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AUTHORS	Robert M. Hull https://orcid.org/0000-0002-0045-9773 https://publons.com/researcher/1372838/robert-hull/ Sungkyu Kwak Rosemary L. Walker

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Robert M. Hull (USA), Sungkyu Kwak (USA), Rosemary L. Walker (USA)

SEO valuation and insider manipulation of R&D

Abstract

We examine a sample of 674 SEOs from 1999-2010 where reduced R&D spending is significantly associated with the lowering of insider ownership proportions. With this association established, we derive an R&D manipulation variable measuring underinvestment in R&D. We add to the SEO-R&D literature by examining the relation between R&D underinvestment and common stock valuation around SEOs. In contrast to the IPO research, we do not find that underinvestment in R&D leads to greater SEO stock valuations during the offer price setting process. Like the IPO research, we find that underinvestment in R&D leads to lower stock valuations for short-run post-offering tests. In contrast to the long-run IPO results, we find a significant association between R&D manipulation and stock valuation for long-run post-offering tests where underinvestment in R&D is associated with lower stock valuations. We also find the five % owner group for SEOs is important in explaining R&D manipulation and discover that underpricing for SEOs is not related to R&D manipulation. These latter two findings are different from IPOs. In conclusion, SEOs can be quite different from IPOs when examining the association between the insider manipulation of R&D and stock valuation.

Keywords: SEO valuation, R&D manipulation, insider ownership.
JEL Classification: D82, G14, G32, M41.

Introduction

Even though efforts have been made on the research topic of how the manipulation of financial variables impacts valuation, unanswered queries remain including the question about the interrelation between insider manipulation of R&D and stock valuation. While researchers (Guo, Lev and Zhou, 2005; Guo, Lev and Shi, 2006; HKW[1], 2013) have explored this question using initial public offerings (IPOs), there has not been much research for seasoned equity offerings (SEOs). This study fills this void by examining the interrelation of insider manipulation of R&D and SEO valuation.

According to the earnings manipulation hypothesis, earnings are the most important variable so that an increase in reported earnings produces the most favorable stock market valuation. If so, insiders are motivated to inflate stock prices by increasing reported earnings. A major means of achieving this increase is through lowering R&D expenditures. HKW (forthcoming) established that a bigger decrease in insider ownership due to an SEO is associated with a bigger decline in R&D spending, supporting the earnings manipulation hypothesis. In this paper, we build on this research by using their regression model on a sample of SEOs to get a manipulation variable that measures the manipulation of R&D by insiders. A second regression model is, then, used to test the impact of this manipulation variable on SEO stock valuation over time. This second model was developed by HKW (2013) who found that greater R&D underinvestment led to greater IPO stock offer price valuation with this underinvestment being associated with poorer valuations in the IPO aftermarket. Thus, while firms manipulating R&D downwards have higher IPO valuations based on the offer price, they have lower IPO valuations based on short-term closing stock prices.

Like IPOs, the pricing of SEOs is accompanied by conflicts of interest between insiders who would profit from an inflated offer price and new owners who would want to purchase at a fair price. Thus, SEO firms might behave similarly to IPO firms. On the other hand, unlike IPO firms, SEO firms' performance and behavior have already been scrutinized in a public fashion by market participants. Since SEO firms have already gone public, earnings manipulation efforts by SEO firms may be better detected, thus, frustrating insiders' desire to inflate offer prices. To properly assess the similarities and differences in the market's reaction to SEOs against IPOs, we formulated six research hypotheses based on the findings of HKW (2013). These hypotheses led to six tests generating six new SEO findings in which four of these findings indicate that SEOs behave differently from IPOs. Below we summarize these six new SEO findings.

First, unlike IPOs, we do not find a significant negative relation between insider R&D manipulation and stock valuations during the offer price setting process. On the contrary, we find a significant positive relation. Thus, any manipulation of R&D downwards by firms undergoing an SEO is a sign of weakness and deflates the SEO offer price. Second, our SEO results for short-run post-SEO valuation tests are similar to IPOs, as we find a

Robert M. Hull, Clarence W. King Endowed Chair in Finance, Washburn University, USA.
Sungkyu Kwak, Professor of Economics, Washburn University, USA.
Rosemary Walker, Professor of Economics, Washburn University, USA.
[1] We will use HKW to indicate all papers by Hull, Kwak and Walker.

significant positive relation between R&D manipulation and stock price valuation indicating downward manipulation of R&D renders poorer short-run valuations. Third, whereas long-run IPO tests were insignificant, all of our SEO long-run tests yield a significant positive relation between R&D manipulation and stock valuation. Thus, SEO firms perform poorer over time when they manipulate R&D downwards so as to inflate stock offer valuation, while those that increase R&D beyond what was expected perform better.

Fourth, like IPOs, we find the change in insider ownership proportions is significantly associated with SEO stock valuation from the offering price process to three years after the offering. Fifth, unlike IPOs, SEO tests reveal that thefive % ownership (*FPO*) group of insiders have an important influence on the relation between insider R&D manipulation and stock valuations. Sixth, we repeat the HKW "change" tests that measure underpricing. For our SEO tests, we find that our R&D manipulation variable is insignificant. This contrasts with IPO results that found a significant positive relation between greater R&D underinvestment (that implies greater negative values) and poorer price performance relative to the offer price. In conclusion, this paper offers new findings and, thus, fills a void in the SEO research in its examination of how unexpected changes in R&D investment influence SEO stock valuations.

We organize the remainder of our paper as follows. Section 1 provides background information, and gives our research hypotheses. In section 2, we describe our data and report descriptive statistics. In section 3, we explain the methodology used to derive our R&D manipulation variable and describe our regression tests. Section 4 presents our empirical findings, while the final section offers conclusions and future research possibilities.

1. Background, goals and research hypotheses

In this section, we provide background information on prior research. We also discuss our six research hypotheses.

1.1. Background. Scholars provide bipolar hypotheses to cover the two contrasting schools of thought related to which variable, R&D or earnings, should be inflated to impact valuation. First, the signaling hypothesis (Trueman, 1986; Aoki and Reitman, 1992) argues increased R&D and other investment expenditures signal optimistic information. This hypothesis, applied to our study, advocates that increasing R&D around the time of a security offering would enhance the offer price and, thus, lead to maximum stock valuation. This theory also suggests that the signaling from increased investment expenditures will lead to strong positive stock valuations over time. Second, the earnings manipulation hypothesis (Stein, 1989; Baber, Fairfield and Haggard, 1991; Sloan, 1996) posits that investors believe earnings are the most important valuation factor. Thus, insiders have an incentive to inflate stock prices by reducing any planned R&D expenditures. R&D is a perfect candidate for reduction to increase earnings as R&D is expensed (and not depreciated) so that the pre-tax reported earnings increase by the amount of the decrease in R&D. Bange and De Bondt (1998) and Osma and Young (2009) examine situations for which companies will adjust R&D to manage accounting earnings and stock valuation.

The IPO-R&D research supports the earnings manipulation hypothesis by showing that the offer price setting process produced greater stock valuation when R&D was managed downwards. Darrough and Rangan (2005) offered proof for this hypothesis using a sample of 243 IPOs from 1986 to 1990. HKW (2014) strengthened this support, by not only using a larger sample of 447 IPOs, but also covering both a bubble period of high IPO intensity (1997-2000) and also a non-bubble period of low IPO intensity (2001-2005). Together Darrough and Rangan and HKW have: (1) verified bigger downward R&D manipulation for greater decreases in insider ownership around IPOs; and (2) demonstrated which insider variables can best be associated with this R&D manipulation. Most recently, the SEO-R&D research of HKW (forthcoming) offers support for both the earnings manipulationand signaling hypotheses. The support for the earnings manipulation hypothesis is found more for those insiders who are in the directors and officers (*DandO*) group, while support for the signaling hypothesis is found more in the five % ownership (*FPO*) group consisting of large owners who are not in the *DandO* group.

There have been several studies on SEO firms' earnings management and market valuation. Rangan (1998) considers discretionary accruals, and finds that the market temporarily overvalues SEO firms and is subsequently disappointed by predictable declines in earnings caused by earnings management. Qian et al. (2012), one of the most closely related to our paper, find that investors respond more favorably to the SEO announcements of high-tech issuers with positive discretionary R&D, thereby supporting the signaling hypothesis. In spite of similarities in methodology, our paper is distinct from Qian et al. (2012) in that (1) our focus is on the market's reaction to insider ownership and R&D underinvestment, while their focus is on the market's reaction to R&D overinvestment of high-

tech and low-tech firms, (2) we offer more detailed analysis of market valuation for various short-run and long-run periods.

As pointed out by HKW (2013), there are two incentives governing why insiders are motivated to achieve a maximum offer price. First, they can be selling their own shares if there is a secondary component to the offering. For SEOs, this reason may be more prevalent, because secondary selling as a proportion of outstanding shares for our sample of SEOs averages 0.056 compared to 0.030, as reported by HKW for IPOs. Second, insiders control large ownership % ages after the offerings (42.6% for SEOs and 63.2% for IPOs) and, thus, has a vested interest in their companies and would want a maximum offer price to raise as much funds as possible for future investments. In conclusion, both incentives can simultaneously occur such that insiders who are selling shares can also be maintaining large control.

1.2. Six research hypotheses. This paper will test six research hypotheses. Each research hypothesis is formulated based on prior IPO results. Thus, if we reject a hypothesis, we have evidence that SEOs perform differently from IPOs. Thus, by testing these hypotheses, we will be able to offer new findings on the similarities and differences between SEOs and IPOs. Our first research hypothesis is:

H–1: *SEOs will successfully manipulate the offer price setting process so that the manipulation of R&D downward to inflate earnings will lead to setting higher offer prices.*

H–1 predicts a negative relation, because when R&D downward manipulation intensifies (greater negative values), then, expected offer price valuations and the actual offer price valuation increase. Rejection of *H*–1 can occur, because SEOs, unlike IPOs, are publicly traded prior to the offer date so that the offer price setting process avoids the opaqueness found in the IPO price setting process.

Our second research hypothesis is:

H–2: *SEOs will have greater negative short-run stock valuations when there is greater downward manipulation of R&D.*

H–2 predicts a positive association, because greater unexpected decreases in R&D will be associated with more negative SEO stock valuations for short-run post-SEO periods. Not only did IPOs have a positive relation on the first day of trading, but also this positive relation got stronger, as the short-run period increased. Rejection of *H*–2 can occur if SEOs have already fully reacted in a positive manner during the offer price setting process which is possible for SEOs since, unlike IPOs, they are already publicly traded prior to the offering. Thus, any positive association found for IPOs may be diluted yielding a non-positive association for SEOs.

Our third research hypothesis is:

H–3: *In the long-run post-SEO market, stock valuation will be neutral in the sense that correct and fair prices have already been efficiently incorporated during short-run post-SEO periods.*

H–3 predicts a neutral SEO response as occurred for IPOs. Rejection of *H*–3 is consistent with signaling theory in that those firms that underinvest in R&D (greater negative values) convey that their future is poor with greater negative stock valuations occurring in the long-run. Similarly, a positive relation would hold for firms that overinvest in R&D, as they signal their future is bright and, thus, should reap greater stock valuations.

Our fourth research hypothesis is:

H–4: *The relation between insider ownership changes and stock price valuation for SEOs will be positive for both short-run and long-run stock valuation tests.*

H–4 is consistent with Leland and Pyle (1977) who predict a positive relation between insider ownership changes and stock value. Rejection of *H*–4 can be explained by SEO insiders having less of an impact due to smaller ownership levels that can imply smaller changes and smaller influence on valuations.

Our fifth research hypothesis is:

H–5: *The directors and officers (DandO) group will drive the R&D manipulation findings.*

H–5 predicts that the relation between insider manipulation of R&D and stock valuation can be explained by the *DandO* group. Rejection of *H*–5 is consistent with SEO insiders having a larger proportion of five % owners such that the *FPO* group can also influence the insider ownership findings.

Our sixth research hypothesis is:

H–6: *Greater underinvestment in R&D leads to less underpricing and poorer post-SEO stock prices relative to the offer price up to one year after the SEO.*

H–6 predicts a positive relation between R&D manipulation and underpricing as computed not only from the offer price to the closing price on day 0 (where day 0 is the day the offer price is first revealed in the final registration statement), but also up to one year after the offering, as found for IPOs. Rejection of *H*–6 is consistent with SEOs having much less underpricing than IPOs such that any change based on the offer price may be too small to have any significant impact.

2. Data and descriptive statistics

Our sample of 674 SEOs is supplied by HKW (forthcoming) where SEOs were identified from the *Investment Dealers' Digest* (*IDD*) for the period of 1999-2010. Observations were expunged if the required data were not found in the prospectus, CRSP and Compustat. Two prevalent causes for a deletion were absence of prospectus data for insider ownership and lack of Compustat data for R&D.

Table 1 gives summary statistics. Panel A provides R&D statistics. This panel reveals the median R&D as a proportion of total assets for the second fiscal year ending before the offer date is 0.106. This median falls to 0.092 for the next fiscal year and further declines to 0.064 for the fiscal year ending after the offer date. R&D as a fraction of net sales has medians of 0.192, 0.205 and 0.212, respectively, for the two years before, one year before, and one year after the offer date. Panel B of Table 1 gives price statistics. We compute two expected offer prices as described in Table 1. The first and second expected offer prices have respective means of \$30.95 and \$30.66. Panel B reports a mean SEO offer price of \$28.97. The closing price on day 0 increases to an average of \$29.70, but falls to \$28.62 by day +50. The average price continues to decline to \$23.12 and \$19.05 at the end of one year and two years after day 0. It rises to \$20.09 by the end of the third year. While average IPO offer prices reported by HKW (2013) are about half those of SEOs, they are over three-quarters that of average SEOs prices by day +50. HKW (2013) show the same general downward trend in IPO prices that we find in Panel B for SEO prices from day 0 to three years later where SEO prices fall 32.4% and IPO prices fall 29.4%.

Table 1. Descriptive statistics for 674 SEOs

In Panel A, Year -2 and Year -1 refer to the second and first fiscal year ending before the offer date, while Year 0 refers to the fiscal year containing the offer date. In Panel B, the 1st Low is the minimum closing price between days -20 to -6 and the 1st High is the maximum for this period. The 2nd Low is the minimum closing price between day -5 and -1 and the 2nd High is the maximum for this period. Day 0 is the date of the final registration statement when the offer price is first revealed. In Panel C, *DandO* refers to the group of insiders who are directors and officers, while *FPO* refers to the group of insiders who are not in the *DandO* group and includes all individuals, institutional owners, and venture capitalists who control at least 5% of the pre-SEO outstanding shares. In Panel D, we use CRSP's exchange-based, equal-weighted monthly index when computing compounded index returns. In Panel E, the industry PE and BM ratios for each SEO is computed (at the time of the offer date) based on the SEO's three-digits SIC code with medians used. The number of observations (*n*) for each statistic is 674 unless noted otherwise.

Panel A: R&D Statistics	Mean	Median	Minimum	Maximum
R&D for Year -2 / Total assets for year-2	0.251	0.106	+0.000	17.230
R&D for Year -1 / Total assets for year-1	0.189	0.092	+0.000	2.991
R&D for Year 0 / Total assets for year-0	0.126	0.064	+0.000	3.361
R&D for Year -2 / Net sales for year-2	20.734	0.192	+0.000	2,504
R&D for Year -1 / Net sales for year-1	41.496	0.205	+0.000	15,633
R&D for Year 0 / Net sales for year-0	30.305	0.212	+0.000	5,614
Panel B: Valuation statistics				
1stEOP: The first expected offer price: (1st Low + 1st High) / 2	\$30.95	\$22.40	\$0.35	\$357.62
1st Low: The first expected low price for the offer price	\$27.38	\$20.64	\$0.29	\$337.06
1st High: The first expected high price for the offer price	\$34.52	\$24.47	\$0.41	\$378.18
2ndEOP: The second expected offer price: (2nd Low + 2nd High) / 2	\$30.66	\$22.21	\$0.35	\$380.39
2nd Low: The second expected low price for the offer price	\$28.85	\$21.17	\$0.32	\$365.80
2nd High: The second expected high price for the offer price	\$32.48	\$23.44	\$0.36	\$394.98
Offer price	\$28.97	\$21.00	\$0.26	\$389.75
Closing price on day 0	\$29.70	\$21.70	\$0.32	\$390.00
Closing price on day 50	\$28.62	\$20.51	\$0.15	\$386.53
Closing monthly price at the end of month 12 (*n* = 659)	\$23.12	\$14.72	\$0.14	\$458.16
Closing monthly price at the end of month 24 (n = 625)	\$19.05	\$13.20	\$0.10	\$440.47
Closing monthly price at the end of month 36 (n = 578)	\$20.09	\$11.86	\$0.10	\$348.06
Panel C: Insider statistics				
Pre-SEO fraction of shares owned by all *insiders*	52.9%	52.1%	0.4%	100.0%
Post-SEO fraction of shares owned by all *insiders*	42.6%	41.1%	0.3%	96.6%
Pre-SEO minus Post-SEO fractions of shares owned by all *insiders*	-10.3%	-8.2%	-58.1%	25.8%
Pre-SEO fraction of shares owned by *DandO*	26.6%	18.7%	0.0%	97.0%
Post-SEO fraction of shares owned by *DandO*	21.8%	14.8%	0.0%	95.0%
Pre-SEO minus Post-SEO fractions of shares owned by *DandO*	-4.7%	-2.5%	-35.3%	2.6%
Pre-SEO fraction of shares owned by *FPO*	26.3%	23.0%	0.0%	97.9%
Post-SEO fraction of shares owned by *FPO*	20.8%	18.5%	0.0%	95.9%
Pre-SEO minus Post-SEO fractions of shares owned by *FPO*	-5.5%	-3.1%	-51.5%	34.4%
Post-SEO 12-month compounded SEO stock return	2.8%	-13.8%	-98.6%	859%
Post-SEO 12-month compounded index return	7.1%	7.2%	-53.5%	116%

Table 1 (cont.). Descriptive statistics for 674 SEOs

Panel D: Compounded index return statistics				
Post-SEO 24-month compounded SEO stock return	-6.1%	-21.5%	-99.3%	823%
Post-SEO 24-month compounded index return	14.6%	17.3%	-57.5%	165%
Post-SEO 36-month compounded SEO stock return	7.0%	-15.1%	-99.2%	1601%
Post-SEO 36-month compounded index return	31.2%	33.5%	-53.3%	180%
Panel E: Other statistics				
1st offer price range width: (1st High – 1st Low) / 1st Low	0.263	0.190	0.030	4.862
2nd offer price range width: (2nd High – 2nd Low) / 2nd Low	0.117	0.087	0.006	1.551
1st price adjustment (2nd EOP – 1st EOP) / 1st EOP	-0.004	-0.009	-0.594	0.911
2nd price adjustment (Offer price – 2nd EOP) / 2nd EOP	-0.061	-0.051	-0.492	0.272
Underpricing (Closing price day 0 – Offer price) / Offer price	0.037	0.026	-0.833	0.364
Primary plus secondary shares offered (in millions)	9.137	5.000	0.650	547.8
Primary shares offered / Pre-SEO shares outstanding	0.134	0.099	0.000	3.335
Secondary shares offered / Pre-SEO shares outstanding	0.056	0.019	0.000	0.446
Post-SEO shares outstanding (in millions)	88.85	35.77	2.10	9,948
Industry price-to-earnings (PE) ratio	41.51	36.63	7.45	190.1
Industry book equity-to-market equity (BM) ratio	3.74	4.18	-13.22	19.0

Panel C of Table 1 gives insider statistics for the all insiders (referred to simply as *insiders* in Panel C) and also for its two groups: the directors and officers (*DandO*) group and the five % ownership (*FPO*) group. The *FPO* group consists of large institutional owners, venture capitalists, and other investors who individually each own at least five % of the company's shares, but who are not in the *DandO* group. For all insiders, their ownership proportions before and after the SEO average 52.9% and 42.6%, respectively, giving an average change of -10.3%. The same respective averages are 26.6%, 21.8% and -4.7% for the *DandO* group and 26.3%, 20.8% and -5.5% for the *FPO* group. Even when insiders are buying, their overall ownership proportions are often falling due to a mean increase of 13.4% in the number of outstanding shares brought about by the average SEO. There are only seventeen SEOs where one of the two insider groups is increasing its ownership proportion. Compared to the numbers reported for IPOs by HKW (2013), the *DandO* group for SEO firms has lower ownership proportions and smaller decreases in their ownership proportions, while the *FPO* group for SEOs has greater ownership proportions and larger decreases in their ownership proportions.

Panel D of Table 1 gives compounded return statistics. For this panel, we use CRSP's exchange-based, equal-weighted index as the SEO market index. Panel D reports that the compounded SEO stock return and compounded market index return have medians of -13.8% and 7.2%, respectively, for one year after offering, -21.5% and 17.3% for two years after offering, and -15.1% and 33.5% for three years after offering. While IPOs perform worse in the post-offering aftermarket in an absolute sense, SEOs perform worse in a relative sense if one considers the changes in index returns. Panel E of Table 1 reports other key statistics. The means for the first and second offer price range widths are 0.263 and 0.117, respectively. Panel E next gives three price adjustment statistics that capture the proportional changes from the first to the second expected offer price, from the second expected offer price to the actual offer price, and from the actual offer price to the closing price on day 0. While the average underpricing for IPOs is 0.387, it is only 0.037 for SEOs. Panel E reports that primary plus secondary shares offered average 9.137 million. Primary and secondary shares offered as a fraction of pre-SEO shares outstanding average 0.134 and 0.056, respectively, compared to 0.288 and 0.030 for IPOs. Thus, SEOs are characterized by offerings composed of relatively more secondary shares, compared to IPOs. For SEOs, 56.5% of insiders could be selling their own shares, compared to only 26.6% for IPOs. Post-SEO shares outstanding averages 88.85 million. Finally, the industry price-to-earnings ratio and book equity-to-market equity ratio average 41.51 and 3.74, respectively.

3. Two regression models

In this section, we use two regression models. Model 1 is utilized to derive a variable that measures the insider manipulation of R&D. Model 2 uses this manipulation variable to test its impact on SEO valuation.

3.1. Model 1. Model 1 was initially used in the IPO research by HKW (2014) to demonstrate the significant positive relation between insider ownership changes and R&D changes. HKW (forthcoming) used this model with their SEO sample and got the same significant relation for SEOs as found for IPOs. Model 1 is:

$$\Delta RD = a_0\text{CON} + a_1 INS + a_2 RIN + a_3 \Delta IB + a_4 \Delta OI + \\ + a_5 L\Delta R + a_6 \Delta CL + a_7 \Delta SE + a_8 IBR + a_9 SOF + \\ + a_{10} BIO + + a_{11} TIM + \varepsilon,$$

where ΔRD = (R&D the year of SEO – R&D three years before) / SAA[2], *INS* = (post-SEO fraction of shares owned by insiders) – (pre-SEO fraction of shares owned by insiders), *RIN* = shares retained by insiders after SEO / shares outstanding after SEO, ΔIB = change in income before extraordinary items /SAA, ΔOI = change in operating income before depreciation and R&D /SAA, $L\Delta R$ = lagged ΔRD: (R&D three years before – R&D four years before SEO) / SAA, ΔCL = change in current liabilities / SAA, ΔSE = change in selling, general, and administrative expenses / SAA, *IBR* = investment bankers rankings from 1 to 9 with 9 the highest (normalized by dividing by 9), *SOF* = 1 if a software company with SIC of 7370 – 7373; else 0, *BIO* = 1 if a biotech company with SIC of 2833 – 2836 and 8731; else 0, *TIM* = 1 if offer date occurs after December 31, 2000; else 0.

The variables in Model 1 are formed based on prior related research (Jaffe, 1986; Berger, 1993; Himmelberg and Peterson, 1994; Darrough and Rangan, 2005; Guo, Lev and Zhou, 2005; HKW, 2013). Both insider variables, *INS* and *RIN*, include the *DandO* and *FPO* groups. While *RIN* represents the post-SEO fraction of shares owned by insiders, *INS* is the post-SEO fraction of shares outstanding owned by insiders minus their pre-SEO fraction of shares owned. HKW (forthcoming) show greater decreases in insider ownership are significantly associated with greater decreases in R&D. With the significant positive relation established for SEOs, we can proceed to derive a variable that measures the insider manipulation of R&D with the end purpose being to test this variable against SEO stock valuation at different points in time. To get this manipulation variable, we follow the HKW (2013) procedure that estimates the change in R&D (ΔRD) that would have existed without considering the influence of the two insider variables of *INS* and *RIN*. For this estimation process, we use a two-step procedure described below.

First, using Model 1[3], ΔRD is regressed against its eleven independent variables. From this regression, the coefficients are identified. Second, excluding the two coefficients for *INS* and *RIN* so as to be free from the influence of insider ownership, we use the coefficients for the nine non-insider variables to get a point estimate of the predicted change in R&D in the absence of insiders' motivation to manipulate R&D. Our predicted ΔRD equation with only the nine non-insider variables is:

$$Predicted\ \Delta RD = 2.186 - 0.104\Delta IB + 0.138\Delta OI - \\ - 0.250 L\Delta R - 0.034\Delta CL + 0.170\Delta SE + 0.499 IBR - \\ - 0.157 SOF + 0.926 BIO - 0.030 TIM.$$

We next subtract the *predicted* ΔRD for each observation from its *actual* ΔRD to estimate R&D manipulation without the influence of insider ownership. This subtraction yields a "*difference in R&D*" variable named *DRD*. In equation form, we have:

$$DRD = actual\ \Delta RD - predicted\ \Delta RD,$$

where *DRD* is the measure of R&D manipulation[4]. A negative *DRD* value implies downward manipulation or underinvestment in R&D where the *actual* ΔRD that includes the influence of insider behavior is less than the *predicted* ΔRD. A negative *DRD* value is associated with the notion that R&D will be cut so as to inflate earnings, and thus, stock valuation. While a positive *DRD* value indicates overinvestment, this rarely occurs, as 95% of the SEOs have negative values for *DRD*.

3.2. Model 2. Model 2 is our *valuation* regression model to determine if there is a significant relation between our R&D manipulation variable (*DRD*) and stock valuation. As given in Table 2, this model is:

$$Valuation = a_0\text{CON} + a_1 DRD + a_2 INS + a_3 RIN + \\ + a_4 RDB + a_5 IPE + a_6 ORW + a_7 MCV + a_8 IBR + \\ + a_9 SIZ + a_{10} TIM + \varepsilon,$$

where *Valuation* = *Price* × (post-SEO shares outstanding) / SAA[5], *DRD* = R&D manipulation variable: (*actual* ΔRD – *predicted* ΔRD)[6], *INS* = (post-SEO fraction of shares owned by insiders) – (pre-SEO fraction of shares owned by insiders), *RIN* = shares retained by insiders after SEO / Shares outstanding after SEO. *RDB* = R&D for the third plus fourth fiscal years ending before the offer date / SAA[6], *IPE* = industry price-to-earnings ratio as defined in Table 1, *ORW* = average of the two expected offer price range widths given in Table 1, *MCV* = market condition variable: compounded monthly index return for one year before SEO, *IBR* = investment bankers rankings from 1 to 9 with nine the highest (normalized by 9), *SIZ* = size variable given by minus one times

[2] As defined in Table 2, "SAA" refers to the square root of average assets.

[3] We use a winsorized model that trims ½% outliers on applicable variables where outliers exist. Our results are similar without winsorization.

[4] In their normalized form, the means (medians) for *actual* ΔRD, *predicted* ΔRD, and *DRD* are 0.864 (0.397), 3.423 (3.190), and -2.560 (-2.662), respectively.

[5] SAA, as defined in Table 3, is the square root of the average assets where average assets consider the total assets for the fiscal year before and after the offer date.

[6] *DRD* is already normalized by SAA, as the *actual* ΔRD and *predicted* ΔRD are normalized by SAA.

[7] The *RDB* was judged the best fit, as it was not significantly correlated with *DRD* like other *RDB* values we tried. The choice of our RDB variables is also consistent with the fact *DRD* for SEOs was derived using a three-year R&D value instead of a two-year R&D value as used by HKW for IPOs.

the log of the inverse of firm value (in millions of dollar), *TIM* = 1 if offer date occurs after December 31, 2000; else 0.

Each *valuation* measure is based on one of eight prices multiplied by the number of post-SEO shares outstanding and then normalized by SAA. As shown in Panel A of Table 2, these eight prices cover three stages during the offer price setting process: first expected offer price, second expected offer price and the actual offer price. We also cover five post-SEO prices; closing prices on days 0 and 50 (where day 0 is the day the offer price is revealed in the final registration statement) and closing monthly prices for months 12, 24, and 36 (where month 0 is the month of the offering). For the five post-SEO prices, our *valuation* variables are calculated after adjusting the prices for a market index return as described in Table 2.

3.3. Predicted coefficient signs. Panel B of Table 2 describes the ten independent variables that take into consideration related research (Darrough and Rangan, 2005; Guo, Lev and Zhou, 2005; Guo, Shi and Zhou, 2006; HKW, 2013), and gives two "prediction" columns for independent variables for each of the eight *valuation* tests. The first column gives the predicted sign for the first three *valuation* tests ($VA1 - VA3$) that occur during the offer price setting process. The second column provides predictions for the five "post-SEO" tests ($VA4 - VA8$). For the pre-SEO R&D variable (*RDB*) and the bubble period variable (*TIM*), the 2nd column has two predictions with the explanations for the two predictions given below. We will now explain the predictions for each independent variable.

The earnings manipulation hypothesis suggests that insiders will manage earnings upwards by reducing R&D to increase stock valuation. Thus, this theory predicts negative coefficients for *DRD* for the first three *valuation* tests ($VA1 - VA3$), as the two expected offer prices and the final offer price should be inflated in proportion to negative values for *DRD* that epitomize degrees of R&D underinvestment. If the market is successfully fooled by the R&D manipulation, we would expect stock valuation to fall once market participants realize the manipulation. If the market does not detect this manipulation until after the offer price is announced, then, we expect a positive coefficient for *DRD* for the $VA4$ test. If the realization of manipulation is gradual, we anticipate greater positive coefficients for *DRD* for the $VA5 - VA8$ tests.

Table 2. *Valuation* regression model

Our regression model to test the impact of R&D manipulation on SEO valuation is:

$Valuation = a_0\text{CON} + a_1 DRD + a_2 INS + a_3 RIN + a_4 RDB + a_5 IPE + a_6 ORW + a_7 MCV + a_8 IBR + a_9 SIZ + a_9 TIM + \varepsilon.$

Panel A describes the eight dependent valuation variables used to capture stock valuation based on the two expected offer prices, the offer price, and the five post-SEO closing prices. Day 0 is the date of the final registration statement when the offer price is first revealed. Month 0 is the offer month. Thus, months 12, 24, and 36 represent one-year, two-year, and three-year periods. Post-SEO prices are adjusted by multiplying by one minus the compounded market index return for the period being considered. The market index uses CRSP's exchange-based, equal-weighted index. We use daily index returns for short-run periods and monthly index returns for long-run periods when computing the market's compounded return. "Post-SEO shares outstanding" refers to the number of shares outstanding after the SEO is completed. 1st EOP and 2nd EOP refer to the first and second expected offer prices, respectively. Panel B describes the ten independent variables. *MCV* uses CRSP's exchange-based, equal-weighted monthly index. The last column offers two predictions for the *valuation variable*s. The first prediction is for the first three *valuation* variables ($VA1 - VA3$), while the second prediction is for the last five *valuation* variables ($VA4 - VA8$). Two exceptions are seen in the last column for *RDB* and *TIM* given by "−/+" which indicates we predict negative coefficients for *VA*4 and *VA*5 and positive coefficients for $VA6 - VA8$. SAA stands for the square root of average assets where average assets are the average of total assets for the fiscal years ending before and after the offer date. The average assets are expressed in millions of dollars before we take the square root. To overcome heteroscedasticity while maintaining a greater value for *SIZ* as firm value increases, we compute *SIZ* as minus one times the log of the inverse of firm value where firm value is expressed in millions of dollars. Firm value includes market value of common stock, liquidation value of preferred stock, and book value of total liabilities. Firm value is adjusted using inflation as given by http://www.usinflationcalculator.com/inflation/historical-inflation-rates/. Since stock values can be positively skewed, we winsorize all dependent variables at the ½% level on each side. *DRD* is already normalized by SAA as the *Actual* ΔRD and *Predicted* ΔRD are normalized by SAA.

Panel A. Eight dependent *valuation* variables (the closing prices are adjusted as described above)	
*VA*1	(1st EOP) × (Post-SEO shares outstanding) **/** SAA
*VA*2	(2nd EOP) × (Post-SEO shares outstanding) **/** SAA
*VA*3	(Offer price) × (Post-SEO shares outstanding) **/** SAA
*VA*4	(Adjusted closing price day 0) × (Post-SEO shares outstanding) **/** SAA
*VA*5	(Adjusted closing day 50) × (Post-SEO shares outstanding) **/** SAA
*VA*6	(Adjusted closing on the last day of month 12) × (Post-SEO shares outstanding) **/** SAA
*VA*7	(Adjusted closing on the last day of month 24) × (Post-SEO shares outstanding) **/**SAA
*VA*8	(Adjusted closing price on the last day of month 36) × (Post-SEO shares outstanding) **/** SAA

Panel B. Ten independent variables		Predictions	
DRD	R&D manipulation variable: (*Actual*ΔRD – *Predicted*ΔRD)	−	+
INS	(Pre-SEO fraction of shares owned by insiders) – (Post-SEO fraction of shares owned by insiders)	+	+
RIN	Shares retained by insiders after SEO / Shares outstanding after SEO	+	+
RDB	R&D for the third plus fourth fiscal years ending before the offer date / SAA	+	−/+
IPE	Industry price-to-earnings ratio	+	+
ORW	Average of the two expected offer price range widths given in Table 1	+	+
MCV	Market condition variable: compounded monthly index return for one year before SEO	−	+

Table 2 (cont.). *Valuation* regression model

Panel B. Ten independent variables		Predictions	
IBR	Investment bankers rankings from 1 to 9 with nine the highest (normalized by 9)	+	+
SIZ	Size variable given by minus one times the log of the inverse of firm value (in millions of dollars)	+	+
TIM	*TIM*= 1 if offer date occurs after December 31, 2000; else 0	–	–/+

Signaling theory premised in Leland and Pyle (1977) predicts positive coefficients for *INS*, as greater insider ownership decreases signal poorer stock valuation expectations. Adverse selection advocates (Akerlof, 1970; Myers and Majluf, 1984) predict positive coefficients for *RIN*, as higher proportions of insider ownership should signal more optimism for the future and thus higher stock values. Signaling theory based in Trueman (1986) predicts positive coefficients for *RDB*, as greater R&D values signal superior future prospects. However, if greater values for *RDB* allow for greater downward manipulation of R&D that inflates the offer price setting process, then, the market reaction should cause negative coefficients especially for the short-run tests of *VA*4 and *VA*5. If the market is not fooled by the manipulation then the negative coefficients can also result for the *VA*1 – *VA*3 tests. Otherwise, we predict positive coefficients, as greater *RDB* values should have positive long-run stock valuations. Thus, we anticipate positive coefficients for the *VA*6 – *VA*8 tests.

Researchers (Kim and Ritter, 1999; Bhojraj and Lee, 2002; Purnanandam and Swaminathan, 2004) suggest stock valuation can be assessed by examining the value of its peer companies. Thus, we expect a positive coefficient for *IPE*, as firms in industries with higher PE ratios would be evaluated as stronger firms. Hanley (1993) writes that the offer price range is an *ex ante* measure of risk. If greater risk renders greater stock values, then, we expect a positive coefficient for *ORW*. Lerner (1994) and Brau and Fawcett (2006) suggest that a positive market condition is an important determinant of issuing new securities implying that more favorable stock valuations will result during stronger markets. Consequently, we anticipate positive coefficients for *MCV*.

Brau and Fawcett (2006) suggest a positive coefficient for *IBR*, since investment bankers with greater reputations will signal higher quality and thus greater stock valuations. Larger firms should be better equipped to time their market offering to take advantage of superior market conditions, should be older and more experienced, and should have larger offerings. Ritter (1991) finds that firms with these attributes perform better after an offering. Thus, we expect a positive coefficient for *SIZ*. We expect a negative coefficient for *TIM* for the *VA*1 – *VA*5 tests, because observations that occur during the internet-technology bubble period (*TIM* = 0) would be expected to have more optimism and higher valuations for the offer price setting tests and short-run post-SEO tests. For longer time frames, many bubble period SEOs will undergo the bursting of the bubble and achieve poorer stock valuations from one to three years after their offerings. Consequently, we predict positive coefficients for the *VA*6 – *VA*8 tests.

4. *OLS* regression results for *valuation* tests using Model 2

Table 3 provides *OLS* regression results for our SEO *valuation* tests using Model 2. We found no evidence of multicollinearity, as variance inflation factors and condition index values are well below cut-off levels. Additionally, we performed clustered regression tests to adjust the standard errors for the fact we have multiple SEOs in a month that would all have the same return data. We also performed clustered regression tests using various schemes of SIC code classifications, because firms with R&D spending are clustered within certain industries. These clustering tests did not change our findings. We also conducted tests that corrected for heteroscedasticity and the statistics remained significant. Finally, our results are the same with winsorizing using standard cut-off levels.

Table 3 gives the largest *adjusted r-square* and *F* values of 0.53 and 75.6 for the *VA*2 test with values falling with longer periods tested. Signs for coefficients for independent variables are generally as predicted. Due to space constraints, we will focus our analysis results pertaining to our six research hypotheses that revolve around our manipulation variable (*DRD*) and our insider ownership change variable (*INS*).

Table 3 reports significant positive *t* statistics for *DRD* for the *VA*1 – *VA*3 tests indicating that underinvestment in R&D leads to smaller offer price valuations. Thus, market participants during the offer price setting process are not fooled by manipulation of R&D downwards to inflate earnings, as those firms underinvesting in R&D are associated with smaller valuations and those overinvesting in R&D have larger valuations. Thus, we reject *H*–1 that states: *SEOs will successfully manipulate the offer price setting process so that the manipulation of R&D downward to inflate earnings will lead to setting higher offer prices*. These SEO results are the opposite of those found for IPOs where the statistics were significantly negative

indicating that underinvestment in R&D to inflate earnings was successful. These results reflect the intrinsic difference between IPOs and SEOs as there exists more public information for SEO market participants and they do not have to wait until the offer day to voice their sentiments.

For the first two short-run market tests, *VA*4 and *VA*5, significant positive *t* statistics for *DRD* are again obtained. This latter result agrees with the IPO results of HKW (2013). Thus, we cannot reject *H*–2 that states: *SEOs will have greater negative short-run stock valuations when there is greater downward manipulation of R&D*. Thus, R&D manipulation is not only detected during the SEO offer price setting process, but also at 50 days after the offering. For the long-run valuation tests of *VA*6 – *VA*8, we find significant positive *t* statistics with the *t* statistics increasing up to two years and remaining high for the third year. These SEO results differ from the IPO results where all long-run IPO tests were insignificant. Thus, we reject *H*–3 that states: *In the long-run post-SEO market, stock valuation will be neutral in the sense that correct and fair prices have already been efficiently incorporated during short-run post-SEO periods*. In conclusion, SEOs decreasing their R&D downward around the offer dates experience negative long-run stock valuations.

Table 3. *OLS* Regression results for *valuation* tests

This table reports results using our *valuation* regression model when the dependent variables are the eight *valuation* variables. Regression variables were defined in Table 2. All eight *valuation* variables and *RDB* are normalized by the square root of average assets where average assets are the average of total assets for the fiscal years ending before and after the offer date. Our R&D manipulation variable (*DRD*) is in essence normalized as it was formed from a regression and computational process that was normalized by the square root of the average of total assets. All tests have the full complement of 674 observations except the *VA*6, *VA*7 and *VA*8 tests where the number of respective observations is 659, 625 and 578. The first two rows for each test report coefficients with *t* statistics below. The last column reports adjusted R^2 values with *F* values below. To eliminate collinearity between pairs of highly correlated variables, we followed HKW (2013) by forming residuals that are nearly perfectly correlated with the variable being replaced while at the same time having near zero correlation with the variable for which collinearity would, otherwise, exist. The residuals are *SIZ*(*R*) which is nearly perfectly correlated with *SIZ*, but uncorrelated with *IBR* and reduced correlation with *INS*; *ORW*(*R*) which is nearly perfectly correlated with *ORW* but uncorrelated with *TIM*; and,*TIM*(*R*) which nearly perfectly correlated with *TIM*, but uncorrelated with *ORW*. Coefficients for independent variables with *t* statistics less than -1.28 or greater than 1.28 are significant at the 10% level or greater for the one-tailed test.

CON	*DRD*	*INS*	*RIN*	*RDB*	*IPE*	*ORW*(*R*)	*MCV*	*IBR*	*SIZ*(*R*)	*TIM*(*R*)	*AdjR²I F*
Valuation = *VA*1 Test: (First expected offer price × post-SEO shares outstanding) / SAA											
-62.233	3.162	254.452	93.105	-2.303	0.343	238.586	19.620	137.374	45.211	-82.047	0.48
-3.39	1.96	6.85	6.08	-2.27	2.75	8.20	2.15	7.57	16.84	-9.48	62.01
Valuation = *VA*2 Test: (Second expected offer price × post-SEOshares outstanding) / SAA											
-52.343	2.974	217.872	72.661	-1.793	0.342	190.517	17.652	126.219	41.244	-70.290	0.53
-3.55	2.29	7.30	5.91	-2.20	3.42	8.16	2.41	8.65	19.13	-10.11	75.57
Valuation = *VA*3 Test: (Offer price × post-SEO shares outstanding) / SAA											
-49.587	2.647	208.649	67.064	-1.762	0.302	170.059	16.775	121.153	40.061	-63.623	0.52
-3.48	2.11	7.24	5.64	-2.24	3.12	7.53	2.37	8.60	19.23	-9.47	73.05
Valuation = *VA4* Test: (Adjusted closing price day 0 × post-SEO shares outstanding) / SAA											
-48.966	2.671	210.864	67.033	-1.749	0.311	173.398	17.137	122.211	40.450	-64.725	0.52
-3.39	2.10	7.22	5.57	-2.19	3.18	7.58	2.39	8.56	19.16	-9.51	72.73
Valuation = *VA*5 Test: (Adjusted closing price day 50 × post-SEO shares outstanding) / SAA											
-39.560	2.925	168.794	62.363	-1.112	0.195	108.448	8.313	109.246	35.947	-51.980	0.43
-2.64	2.22	5.57	5.00	-1.34	1.92	4.58	1.12	7.38	16.43	-7.37	51.01
Valuation = *VA*6 Test: (Adjusted closing price on the last day of month 12 × post-SEO shares outstanding) / SAA											
-28.390	2.995	73.646	35.049	0.708	0.078	-19.282	5.678	78.601	20.668	-10.961	0.26
-2.19	2.69	2.88	3.32	1.01	0.91	-0.97	0.90	6.14	11.20	-1.84	23.84
Valuation = *VA*7 Test: (Adjusted closing price on the last day of month 24 × post-SEO shares outstanding) / SAA											
-32.395	4.799	40.686	34.646	1.804	0.006	-47.783	13.499	69.941	14.295	10.508	0.26
-2.89	5.13	1.89	3.83	3.04	0.09	-2.82	2.49	6.38	9.15	2.07	22.46
Valuation = *VA*8 Test: (Adjusted closing price on the last day of month 36 × post-SEO shares outstanding) / SAA											
-27.556	3.014	32.891	26.283	1.770	0.023	-63.577	13.054	53.730	12.116	17.302	0.22
-2.70	3.02	1.63	3.15	3.16	0.34	-3.89	2.62	5.33	8.53	3.70	17.40

The coefficients for *INS* are all positive and significant. These results emulate the IPO results given by HKW (2013). Thus, for both IPOs and SEOs, the change in insider ownership proportions is significantly associated with stock valuation from the offering price process to three years after the offering. Thus, we cannot reject *H*–4 that states: *the relation between insider ownership changes and stock price valuation for SEOs will be positive for both short-run and long-run stock valuation tests*. Because our long-run positive coefficients for *INS* and *RIN* disagree with HKW (2010, 2012) who examine SEOs and insider behavior for periods before 2006, we divided our sample into those

observations from 1999-2005 and from 2006-2010. Consistent with HKW (2010, 2012), we found negative statistics for *INS* and *RIN* for the 1999-2005 group. Thus, our insider results are driven by inclusion of the years from 2006-2010. We also suspect our insider results are driven by our "restricted" sample that is limited to companies that have R&D and for which greater insider activity could arguably be greater.

To test the fifth hypothesis, we repeated the tests using just the *DandO* group and, then, just the *FPO* group to form *DRD* values with the two insider variables (*INS* and *RIN*) now representing just one of the two groups at a time. We found that the insider R&D manipulation variable created by using the *DandO* group performed better overall although both groups perform well manifesting significant statistics. Since the results were weaker for both the *DandO* and *FPO* tests separately, we conclude that both groups together are needed to determine the extent of R&D manipulation on stock valuation. Thus, we reject *H*–5 that states: *The directors and officers (DandO) group will drive the R&D manipulation findings*. The rejection stems from the fact that the *FPO* group for SEOs (unlike that for IPOs) has an impact and produces statistically significant results especially for the long-run tests.

We conducted the *change* (or "underpricing") tests given by HKW (2013) who found that less underpricing occurs when insiders are manipulating earnings upwards by lowering R&D. This occurred not only during the offer price process, but also as much as one year after the offer date. Unlike IPOs, we found that *DRD* was not significant for any of the SEO tests. Thus, we reject *H*–6 that states: *Greater underinvestment in R&D leads to less underpricing and poorer post-SEO stock prices relative to the offer price up to one year after the SEO*. The insignificant SEO results reflect the differences in underpricing between IPOs and SEOs as the *change* tests focus on the change in the stock price over time relative to the offer price as opposed to just stock valuation at points in time.

In conclusion, we find major differences between IPOs and SEOs as we rejected four of our six hypotheses, thus, demonstrating that SEOs can be quite different from IPOs when examining the influence of insider manipulation of R&D. Besides those tests already mentioned, we conducted other robustness checks. For example, we repeated our tests using firm value as the normalization variable. We also performed tests with only those 574 observations without missing prices and returns. We also recomputed "*Predicted* ΔRD" by including the *RIN* coefficient in the equation and only omitting the *INS* coefficient. Additionally, we repeated our regression tests by deleting *INS* to see if this affected the results for *DRD* and, then, by deleting *DRD* from the tests to see if the results for *INS* were affected. Next we tested *SIZ* using other substitutes. Our *SIZ* results are invariant to whether or not we adjust for monthly inflation. For all these robustness checks, we found nothing to change our findings. Finally, we divided our sample based on the variable *TIM* and also a division based on small versus large firms. We found our results for *DRD* are driven by observations located after the internet-technology bubble period (*TIM* = 1) and by larger firms.

Conclusions and future research

We examine a sample of 674 SEOs from 1999-2010 where reduced R&D spending is significantly associated with the lowering of insider ownership proportions. With this positive association established, we derive an insider R&D manipulation variable to test its influence on SEO stock valuation. The results of these tests generate six new SEO findings that are summarized below.

In contrast to the IPO research, we do not find that underinvestment in R&D leads to greater SEO stock valuations during the offer price setting process. Like the IPO research, we find that underinvestment in R&D leads to lower stock valuations for short-run post-offering tests. Contrary to IPOs, we find a significant association between R&D manipulation and SEO stock valuation for long-run post-offering tests where underinvestment in R&D is associated with lower stock valuations. Like IPOs, the change in insider ownership proportions is significantly associated with SEO stock valuation from the offering price process to three years after the offering. We find the five % owner group for SEOs is important in explaining R&D manipulation and also discover that underpricing for SEOs is not related to R&D manipulation. These latter two findings are different from IPOs. In conclusion, SEOs can be quite different from IPOs when examining the association between the insider manipulation of R&D and stock valuation.

This study fills a void in the SEO research by examining the effect of R&D manipulation on SEO stock valuation. We pattern our research after the recent IPO research, so comparisons between SEOs and IPOs could be better performed. There is a limitation of patterning our SEO study on IPO research, because IPOs have no stock values to analyze in the pre-IPO market, as IPO shares have yet to be traded publicly. Thus, future SEO and R&D research should look at the relation between R&D manipulation and stock valuation in the pre-

SEO market. Research issues that can be explored when analyzing the pre-SEO market include whether there is manipulation at some pre-SEO point in time. In other words, at what point in time, if such a point in time exists, might we find evidence consistent with the earnings manipulation? Relatedly, can we establish a general time frame when the market begins to recognize this manipulation? One to two years before the SEO? Two to three years before? Finally, given the strong relation we found between R&D manipulation and SEO stock valuation, future research can study the interrelation between R&D manipulation and stock valuation for other applicable corporate events such asmergers, restructurings, repurchases, stock splits and dividend changes. In closing, there are major implications for practicing managers and investors concerned with understanding R&D spending and stock price behavior around SEOs. For example, insiders for SEOs cannot inflate the offer price setting process by manipulating R&D. Furthermore, underinvesting in R&D is associated with poor stock performance in the SEO aftermarket. These practical implications have a societal impact, as they influence the activities of the business and investment communities in regards to how they perceive SEOs compared to IPOs. For example, unlike IPOs, decreases in R&D to inflate earnings cannot increase the offer price. Additionally, unlike IPOs, the direction of the unexpected change in R&D for SEOs is positively related to future stock price behavior. These latter differences reveal to the investment community that, whereas it may be possible to manipulate IPO prices, it is difficult to manipulate SEO prices and those that do are foretelling poor future performances.

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