an estimate of the minimum level of incentives the CEO is expected to hold throughout her tenure. Instead of assuming an incentive horizon of zero years for these minimum levels of vested incentives, we assume that these incentives have a horizon of four years. Vested stock and stock options above this minimum level are assumed to be able to be sold at the CEO's discretion, so we assume a horizon of zero years for them.[5]

Our measure captures the vesting horizon length going forward from *each* firm-year. The measures also explicitly incorporate differences in granting behavior across firms and differences in the prior exercise and stock sales behavior across CEOs.

With the horizons from each source of incentives in hand, we combine them into weighted measures that reflect the relative magnitudes of the incentives from each source. The weighted measure should capture the overall time horizon element of the incentives that a CEO faces. For example, a CEO may have incentives that take a long time to vest, but those incentives are small in magnitude compared to her short-term incentives. This CEO faces very different incentives to boost short-term stock prices compared to a CEO with relatively small short-term incentives and relatively large incentives that vest in the long term. To capture such differences, we compute weighted incentive horizon measures based on the relative magnitudes of each source of incentives. We use stock and stock option deltas to measure the magnitudes of incentives.

[5] It is possible that CEOs who hold stock above the time-series minimum simply prefer to hold equity long term, which is opposite of our assumption about it having a horizon of zero. To investigate the likelihood of this, we regress future (year-ahead) stock sales on the proportion of incentives from vested stock and options above the time-series minimum, the proportion of incentives from unvested options, and the proportion of incentives from unvested (restricted) stock. We find that future stock sales are positively related (p-value < 0.05) to the proportion of incentives provided by vested stock and options above the time-series minimum, which validates our assumption that these incentives have a short horizon.

To calculate the deltas for stock options, we use the Black and Scholes (1973) model modified by Merton (1973) to incorporate dividends. Executives typically exercise their options before maturity (Hemmer et al., 1996; Huddart and Lang, 1996; Heath et al., 1999), so we reduce the contractual option maturity from ExecuComp by 30%. As a proxy for the risk-free rate, we use the average yield on U.S. Treasury securities that most closely matches the option's (reduced) maturity. We use the standard deviation of stock returns over the prior 60 months to estimate the stock return volatility. We use the average dividend yield over the prior three years as a proxy for the future dividend yield. For newly granted options, strike price and maturity are taken directly from ExecuComp. ExecuComp does not report terms and numbers of individual grants for previously granted options, so we use Core and Guay's (2002) one-year approximation method to estimate the strike price of previously granted options.

Given the option pricing parameter values and the numbers of vested and unvested options each CEO holds, we use the option pricing model to compute delta, defined as the change in value for a one-percentage-point increase in the market value of the firm's equity, and then multiply by the number of options held. We compute separate measures for vested and unvested options. We compute deltas for restricted and unrestricted stockholdings as one percent multiplied by the stock price and then multiplied by the number of shares held.

For each CEO, we compute the overall weighted incentive horizon as the sum of (1) the restricted stock horizon (in years) multiplied by the proportion of total delta that is provided by restricted stock; (2) the unvested stock option horizon (in years) multiplied by the proportion of total delta that is provided by unvested stock option; (3) four years times the proportion of total delta that the time-series minimum represents (i.e., four years times those incentives that we assume the CEO must hold even though they are vested); and (4) zero years times the proportion of total delta provided by the vested stock and stock options above the time-series minimum level. Finally, we define incentive horizon less than one year as "short" and greater than two years as "long." We therefore exclude firm-years where a CEO's incentive horizon is between one and two years to achieve greater dispersion in horizon.

The incentive horizon measure that we compute omits the effects of bonuses, which are frequently tied to accounting figures. While such bonuses may also induce CEOs to manipulate accounting figures, the bonuses do not depend upon fooling investors into overvaluing a firm. Although we do not see a clear way to incorporate a bonus horizon into our weighted incentive horizon measure, we can report that all of our reported results are robust to controlling for bonus scaled by total compensation (ExecuComp variables *bonus*/*TDC2*).

3 Hypotheses development

Several theoretical models formalize the link between short-horizon incentives and CEO strategies that attempt to boost short-run stock prices artificially. In Goldman and Slezak (2006) and Peng and Röell (2014), CEOs who face relatively shorter incentive horizons are more likely to attempt strategies designed to boost stock prices artificially in the short run. Bolton et al. (2006) provide similar arguments, but in their model current shareholders deliberately structure the horizon of CEO incentives to induce managers to pursue such strategies. In their model, a firm's stock price has a long-term fundamental value component and a short-term speculative component. CEOs can pursue strategies that fool a subset of investors into believing that firm value is higher than its true long-term value. If short-sale constraints bind, the trading actions of the fooled investors lead to an increase in the short-term speculative component of the stock price. Investors eventually realize that the stock is overvalued (or short-sale constraints relax), and correction occurs as the stock price falls to the long-term fundamental value. Because current shareholders value the option to sell their stock to the more optimistic investors in the near term at an inflated price, they optimally incentivize CEOs to undertake strategies to inflate prices in the short run by giving them relatively more short-horizon incentives.

While the various models differ from each other on various dimensions, a common prediction is that CEOs with short incentive horizons are more likely to attempt to inflate share prices. If CEOs are successful in their inflation attempts, we should observe two outcomes: 1) stock price inflation and reversal and 2) CEOs exploit the inflation by selling more stock and selling it at overvalued prices. This leads to the first two hypotheses we test, stated in alternative form:

H1: Firms whose CEOs have short-horizon incentives exhibit evidence of share price inflation (positive abnormal returns) and eventual correction (negative abnormal returns) around the short-horizon period. These effects should obtain only among stocks with high short-sale constraints because these constraints limit downward pressure on the stock by informed investors.

H2: CEOs who have short-horizon incentives sell significantly more stock and earn positive abnormal profits than comparable long-horizon CEOs do. As in H1, these effects should obtain only among firms with high short-sale constraints.

These two hypotheses focus on the potential outcomes of any attempts CEOs make to inflate share prices and focus on stock returns over relatively long time periods. As such, the hypotheses do not depend on identifying specific actions or information releases that drive share price inflation. Earnings releases are arguably one of the most value-relevant disclosures that firms make on a routine basis, and are thus plausible drivers of stock price inflation. Thus, we formulate hypotheses about the magnitude of earnings surprises and stock price responses to earnings surprises, stated in alternative form as:

H3: Firms whose CEOs have short-horizon incentives provide greater earnings surprises than matched long-horizon firms. As in H1, these effects should obtain only among firms with high short-sale constraints.

H4: Firms whose CEOs have short-horizon incentives exhibit greater stock price responses to earnings surprises than matched long-horizon firms. As in H1, these effects should obtain only among firms with high short-sale constraints.

Sloan (1996) finds that investors misprice the accrual component of reported earnings, and Beneish and Vargus (2002) find that the mispricing occurs primarily for income-increasing accruals. Investors appear to interpret the income-increasing accruals to imply higher future earnings even though the accruals ultimately reverse and reduce earnings. Thus, ceteris paribus, a manager attempting to lead investors to overvalue a firm should be more likely to employ income-increasing accruals, and ceteris paribus, those abnormal accruals should be larger. Stated in alternative form, we hypothesize that:

H5: Firms whose CEOs have short-horizon incentives are more likely to employ income-increasing discretionary accruals than are matched long-horizon firms.

H6: The magnitude of abnormal discretionary accruals is greater for firms whose CEOs have short-horizon incentives than for firms whose CEOs have long-horizon incentives.

4 Data and methods

4.1 Sample

Our sample includes all firm-years in Standard and Poor's ExecuComp database over the period 1992-2006 that have the data required to compute the various incentive measures for CEOs, stock returns, and control variables we discuss below. We end the sample in 2006 for two reasons. First, we want to avoid extending the sample into the financial crisis period that began in 2007 because that is a relatively unusual period for stock returns. Second, the incidence of performance vesting of stock and option grants increased significantly in years beyond 2006 (see Bettis, et al. 2015). As we discuss later in this section, performance vesting potentially complicates inferences about the relation between short incentive horizon and stock returns.

4.2 Short-sale constraints

We measure short-sale constraints using three different measures: idiosyncratic risk of a stock, level of short interest, and total market capitalization of the firm's stock. Idiosyncratic risk of a stock presents considerable challenges for arbitrageurs. Pontiff (2006) argues that high holding costs and limited opportunity to hedge short positions in a stock with high idiosyncratic risk force arbitrageurs to hold limited positions in it. Consistent with Pontiff's argument, Mashruwala et al. (2006) report a higher concentration of accrual anomaly in stocks with high idiosyncratic volatility. The association between idiosyncratic volatility and short-sale constraints is also documented by Fu (2009). We follow Fu and measure idiosyncratic volatility by regressing stocks' daily excess returns on market excess returns.[6] We require at least 15 trading days in a month for each regression to reduce the influence of infrequent trading. We

[6] We find nearly identical results if we use the three-factor model of Fama and French (1993) instead of a single market factor.

compute idiosyncratic risk as the standard deviation of regression residuals multiplied by the square root of the number of trading days.

The second measure of short-sale constraints we use is the level of short-interest scaled by monthly trading volume. We collect data on short interest from the Compustat Monthly Short Interest File. A higher level of short interest indicates more binding short-sale constraints because borrowing shares to short becomes more difficult if the stock already has a very high level of short interest (Desai et al., 2002; Asquith et al., 2005; Boehme et al., 2006). A limitation of this measure is that in some situations, a lower level of short interest might indicate higher, rather than lower, short-sale constraints because a lower level of short interest might be the result of short sellers unable to borrow the stocks to sell short.

The third measure we use for short-sale constraints is market value of equity. Smaller firms likely have greater information asymmetry and less liquidity, and therefore are likely to have higher short-sale constraints.

We combine the three measures of short-sale constraints into one composite measure defined as the sum of firm's quartile rank (1 through 4) for each measure. The minimum is 3 indicating a firm is in the first quartile on all three measures; the maximum is 12 indicating a firm is in the top quartile on all three measures; the median rank of a firm is 6 on the scale of 1 to 12. We classify firms with above (below) median composite short-sale constraints as those with high (low) short-sale constraints.

4.3 Calendar time portfolio returns

We employ the calendar-time-portfolio method to measure abnormal stock returns in the periods leading up to, during, and following the years that CEOs face short incentive horizons. Combining stocks in calendar time portfolios corrects for lack of independence among firms' returns measured contemporaneously (Fama, 1998). We form two equally-weighted portfolios every month based on incentive horizon, one for short-horizon firms with CEO incentive horizon less than a year and another for long-horizon firms with CEO incentive horizon greater than two years. We also form an arbitrage portfolio that buys the short-horizon portfolio and sells short the long-horizon portfolio. We then regress portfolio returns on market, SMB, HML, and momentum factors (Fama and French, 1993; Carhart, 1997) to measure abnormal stock returns.

4.4 Insider trades and profits

To examine whether CEOs facing short incentive horizons appear to exploit price inflation, we examine CEOs' trading activity prior to and during the period when CEOs face short incentive horizon. We identify insider trading activity from Thomson Reuters' Insider Filing Data Feed. Following Jagolinzer et al. (2011), we accumulate CEO's transactions each day while netting out purchases from sales. We then estimate abnormal returns for up to 180 days as the intercept of a regression of the firm's returns in excess of the risk free rate on market, SMB, HML, and momentum factors. CEO's transactions are profitable (unprofitable) if the stock experiences a negative (positive) abnormal return, i.e., the regression intercept is negative (positive). We multiply the intercept by −1 for ease of interpretation and exposition. Finally, we weight the intercept by the size of transaction to estimate the dollar value of the CEO's trading profit.

4.5 Earnings surprises and market reaction to earnings

Earnings announcements are an important corporate information event and plausibly an opportune venue for CEOs to influence investors' valuation of their firms. We first examine the size of quarterly earnings surprises around the short-horizon period. We measure unexpected earnings by the difference between actual earnings and the I/B/E/S analyst consensus earnings.

We standardize the unexpected earnings by the standard deviation of unexpected earnings during the past 20 quarters, requiring at least 8 quarters of available data (e.g., see Doyle et al., 2006). This standardization is important for our test because we want to control for the typical inherent profit volatility of each firm and capture the unexpected earnings beyond that. Standardizing by stock price does not control for the inherent profit volatility and would potentially contaminate our test because of the mispricing we document in Table 2. To measure investors' response to the SUE, we scale the day (–1, +1) earnings announcement cumulative abnormal return (CAR) by the SUE. We winsorize SUE, CAR, and CAR/SUE at the top and bottom one percentiles to reduce the influence of extreme outliers. We alternatively measure CAR over the (–1, +5) window and obtain similar findings.

4.6 Earnings management

To identify firms that use income-increasing discretionary accruals, we begin with a discretionary accrual measure obtained from a modified version of the Jones (1991) model. We run annual cross-sectional regressions of the following model for each of the Fama and French (1997) 48-industry groups:

$$\frac{TA_{it}}{Assets_{it-1}} = \alpha \frac{1}{Assets_{it-1}} + \beta_1 \frac{\Delta Sales_{it} - \Delta AR_{it}}{Assets_{it-1}} + \beta_2 \frac{PPE_{it}}{Assets_{it-1}} + \varepsilon_{it}, \qquad (1)$$

where $\Delta Sales_{it}$ is the change in sales, ΔAR_{it} the change in accounts receivables, and PPE_{it} property, plant, and equipment. Following Hribar and Collins (2002), we calculate total accruals, TA_{it}, as Compustat data item *ibc* (income before extraordinary items and discontinued operations from the Cash Flow Statement) minus OCF (Operating activities-net cash flows (*oancf*) minus extraordinary items and discontinued operation (*xidoc*)). We winsorize the variables in equation

(1) at 1st and 99th percentile before running the regressions and exclude those industry-years that have fewer than eight observations. We obtain discretionary accruals as the residuals from equation (1).

Kothari et al. (2005) recommend adjusting discretionary accruals using performance-matched firms. They match firm observations with another firm from the same industry on the basis of their return on assets. Performance-adjusted discretionary accruals are then defined as the difference in discretionary accruals of the subject firm and the matched firm. Given our focus on how managerial incentive horizon affects the discretionary accrual measures, we need to ensure that such matching procedures do not wipe out any effect of incentive horizon by, for example, subtracting discretionary accruals for sample and matched firms with similar incentive horizons. If incentive horizon affects discretionary accruals, then netting accruals for firms with similar incentive horizons could net out any effects of the incentive horizon. Thus, we follow Kothari et al. except that we impose the additional requirement on the matched firm that it has a different incentive horizon than the sample firm. Specifically, for every observation with an incentive horizon shorter than the sample median (about one year), we choose the match (based on the Fama-French 48 industry, year, and ROA) from among firms with incentive horizons longer than the sample median. We do the converse for every observation with an incentive horizon longer than the sample median. This approach preserves the performance matching from Kothari et al. and also ensures that we retain any variation that depends on differences in incentive horizons.

Beneish and Vargus (2002) find that the accrual mispricing in Sloan (1996) occurs primarily for income-increasing accruals, and the theoretical models that underpin our study focus on managerial attempts to cause overvaluation. Thus, in addition to examining the continuous discretionary accrual measure, we define a dummy variable equal to one to indicate firm-years in which the discretionary performance-adjusted accrual is income-increasing (i.e., positive), and zero otherwise.

4.7 Method

The propensity-score matching method has been shown to be more effective than OLS in matching firms experiencing a particular treatment (for example, CEOs with short incentive horizon) with those without the treatment (for example, CEOs with long incentive horizon). As Armstrong et al. (2010) note, controlling for determinants of a treatment in an OLS regression imposes a functional form on the relation between treatment and firm characteristics.[7] Applying the propensity-score matching methodology, Armstrong et al. find that the positive relation between the *level* of managerial incentives and accounting irregularities as documented in the literature disappears. Extending this line of research, we employ the propensity-score matching methodology to study the effects of the *horizon* of managerial incentives. In particular, we estimate the propensity of a firm to award shorter horizon incentives to its CEOs using the following probit model:

$$\Pr(Short\ Horizon_i) = \alpha + \beta_1 \times IncentiveRatio_i + \beta_2 \times Log\left(\frac{M}{B}\right)_i + \beta_3 \times Log(Total\ Assets)_i + \beta_4 \times Leverage_i + \beta_5 \times ROA_i + \beta_6 \times Stdev(CFO)_i + \beta_7 \times CapIntensity_i + \beta_8 \times InstiOwn_i + \beta_9 \times GIndex_i + \beta_{10} \times BoardIndPct_i + \beta_{11} \times BoardSize_i + \beta_{12} \times Year_i + \varepsilon_i \quad (2)$$

As shown in equation 2, we employ a wide range of firm characteristics that 1) potentially explain managerial incentive horizon and 2) are plausibly correlated with the outcomes that we study, namely insider trading volume and profits, earnings surprises and market reactions, and

[7] Also see Core (2010) for a discussion of Armstrong et al. (2010).

discretionary accruals. To control for the effect of the level of incentives, we include the incentive ratio from Bergstresser and Philippon (2006) as a control variable. They define the incentive ratio as the delta of the manager's stock and stock options divided by the sum of that delta, salary, and bonus.

We use the logarithm of market-to-book ratio to control for firm valuation and growth potential. Watts and Zimmerman (1990) argue that large firms face higher political costs and thus have a stronger incentive to use accounting discretion to reduce these costs. Dechow and Dichev (2002) posit that larger firms can estimate accruals more accurately as they have more stable operations. We include log of book assets (Compustat item *at*) to control for firm size. We also control for financial leverage (items *dltt* / *at*). Higher financial leverage increases the volatility of net income and gives the manager a stronger incentive to manage earnings to avoid covenant violations and preserve their credit ratings. On the other hand, higher leverage is a proxy for closer monitoring from debt-holders and could be related to less earnings management. Firm performance potentially affects the incentive level and structure, so we control for firm performance with the return-on-assets ratio (items *ni* / *at*). Firms with more volatile business have a greater incentive to manage earnings to reduce their apparent risk level (Dechow and Dichev, 2002). Thus, we include the standard deviation of cash flows from operations (items *oancf* / *at*) for the last five years (requiring a minimum of three years of data). Francis et al. (2004) recognize the effects of differences in measurement and recognition of tangible and intangible assets on accrual quality. We control for differences in asset structure through capital intensity, the ratio of net fixed assets to total assets (items *ppent* / *at*).

Corporate governance mechanisms plausibly affect the incentive structure and managerial behavior, so we control for four governance variables: total institutional ownership from

Thomson Reuters 13F filings, the Gompers et al. (2003) Governance Index, percentage of independent directors on the board, and board size, all from Risk Metrics. To preserve the sample size, we set missing governance values to zero, and create a dummy for each variable indicating whether the variable value is missing. The dummies are then included in the propensity score model.

Next, using the propensity scores predicted from equation (2), we match firms with short CEO incentive horizons with firms with long CEO incentive horizons. We retain matches with the smallest difference in propensity scores. To establish the validity of the matching process, we test whether characteristics of firms with short incentive horizon are statistically different from those with long incentive horizon. We then compare various outcomes for the test variables defined earlier, i.e., insider trading and profits, earnings surprises, and discretionary accruals, for the matched pairs.

Using 1992-2009 ExecuComp data to compute 1992-2006 CEO incentive horizons, we are able to estimate the horizon for 11,137 CEOs. After requiring that a CEO needs to remain in office for the future 3 years, we are left with 10,528 observations. We also remove the CEOs with horizon between 1 and 2 years to create greater contrast in horizon, and 7,257 observations remain. After requiring the availability of the control variables and the outcome variables, we have 5,445 observations for the abnormal return tests and 5,754 observations for the discretionary accruals test.

Table 1 reports the summary statistics. The average CEO incentive horizon is 2.14 years, and the median is 2.42 years. 32.1% of the CEOs in our sample have an incentive horizon of less than one year. All the other variables appear to have reasonable distribution characteristics.

5 Results

5.1 Abnormal stock returns

A key prediction of the theoretical models that motivate our study is that a short-horizon CEO is more likely to attempt to inflate the firm's stock price. To test this prediction, we form calendar-time portfolios based on incentive horizon and examine the portfolio abnormal returns in periods surrounding the point at which the manager has a short incentive horizon. Recall that the incentive horizon is measured at the end of each fiscal year, which we label as months 1 to 12. We compute abnormal returns for the year leading up to the short-horizon year (months -12 to -1), during the short-horizon year (months 1 to 12), and two years after (months 13 to 36).

The results are in Table 2. The left side of Panel A shows that for the high short-sale constraints subsample, short-horizon firms have a significantly positive alpha of 0.621% per month in months -12 to -1, while long-horizon firms have an alpha of -0.442%. The arbitrage portfolio has a large positive alpha of 1.063% (p-value = 0.001). During months 1 to 12 and 13 to 36, the arbitrage portfolio alpha turns negative and completely offsets the positive alpha in months -12 to -1. Thus, the evidence is consistent with the prediction that short incentive horizon firms exhibit stock price inflation (positive abnormal returns) followed eventually by correction (negative abnormal returns). We see a similar pattern of alphas for the low short-sale constraints subsample, but the magnitude of the alphas is smaller and the statistical significance is lower. The contrast between the high versus low short-sale constraints subsamples provides further confidence in our interpretation that the observed arbitrage portfolio alphas are the result of mispricing.

In Panel B of Table 2 we zero in on the 1 to 12 months alphas. For the high short-sale constraints subsample, we see that the reversals in the short-horizon portfolio alpha and the arbitrage portfolio alpha occur mainly during months 7-12. That is, it seems that short-horizon CEOs are able to maintain the stock price inflation for a while, i.e., during months 1 to 6. For the low short-sale constraints subsample, we again see relatively muted reversals in the short-horizon portfolio alpha and the arbitrage portfolio alpha.

As noted earlier, performance vesting may potentially contaminate our finding because greater stock return can accelerate vesting and thus shorten incentive horizon. That is, greater abnormal return may cause short horizon rather than the other way around. We first note that if performance vesting is indeed driving our finding, we should not observe the difference between firms facing high versus low short-sale constraints. The contrast of abnormal returns between high versus low short-sale constraints groups supports our mispricing interpretation.

Nevertheless, to assess whether performance vesting effects are likely to bias our findings, we repeat our main stock return tests in Table 2 while excluding sample years beyond 2002. Performance-vested option and stock grants began to increase in frequency and value in 2003; in 2002, only 9% of the value of grants was performance based according to Bettis et al. (2015). When omitting years 2003 and beyond, untabulated results for the stock return analysis are qualitatively similar to those reported in Table 2. As a second assessment of the potential importance of performance vesting, we include in our propensity-score matching approach (discussed below) a large set of future performance variables that are potentially performance vesting metrics and thus trigger vesting in the years that enter into our horizon calculation. The performance measures include: year +1 and +2 stock returns, the percentage change in earnings per share, and return on assets. We use unadjusted and industry-adjusted versions of these measures, and also include the squares of the measures to attempt to capture nonlinearities in performance vesting rules. When controlling for these future performance measures, we obtain results similar to those tabulated in our following tests for insider trading and abnormal profits, standard earnings surprises and associated abnormal returns, and earnings management.[8]

In sum, Table 2 presents evidence that in the presence of higher short-sale constraints, firms with short CEO incentive horizon experience stock price inflation leading up to the short-horizon year, the price inflation persists for several months, and then reverses. Do the short-horizon CEOs exploit the temporary stock price inflation? We examine this question next.

5.2 Insider trading volume and profits

Table 3 compares insider trading dollar volume and dollar trading profits between short-horizon CEOs and long-horizon CEOs. We focus our discussion on the high short-sale constraints subsample because short-sale constraints are a key conditioning characteristic in the various theoretical models that underpin our analysis. As shown in Panel A and for the year leading up to the short-horizon year (year *t*-1), on an unmatched basis, short-horizon CEOs sell more stock than long-horizon CEOs, but the difference disappears when we apply the propensity-score matching procedure. The average treatment effect on the treated (ATT) has a *t*-stat of 1.02. However, during the short-horizon year (year *t*), short-horizon CEOs sell significantly more stock than long-horizon CEOs: almost \$1.6 million versus \$0.9 million with a difference of \$642,456 (difference test *t*-stat = 6.34). When we apply the propensity-score matching procedure, we still find that short-horizon CEOs sell significantly more stock than do matched long-horizon CEOs—the difference is \$462,581 (*t*-stat = 3.97). The lower half of Panel A repeats the test for the low short-sale constraints subsample. Although without the matching procedure short-horizon CEOs still show more sales, the matching procedure shows no statistical difference in sales between short versus long-horizon CEOs.

[8] As we note earlier, we end our sample period in 2006 in part to avoid an increased incidence of performance vesting in more recent year.

The results in Panel A provide two important insights. First, during the short-horizon year, short-horizon CEOs sell significantly more stock (in dollars) than do long-horizon CEOs, but only when short-sale constraints are high. This finding is consistent with the earlier finding of stock price inflation for short-horizon firms with high short-sale constraints. Second, because short-horizon CEOs by definition have more shares available to sell than long-horizon CEOs, the greater sales by short-horizon CEOs might be viewed as driven strictly by the very fact that they have more stock that can be sold. Importantly, however, short-horizon CEOs having more stock available to sell does not necessarily mean that they *must* sell more stock—indeed, we do not find more sales by short-horizon CEOs for the low short-sale constraints subsample. Therefore, more sales by short-horizon CEOs are not driven by the definition of short-horizon CEOs. A plausible interpretation, consistent with the abnormal-return results reported earlier, is that short-horizon CEOs are able to inflate stock price when short-sale constraints bind, and they take advantage of the inflated stock price to sell more stock.

Not only do short-horizon CEOs sell more stock, they also generate greater abnormal profits through their trading. We show this in Panel B of Table 3. In the year leading up to the short-horizon year, short-horizon CEOs do not generate higher trading profits. During the short-horizon year and when short-sale constraints are high, short-horizon CEOs generate a positive *abnormal* profit of $47,419 without applying the matching procedure. The difference between short versus long-horizon CEOs is $136,913 ($t$-stat = 5.33). On a matched basis, the difference in abnormal profit is still large at $93,780 and strongly significant (t-stat = 3.23). In contrast, when short-sale constraints are low, there is no difference in abnormal trading profits between short and long-horizon CEOs. The abnormal trading profits are consistent with the earlier findings for abnormal stock returns and CEO dollar trading volume.

Next, we compare how well our sample of short-horizon firms matches with long-horizon firms in Panel C of Table 3. The first column reports slope coefficients for a probit regression for determinants of short incentive horizon. The last column reports standardized bias after matching (Rosenbaum and Rubin, 1985) and *p*-value for significance of standardized bias. The only matching variable for which standardized bias is significant is institutional ownership and even for that the magnitude of bias is small (6.1%). A standardized bias of less than 10% indicates negligible difference between the sample and treatment group (Austin, 2011; Harder et al., 2010). These findings suggest validity of matches used in this comparison.

To summarize the findings so far, firms with short-horizon CEOs experience temporary stock price inflation, and CEOs sell more stock and make greater positive abnormal profits; all of these findings are driven by firms with high short-sale constraints and are consistent with the mispricing interpretation.

5.3 SUE and CAR

Given the stock price inflation and reversals of short-horizon firms and evidence that short-horizon CEOs exploit the mispricing, we next attempt to identify more precisely what drives the mispricing. In particular, we focus on differences in firms' reported earnings and on abnormal returns surrounding the earnings announcements. Table 4 reports the SUE and CAR tests. We first focus on the results for year *t*-1, the year leading up to the year when we measure CEO incentive horizon, which is also the year that we find stock price inflation for firms with high short-sale constraints and short-horizon CEOs (as reported in Table 2). To ensure that the surprises and investor responses are truly from the horizon effect and not from the inherent business volatility or information asymmetry, we impose three more matching variables in addition to those listed in equation 2: analyst forecast dispersion scaled by the median forecast, number of analysts, and standard deviation of sales. The propensity-matching provide matches with less than 10% standardized bias for all matching variables. We do not report covariate balance for brevity.

In Panel A of Table 4, we observe that in year *t*-1 and for firms with high short-sale constraints, those with short-horizon CEOs report significantly higher SUEs than those with long-horizon CEOs. In the propensity-score-matched sample, the short-horizon firms report SUEs of 0.29, which is significantly greater than the figure of 0.11 for long-horizon firms (*t*-stat = 2.43). In contrast, there is no significant difference in SUEs between matched short and long-horizon CEOs when short-sale constraints are low. The contrast mitigates the concern that firms with short-horizon CEOs are merely better performing firms, and that short horizon is merely the result of better performance. The correlation coefficient between SUE and short-sale constraints is -0.077, which demonstrates that sorting on short-sale constraints is not effectively sorting on performance.

In Panel B of Table 4, we examine investors' reaction to SUE by examining the ratio of each earnings announcement abnormal return and its corresponding SUE. In year *t*-1 and when short-sale constraints are high, the CAR/SUE ratio is significantly greater for firms with short-horizon CEOs (3.79%) than for matched long-horizon firms (2.71%) (*t*-stat = 1.98). Thus, investors react more strongly to earnings surprises by short-horizon firms. In contrast, the difference is insignificant for firms with low short-sale constraints. The findings in Panels A and B are consistent with our interpretation that high short-sale constraints contribute to the stock price inflation evident in the year leading up to the short-horizon year. The results indicate that higher SUEs and higher CAR/SUE for short-horizon firms with high short-sale constraints are one contributor to the stock price inflation identified for these firms in Table 2.

Also shown in Table 4, we repeat the SUE and CAR/SUE tests for year *t*, i.e., the short-horizon year. For that period, we find no significant differences in SUE or CAR/SUE across short and long-horizon firms. Thus, the stock price reversals that we show in Table 2 are not driven by significantly lower returns for short-horizon firms surrounding earnings announcements.

5.4 CEO incentive horizon and discretionary accruals

Earnings management through discretionary accruals is well documented in the accounting and finance literature, but the literature has yet to reach a consensus on whether there is a reliable relation between managerial incentives and earnings management (see a thorough review and analysis in Armstrong et al. (2010)). We next examine whether shorter CEO incentive horizon is associated with higher discretionary accruals, which may help explain the stock price inflation and higher SUE for firms with short-horizon CEOs. We again employ a propensity score approach that matches firms with short-horizon CEOs with firms with long-horizon CEOs on many different characteristics. Given our focus on the *horizon* of CEO incentives, we also match on the *level* of the equity-based incentives the CEOs face. We essentially ask whether similar firms whose CEOs face the same level of equity-based incentives, but differ on when their CEOs can profit from the incentives, differ in their likelihood of employing income-increasing discretionary accruals. We examine both the likelihood of employing income-increasing discretionary accruals and the magnitudes of the (continuous) discretionary accruals. Again, the propensity-matching procedure provides matches with less than 10% standardized bias for all matching variables. We do not report covariate balance for brevity.

As shown in Table 5, firms with short-horizon CEOs are no more likely to exhibit income-increasing discretionary accruals in the year leading up to the short-horizon year. The insignificance is particularly striking because that is the time period over which we find that short-horizon firms exhibit significantly positive abnormal returns, and greater SUEs and CAR/SUE ratios than matched long-horizon firms. The results imply that short-horizon firms are able to earn significantly positive abnormal returns, driven in part by greater SUEs and CAR/SUEs, without resorting to standard, and arguably easily detectable, discretionary accrual-based earnings management strategies. Although one might interpret the greater SUEs and CAR/SUEs, and the resulting stock prices, in the year prior to the short-horizon year as non-manipulated in any way, that interpretation is difficult to reconcile with the stock price reversals in the periods that follow.

Moving to the short-horizon year, we find that short-horizon firms *are* significantly more likely to exhibit income-increasing discretionary accruals than are matched long-horizon firms. As shown in Table 5, in the high short-sale constraint subsample, 52.9% of short-horizon firms employ income-increasing discretionary accruals which is significantly greater than the 44.6% of long-horizon firms (*t*-stat = 3.91). We also find that short-horizon firms have a significantly greater magnitude of abnormal discretionary accruals than do matched long-horizon firms (0.10 vs. -1.20, *t*-stat = 2.93). There are no significant differences across short and long-horizon firms within the low short-sale constraint subsample.

Combining the earning management results with the return results in Table 2 and the SUE and CAR/SUE results in Table 4, we can infer that even though short-horizon firms employ earnings management strategies more aggressively during the short-horizon year than do their matched long-horizon counterparts, they do not provide greater earnings surprises nor do they earn greater announcement period returns or longer-term returns over the short-horizon year. Thus, the more aggressive earnings management actions of short-horizon firms *during* the short-horizon year have the effect of sustaining already-inflated share prices for the first six months of the year (i.e., zero abnormal returns over those six months), after which correction sets in and the firms exhibit negative abnormal returns.[9] In the year prior to the short-horizon year when short-horizon firms do earn positive abnormal returns, they do not appear to employ accrual-based earnings management strategies. Rather, they seem to employ other subtle and less detectable strategies to provide more positive earnings surprises and induce stronger investor responses to the surprises.

Armstrong et al. (2010) apply the propensity-score matching method and find no significant relation between managerial equity incentive level and accounting irregularities. Their finding challenges earlier studies that do show a positive relation between managerial incentive level and earnings manipulation. Applying the same propensity-score matching technique as in Armstrong et al. except also matching on the level of equity incentives, we find that the horizon of incentives is related to earnings management behavior. Our results suggest that future studies may gain additional insights by treating the horizon of equity incentives as an important dimension of managerial incentives.

5.5 Matched pair sensitivity tests

When conducting an analysis of matched treatment-control pairs based on observational data, one wants the pairs to be identical except for the presence or absence of the treatment. In such a perfect situation, endogeneity concerns are avoided. In reality, as Armstrong, et al.

[9] Note that our results are not necessarily inconsistent with the accrual anomaly (Sloan, 1996) because no study on the accrual anomaly has considered the effect of managerial incentive horizon. Note also that our results are consistent with Johnson et al.'s (2009) finding of statistically zero raw returns over the period in which their sample firms engaged in misreporting.

(2010) note, there may be “endogenous matching of executives and contracts on unobservable firm and CEO characteristics such as CEO risk aversion.” This “hidden bias” may affect inferences because it is possible for an unobservable characteristic to cause non-random assignment of an observation to the treatment or the control group and also affect the outcome. Rosenbaum (2002) develops a sensitivity analysis to assess how large any deviation from random assignment could be before one’s conclusion about a statistically significant treatment-control difference would be altered. For example, a sensitivity analysis might conclude that a non-zero treatment effect exists even if an unobservable characteristic makes it 50% more likely that an observation is in the treatment group instead of the control group, which would imply a 60%/40% odds ratio of being a treatment vs. control. In this case, the parameter Γ that indicates the departure from random assignment would be 1.5 (=60%/40%) vs. a Γ of 1.0 (=50%/50%) for random assignment. However, if an unobservable characteristic makes it 60% more likely for an observation to be the treatment group instead of the control group ($\Gamma = 1.6$), the sensitivity analysis that produces $\Gamma = 1.6$ might indicate that one could no longer be confident in rejecting the null hypothesis of no treatment effect.

Similar to other statistical analyses, one can consider the power of a sensitivity analysis. The power of a sensitivity analysis is the probability that it rejects a *false* null hypothesis of no treatment effect allowing for a specified level of non-random assignment to the treatment and control groups. A low power sensitivity analysis has a low probability of rejecting a false null while a higher power sensitivity analysis has a greater likelihood of rejecting a false null for the same level of hidden bias.

In an extension of his 2002 work, Rosenbaum (2011) explores the power of various sensitivity analyses, and concludes that in many situations the Wilcoxon-based sensitivity analysis from his 2002 work has relatively low power compared to an alternative class of sensitivity analyses based on *u*-statistics. Briefly, the new tests are based on triples $(m, \underline{m}, \overline{m})$, where *m* defines the number of treatment minus control differences in outcomes that are sorted in increasing order based on absolute magnitude. One then counts the number of positive differences among the pairs numbered from $\underline{m}$ up to $\overline{m}$ in the sorted set. By choosing the appropriate triple, one can place less weight on small-magnitude paired differences to increase power, while also controlling the influence of very large magnitude paired differences. We refer the reader to Rosenbaum (2011) for the derivation of the test statistics and other details because there is not a compact way to describe them here.

For our purposes, we note that Rosenbaum (2011) conducts simulation analyses of many different $(m, \underline{m}, \overline{m})$ triples to assess their power under various assumptions. Based on those analyses, Rosenbaum concludes that $(m, \underline{m}, \overline{m})$ = (8,5,8) or (8,6,8) are "safe choices." He notes that for short-tailed distributions of matched pair differences like the Normal or the logistic, (8,7,8) is a better choice, whereas with long-tailed distributions of matched pair differences, (8,6,7) is a better choice.

In Table 6, we summarize the resulting Γs for the matched pair difference tests that are significant in our earlier analyses. To give readers examples of how the Γs can change for different triples, we tabulate the Γs for five different triples, the four discussed in the previous paragraph and (2,2,2), which is equivalent to the Wilcoxon-based test from Rosenbaum (2002). The most striking case is the test of whether short-horizon firms are more likely than matched long-horizon firms to employ incoming-increasing discretionary accruals. The Γ of 4.94 for the (8,5,8) triple indicates that an unobservable characteristic would have to make it 4.94 times more likely that a firm is a treatment (short-horizon firm) than a control (long-horizon firm) before we would fail to reject the null hypothesis of no treatment effect based on concerns about hidden bias. For the (8,6,8) triple, the Γ rises to 8.8 and to 17.5 for the (8,7,8) triple. The results of the sensitivity analyses are somewhat unsurprising given the economically large magnitude of the difference (recall from Table 5 that short-horizon firms have a 52.9% likelihood of employing income-increasing discretionary accruals vs. a 44.7% likelihood for long-horizon firms). Thus, the conclusion that short-horizon firms are more likely to employ income-increasing discretionary accruals is quite robust.

Table 6 also shows that the Γ for the corresponding Wilcoxon-based sensitivity test (the (2,2,2) triple) from Rosenbaum (2002) for the difference in the likelihood of employing income increasing discretionary accruals. The Γ is 2.82, which means one would infer that the rejection of the null of no treatment effect would be in doubt if hidden bias made it 2.8 times more likely for an observation to be in the treatment vs. the control group. The higher power test discussed in the previous paragraph, however, concludes that the nonrandom assignment would have to make it 17.5 times as likely to be a treatment observation before we would alter the inference. This example is a good illustration of the potential power differences between the two types of Rosenbaum sensitivity tests.

As shown in Table 6, the Γs for the other difference tests are much lower than the one for the likelihood of employing income-increasing discretionary accruals. Whether one is willing to alter the conclusions about the statistical significance for the tests depends upon his or her subjective assessments of how large the effects of unobservable characteristics might be on both the likelihood of assignment to the treatment group and the magnitude of the outcome for treatment and control observations. For example, the Γ for the continuous measure of discretionary accruals is 1.15 for the (8,7,8) triple and 1.23 for the (2,2,2) triple. Importantly, the relatively lower values of Γ do not *necessarily* indicate that there is no true positive effect of short horizon on the continuous accrual measure. Ideally, one would know both how an unobservable characteristic alters the likelihood that an observation is assigned to the treatment group *and* how that characteristic affects the outcome being tested. If an unobservable characteristic affects the likelihood of assignment to the treatment group, but it does not affect the outcome, then the original inference remains. Unfortunately, there is no way to measure how much an unobservable characteristic might affect the outcome variable.

6 Conclusion

We develop a dynamic algorithm that estimates a comprehensive measure of equity-based incentive horizon. We find that firms with short-horizon CEO incentives exhibit stock price inflation followed by reversal. We also find evidence that short-horizon CEOs exploit the price inflation by selling relatively more stock and making greater abnormal profits than matched long-horizon CEOs do. Firms with short-horizon CEO incentives provide greater earnings surprises and experience more positive investor reaction to the surprises during the period over which we observe stock price inflation. Short-horizon firms are significantly more likely to employ income-increasing discretionary accruals than are matched long-horizon firms, but this accrual management at most sustains the inflated price for a while as CEOs sell their shares. The findings are consistent with recent theoretical models in which short-horizon incentives induce CEOs to attempt to inflate stock prices, suggest that they have some success in doing so and that they profit from it. The finding also sheds new light on the role that earnings management plays in sustaining already-inflated stock prices. Broadly, our findings highlight the importance of CEO incentive horizons in studying the effects of CEO incentive compensation.

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Table 1

Summary statistics

All variables are at the firm-year level. For incentive horizon measures, we first estimate executive-level vesting years, and then weight across executives by their total cash compensation. Vesting measures and incentive ratios are estimated using Execucomp data. Institutional ownership data are from Thomson Financial. G-Index and board data are from IRRC. All other variables are calculated using Compustat data. The sample period is from 1992 to 2006.

Variable name	Definition	N	Mean	Std	p25	p50	p75
Weighted incentive horizon (all incentives)	Vesting years weighted by deltas of all equity incentives (restricted and unrestricted stocks, vested and unvested options).	5754	2.144	1.191	0.844	2.418	3.057
Short Horizon Dummy	A dummy variable equal to one if the weighted incentive horizon < 1 year	5754	0.321	0.467	0	0	1
Discretionary accruals (DACC) (%)	Performance-adjusted discretionary accruals scaled by total assets, in %.	5754	-0.453	9.843	-6.411	-0.283	5.511
Positive DACC dummy	A dummy variable equal to one if DACC is positive.	5754	0.489	0.500	0	0	1
Incentive ratio	Delta (measuring the sensitivity of an executive's equity-based incentive to the company's stock price) scaled by the sum of delta, salary, and bonus, as in Bergstresser and Philippon (2006).	5754	0.265	0.234	0.092	0.183	0.369
Log(M/B)	The natural logarithm of market value of assets to book value of assets.	5754	0.956	0.705	0.488	0.903	1.371
Log(total assets)	The natural logarithm of total book assets.	5754	7.035	1.480	5.972	6.861	7.962
Long-term debt	Long-term debt over total book assets.	5754	0.171	0.150	0.020	0.157	0.276
ROA	Income before extraordinary items over total book assets.	5754	0.049	0.100	0.024	0.058	0.095
Std dev of cash flows	Standard deviation of cash flow from operations over total book assets for the last five years.	5754	0.050	0.039	0.025	0.040	0.062
Fixed assets	Net fixed assets over total book assets.	5754	0.310	0.216	0.145	0.256	0.437
Institutional ownership	Total institutional ownership.	4917	0.662	0.212	0.528	0.683	0.821
G-Index	The number of corporate-governance provisions a firm has, as in Gompers et al. (2003).	3949	9.320	2.694	7	9	11
Board independence	Fraction of board members who are independent.	3809	0.648	0.173	0.545	0.667	0.778
Board size	Number of directors on the board.	3824	9.146	2.464	7	9	11

Table 2

Abnormal Returns for Portfolios Formed on CEO's Incentive Horizon and Short-Sale Constraints

This table presents average monthly abnormal returns from calendar-time portfolios formed on CEO's incentive horizon and short-sale constraints. Each month we assign firms to one of the four portfolios on the basis of CEO's incentive horizon and firm's short-sale constraints, both measured at the beginning of the year. We require at least ten observations per portfolio. We use the four-factors from Fama and French (1993) and Carhart (1997) and report abnormal returns from equally-weighted portfolios. All variables are described in table 1. The sample period is from 1992 to 2006. Panel A reports monthly average abnormal returns held for annual intervals, while Panel B reports average abnormal returns held for 6-months intervals. *p*-values are in parentheses.

Panel A:

	High Short-Sale Constraints			Low Short-Sale Constraints		
Portfolio Duration	Horizon < 1 year	Horizon > 2 years	Arbitrage Portfolio	Horizon < 1 year	Horizon > 2 years	Arbitrage Portfolio
Months -12 to -1	0.621	-0.442	1.063	0.759	0.188	0.571
	(0.005)	(0.017)	(0.001)	(0.000)	(0.190)	(0.006)
Months 1 to 12	-0.397	0.498	-0.894	-0.058	0.163	-0.220
	(0.034)	(0.004)	(0.000)	(0.745)	(0.215)	(0.162)
Months 13 to 36	-0.214	0.309	-0.524	-0.090	0.245	-0.335
	(0.334)	(0.066)	(0.004)	(0.597)	(0.075)	(0.009)
Number of Observations	861	2110		694	1780	

Panel B:

	High Short-Sale Constraints			Low Short-Sale Constraints		
Portfolio Duration	Horizon < 1 year	Horizon > 2 years	Arbitrage Portfolio	Horizon < 1 year	Horizon > 2 years	Arbitrage Portfolio
Months 1 to 6	-0.015	0.661	-0.676	0.003	0.278	-0.275
	(0.967)	(0.0178)	(0.074)	(0.991)	(0.180)	(0.265)
Months 7 to 12	-0.654	0.481	-1.135	-0.203	0.151	-0.354
	(0.009)	(0.039)	(0.000)	(0.322)	(0.345)	(0.088)
Number of Observations	861	2110		694	1780	

Table 3

Insider Trading Volume and Profits, for Firms Sorted on CEO's Incentive Horizon and Firm's Short-Sale Constraints

Panel A presents CEO's insider trades in the year before (year *t*-1) and the year during (year *t*) the short-horizon year. Panel B reports the abnormal profits earned on those trades in the 180-day period following each trade. Differences are presented for unmatched samples, and the average treatment effect for the treated (ATT) is reported for propensity score matched samples. We identify insider trading activity from Thomson Reuters' Insider Filing Data Feed. We accumulate CEO's transactions each day while netting out purchases from sales. We then estimate abnormal returns for up to 180 days as the intercept of a regression of firm's returns in excess of risk free rate on market, SMB, HML, and momentum factors (Fama and French, 1993; Carhart, 1997). CEO's transactions are profitable (unprofitable) if the stock experiences a negative (positive) abnormal return, i.e., the regression intercept is negative (positive). We multiply the intercept with a negative one and weight the intercept by the size of transaction to estimate dollar value of CEO's trading profit. Panel C reports slope coefficients for a probit regression for determinants of short incentive horizon (horizon < 1 year) and compares firm characteristics of short horizon with long horizon (> 2 years). All variables are described in Table 1. The sample period is from 1992 to 2006. ***, **, and * indicate p<0.01, <0.05, and <0.1, respectively.

	In Year t-1				In Year t			
	Horizon < 1 year	Horizon > 2 years	Difference	*t*-statistic	Horizon < 1 year	Horizon > 2 years	Difference	*t*-statistic
	Panel A: Trading Volume (in $)							
	High Short-Sale Constraints							
Unmatched	1,224,606	897,569	327,036	3.69***	1,575,163	932,707	642,456	6.34***
ATT	1,243,294	1,138,742	104,551	1.02	1,597,041	1,134,459	462,581	3.97***
Number of Observations	1661	2751			1839	2540		
	Low Short-Sale Constraints							
Unmatched	3,852,461	2,293,944	1,558,516	7.95***	3,660,553	2,331,481	1,329,071	6.84**
ATT	2,553,269	3,971,617	-1,418,348	-5.66***	3,660,553	3,319,989	340,563	0.99
Number of Observations	1013	1509			1666	1373		
	Panel B: Abnormal Trading Profits (in $)							
	High Short-Sale Constraints							
Unmatched	-55,900	-64,094	8,194	0.33	47,419	-89,494	136,913	5.33***
ATT	-56,771	-50,278	-6,492	-0.23	49,550	-44,227	93,780	3.23***
Number of Observations	1661	2751			1839	2540		
	Low Short-Sale Constraints							
Unmatched	-206,551	-33,601	-172,950	-4.22***	-112,701	-93,427	-19,274	-0.44
ATT	-58,649	-64,896	6246	0.12	-112,701	-125,854	13,152	0.17
Number of Observations	1013	1509			1666	1373		

Panel C: Determinants of Incentive Horizon

	High Short-Sale Constraints in Year t			
	Coefficient (p-value)	Mean for Horizon < 1	Mean for Horizon >2	Bias % (p-val)
Year	0.041***	2003.2	2002	4.2
	(0.000)			(0.160)
Incentive Ratio	0.913***	0.3441	0.3354	4.0
	(0.000)			(0.249)
Log(M/B)	0.271***	1.0776	1.1040	-3.9
	(0.000)			(0.189)
Log(total assets)	-0.006	6.7117	6.6938	1.8
	(0.813)			(0.580)
Long-term debt	0.945***	0.1710	0.1789	-4.7
	(0.000)			(0.133)
ROA	-0.667***	0.0677	0.0693	-1.6
	(0.004)			(0.590)
Std dev of cash flows	3.373***	0.0577	0.0579	-0.3
	(0.000)			(0.910)
Fixed Assets	-0.422***	0.2469	0.2473	-0.2
	(0.000)			(0.943)
Institutional Ownership	0.566***	0.755	0.738	6.1**
	(0.000)			(0.044)
G-Index	0.062***	6.133	6.124	0.2
	(0.000)			(0.953)
Board Independence	0.417***	0.567	0.557	3.2
	(0.003)			(0.297)
Board Size	-0.017	6.899	6.937	-1.0
	(0.216)			(0.739)
Constant	-82.301***			
	(0.000)			
Observations	4,407			
Pseudo R-squared	0.0972			
p-value for H_0 that there is no difference in sample with Horizon <1 and Horizon > 2			(0.333)	

Table 4

Earnings Surprise and Market Reaction to Earnings Surprise for Firms Sorted on CEO's Incentive Horizon and Firm's Short-Sale Constraints

This table compares quarterly earnings surprises (SUE) and earnings announcement cumulative abnormal returns (CAR) for firms sorted on CEO's incentive horizon and firm's short-sale constraints. Differences are presented for unmatched samples, and the average treatment effect for the treated (ATT) is reported for propensity score matched samples. We perform the comparison in the year before (year t-1) and the year during (year t) the short-horizon year. We measure unexpected earnings by the difference between actual earnings and the I/B/E/S analyst consensus earnings. We standardize the unexpected earnings by the standard deviation of unexpected earnings during the past 20 quarters, requiring at least 8 quarters of available data. To measure investors' response to the SUE, we scale the day (-1,+1) earnings announcement cumulative abnormal return (CAR) by the SUE. All variables are described in table 1. The sample period is from 1992 to 2006. ***, **, and * indicate p<0.01, p<0.05, and p<0.1, respectively.

	In Year t-1				In Year t			
	Horizon < 1 year	Horizon > 2 years	Difference	T-stat	Horizon < 1 year	Horizon > 2 years	Difference	T-stat
Panel A: SUE								
High Short-Sale Constraints								
Unmatched	0.292	0.038	0.254	3.75***	0.161	0.115	0.045	0.61
ATT	0.292	0.111	0.180	2.43**	0.161	0.168	-0.007	-0.09
Number of Observations	713	1418			524	1201		
Low Short-Sale Constraints								
Unmatched	0.615	0.340	0.274	5.10***	0.582	0.335	0.247	3.81***
ATT	0.586	0.482	0.103	1.58	0.586	0.589	-0.002	-0.03
Number of Observations	827	1517			589	1428		
Panel B: CAR/SUE								
High Short-Sale Constraints								
Unmatched	3.817	2.655	1.161	2.36**	3.421	2.827	0.593	1.08
ATT	3.794	2.714	1.080	1.98**	3.421	3.143	0.277	0.44
Number of Observations	713	1418			524	1201		
Low Short-Sale Constraints								
Unmatched	2.224	2.289	-0.064	-0.17	1.671	1.860	-0.188	-0.44
ATT	2.246	2.359	-0.113	-0.24	1.649	1.633	0.015	-0.03
Number of Observations	827	1517			589	1428		

Table 5

Discretionary Accruals for Firms Sorted on CEO's Incentive Horizon and Firm's Short-Sale Constraints

This table compares discretionary accruals by firms sorted on CEO's incentive horizon and firm's short-sale constraints measured in the year before (year t-1) and the year during (year t) the short-horizon year. Differences are presented for unmatched samples, and the average treatment effect for the treated (ATT) is reported for propensity score matched samples. Discretionary accrual is measured as regression residual using the following industry-year regression: $\frac{TA_{it}}{Assets_{it-1}} = \alpha \frac{1}{Assets_{it-1}} + \beta_1 \frac{\Delta Sales_{it} - \Delta AR_{it}}{Assets_{it-1}} + \beta_2 \frac{PPE_{it}}{Assets_{it-1}} + \varepsilon_{it}$, where $\Delta Sales_{it}$ is the change in sales, ΔAR_{it} the change in accounts receivables, and PPE_{it} property, plant, and equipment. Following Hribar and Collins (2002), we calculate total accruals, TA_{it}, as *ibc* (income before extraordinary items and discontinued operations from the Cash Flow Statement) minus OCF (Operating activities-net cash flows (*oancf*) minus extraordinary items and discontinued operation (*xidoc*)). We follow Kothari et al. (2005) and performance-adjust the discretionary accruals using ROA-matched firms. DACC (panel B) is the difference in regression residuals of a sample firm with its matched firm. We define DACC dummy (panel A) equal to one to indicate firm-years in which the discretionary performance-adjusted accrual is income-increasing, and zero otherwise. The sample period is from 1992 to 2006. ***, **, and * indicate p<0.01, p<0.05, and p<0.1.

	In Year t-1				In Year t			
	Horizon < 1 year	Horizon > 2 years	Difference	T-stat	Horizon < 1 year	Horizon > 2 years	Difference	T-stat
Panel A: DACC Dummy								
High Short-Sale Constraints								
Unmatched	0.5226	0.4903	0.0323	1.49	0.5269	0.4646	0.0623	3.29***
ATT	0.5222	0.4989	0.0233	0.95	0.5292	0.4467	0.0824	3.91***
Number of Observations	877	1344			1011	2144		
Low Short-Sale Constraints								
Unmatched	0.4763	0.4814	-0.0050	-0.21	0.4872	0.4960	-0.0088	-0.41
ATT	0.4756	0.5021	-0.0264	-0.93	0.4878	0.5077	-0.0199	-0.80
Number of Observations	738	1049			822	1762		
Panel B: DACC								
High Short-Sale Constraints								
Unmatched	0.2532	-0.5680	0.8213	1.80*	0.0256	-0.9926	1.0182	2.58**
ATT	0.2627	-0.6705	0.9332	1.80*	0.1022	-1.1993	1.3015	2.93***
Number of Observations	877	1344			1011	2144		
Low Short-Sale Constraints								
Unmatched	-0.2904	-0.7085	0.4181	0.96	-0.3063	-0.1414	-0.1649	-0.43
ATT	-0.3129	0.2864	-0.0265	-0.05	-0.2853	0.2461	-0.5315	-1.15
Number of Observations	738	1049			822	1762		

Table 6
Rosenbaum Bounds
This table reports the gamma (Γ) statistics from the sensitivity tests developed in Rosenbaum (2002 and 2011). We show the Γs for the matched-pair-difference tests that are significant in earlier tables. The $(m, \underline{m}, \overline{m})$ triples are the parameter inputs for the sensitivity test as described in the text.

Outcome	*t*-stats for difference in Short versus Long sample	(8,7,8)	(8,5,8)	(8,6,8)	(8,6,7)	(2,2,2)
DACC Dummy, t	3.91***	17.5	4.94	8.8	6.14	2.82
DACC, t	2.93***	1.15	1.22	1.18	1.16	1.23
DACC, t-1	1.80*	1.09	1.09	1.10	1.09	1.09
Insider Trading Volume, t	3.97***	1.02	1	1	1	1
Insider Trading Volume, t-1, for Low SSC	-5.66***	2.19	3.21	2.85	4.83	3.11
Insider Trading Profits, t	3.23***	1.30	1.35	1.31	1.27	1.38
SUE, t-1	2.43**	1.31	1.48	1.43	1.63	1.53
CAR/SUE, t-1	1.98**	1.25	1.02	1.12	1	1