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Limited attention to detail in financial markets: Evidence from reduced-form and structural estimation ☆

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ABSTRACT

We show that firm valuations fell after a key expense became more visible in financial statements. FAS 123-R required firms to deduct option compensation costs from earnings, instead of disclosing them in footnotes. Firms that granted high option pay experienced earnings reductions, while fundamentals remained unchanged. These firms were more likely to miss earnings forecasts, and they experienced recommendation downgrades and valuation declines. Our findings suggest that market participants exhibited limited attention to option costs before FAS 123-R. As we reuse the FAS 123-R natural experiment, we show how one can address confounding channels by integrating reduced-form and structural estimation.

1. Introduction

Economic agents possess limited cognitive resources and rely on simplifying heuristics to process large quantities of information (Kahneman, 1973; Hirshleifer, 2015). As such, the amount of attention devoted to value-relevant information may depend on how it is presented. Recent work shows that information presented in a striking manner can trigger retail trading and short-term stock mispricing (e.g., Barber and Odean, 2008; Da et al., 2011; Engelberg et al., 2012). In contrast, investors react more slowly to information that arrives when they are distracted (e.g., Hirshleifer et al., 2009; DellaVigna and Pollet, 2009). One important gap in this literature is a lack of evidence on how information presentation influences sophisticated market participants, whose knowledge or experience could moderate cognitive constraints. Another is how quickly agents with limited attention learn to process information when its visibility increases, and whether the outcomes of their learning influence other market participants.

Theory suggests these are important questions. Hirshleifer and Teoh (2003) (henceforth HT) develop a model in which some investors are less likely to process information when it is not presented in an easily accessible format. They apply the model to the disclosure of stock option pay. In the model, when option pay is reported only in the footnote disclosures of 10-K filings, investors with limited attention do not fully incorporate the grants' costs into their valuations. Thus, firms' market valuations are too high in a non-expensing regime. When options are instead expensed in the income statement, they become more visible to investors with limited attention, causing market valuations to decline. HT do not model the transition from a non-expensing to expensing regime, but a reasonable corollary is that market participants require time to fully incorporate option costs, and learn to do so at different speeds.

This paper tests these predictions using the implementation of accounting standard FAS 123-R in the U.S. between 2005 and 2006. Prior to FAS 123-R, financial statements contained all the information needed

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to calculate the cost of option grants, but this information only had to be reported in statement footnotes. FAS 123-R required firms to begin expensing new option grants in their income statements, along with previous grants as they vested. This increased the visibility (but not the magnitude) of the option grants' economic costs.

FAS 123-R compliance varied quasi-randomly: Each firm had to comply in the first new *fiscal year* starting after June 2005, so firms adopted option expensing at different times between July 2005 and June 2006 (options had to be expensed from the first fiscal quarter onward). We estimate a staggered difference-in-differences (DiD) model based on this time-series variation in compliance, and also based on cross-sectional variation in firms' usage of option pay prior to FAS 123-R. We confirm that FAS 123-R compliance reduced high-option firms' quarterly earnings per share (EPS) by $0.046 relative to low-option firms (10% of the standard deviation), which is similar to the relative rise in high-option firms' compensation expenses. High-option firms saw no relative change in revenues, which would have decreased if FAS 123-R coincided with a shock to fundamentals.

We first examine how sell-side analysts reacted to the increased visibility of option costs after FAS 123-R. Analysts are sophisticated market participants who synthesize large amounts of information to forecast earnings and make stock recommendations, and commonly use earnings to value firms (Mukhlynina and Nyborg, 2020). If some analysts lack the time or cognitive resources to collect data from statement footnotes, then before FAS 123-R they would have overlooked some (or all) of a firm's option grants. Once a firm complied with FAS 123-R, these analysts should have devoted greater attention toward its option costs. We predict that analysts initially underestimated firms' option expenses after FAS 123-R, leading to a rise in missed EPS forecasts. Over time analysts learned to incorporate more option grants and forecast accuracy should have improved. Increased attention also should have led analysts to revise down their stock recommendations after FAS 123-R.

We document reduced-form estimates that are consistent with these predictions. For high- versus low-option firms, we compare outcomes in the four quarters before (FQ-4 to FQ-1) versus after (FQ1 to FQ4) each firm's FAS 123-R compliance date. High-option firms' likelihood of missing a consensus quarterly EPS forecast rose by 6.7 pp after FAS 123-R, relative to low-option firms (a 17.8% increase over the mean). They experienced a rise in missed forecasts only when reporting EPS for FQ1 and FQ2, and missed forecasts at the same rate as low-option firms in FQ3 and FQ4. This indicates that analysts initially underestimated option expenses, but learned over time to fully incorporate grants into their forecasts. High-option firms' consensus recommendations for FQ1 declined by 0.060 relative to those of low-option firms, or 10% of the standard deviation—a large effect since analysts typically resist downgrades. This is consistent with analysts realizing that they had previously overvalued high-option firms. Recommendations remained lowered in subsequent fiscal quarters relative to low-option firms. Thus, analysts continued to regard high-option firms as overpriced by the market, which suggests that they learned to incorporate option grants into their valuations faster than investors.

Next, we directly test whether investors were also constrained by limited attention. If so, high-option firms' market valuations should have fallen once investors devoted more attention toward option costs after FAS 123-R. Indeed, high-option firms' market-to-book ratios declined by 0.141 by the end of FQ2, relative to those of low-option firms. The timing of this price adjustment is consistent with investors devoting attention toward option costs only after observing high-option firms report lower EPS for FQ1 and miss forecasts at a higher rate (which occurred during FQ2). Investors learned only gradually about options, as the valuation gap widened to 0.310 by FQ4.

A challenge to interpreting these results is that FAS 123-R led to several other changes among high-option firms, alongside the increase in option cost visibility. In an exhaustive review of studies that use FAS 123-R, we identify 35 additional outcomes of the regulation. We explain how our staggered DiD model requires a compound exclusion restriction (CER) assumption, which may be violated if any of the additional changes affect our outcome variables (Heath et al., 2023, henceforth HRSW). Each additional study necessitates another condition for the CER, making the overall CER assumption progressively harder to verify. This is a challenge that researchers face whenever a natural experiment is reused.

We show how this challenge can be addressed by combining two strategies, which other researchers can also implement to credibly reuse a natural experiment. The first strategy implements a reduced-form approach developed by Bakke et al. (2022) (henceforth BFMZ). Based on the review of prior studies, we classify FAS 123-R's additional outcomes into three economic channels that could violate the CER. First, firms substituted options with restricted stock after FAS 123-R, which reduced CEOs' risk-taking incentives and led to more conservative firm policies (e.g., Hayes et al., 2012; Bakke et al., 2016). Second, this change in pay structure, as well as accelerated option vesting among some firms, affected the prevalence of managerial manipulation (e.g., Ladika and Sautner, 2020; Nienhaus, 2022). Third, CEO turnover rose due to option acceleration (Jochem et al., 2018).[1]

Following BFMZ, we repeatedly re-estimate our staggered DiD model using each additional outcome from the three channels as a dependent variable. Several outcomes (only related to risk-taking or manipulation) exhibit staggered changes for high- relative to low-option firms after FAS 123-R. Next, we examine to what extent these outcomes affect our main results, by controlling for them in our baseline regressions. In these tests, changes in analyst outcomes and valuations between high- and low-option firms remain large and highly significant, while coefficients on the additional outcomes are mostly insignificant. Overall, the BFMZ approach provides support for our limited attention hypothesis.

Reduced-form tests that evaluate the CER assumption possess limitations. Because FAS 123-R's various effects occurred almost simultaneously, reverse causality may bias regression estimates from our first strategy (e.g., a drop in firm valuations could influence CEO risk-taking). Additionally, analyst outcomes and valuations could depend on (unobservable) expectations about future risk-taking, rather than the actual policies that we can control for. More generally, the reduced-form tests do not *quantify* the prevalence of limited attention.

We develop a second strategy that does not suffer from these limitations. We follow Whited (2023) and Briggs et al. (2021) in combining our reduced-form results with structural estimation. We build and estimate an economic model that features the adoption of FAS 123-R. This strategy provides quantitative estimates of a limited attention parameter before and after FAS 123-R, while accounting for simultaneous changes to risk-taking and manipulation incentives (we exclude the CEO turnover channel, based on the BFMZ analysis).

Our model extends the dynamic principal-agent setup of Marinovic and Varas (2019) (henceforth MV), whose model allows for manipulation in the optimal contact. Firm value is the sum of expected discounted cashflows net of CEO pay. As in MV, the CEO can manipulate immediate cashflows upward, but manipulation accumulates over time and reduces future cashflows. We capture risk-taking by allowing the CEO to control the variance of the cashflow process (next to the mean). Importantly, the market's valuation of CEO pay costs varies with the amount of limited attention in the economy. Limited attention changes across a non-expensing state, an interim state between the announcement of FAS 123-R and its implementation, and an expensing state. The board is aware of this, and accounts for both incentive provision and investor inattention when setting compensation in each period. The duration of incentives provided by the optimal contract changes over time.

[1] The Financial Accounting Standards Board allowed firms to avoid accounting charges on previously granted, unvested options by accelerating them to fully vest before FAS 123-R's compliance date.

We use the simulated method of moments (SMM) to estimate model parameters. We estimate that the limited attention parameter declines from 8.6% in the non-expensing state to 6.2% in the interim state, and further to 1.7% in the expensing state. This implies that investors overlooked 8.6% of CEO pay costs when option grants were reported in footnotes. Counterfactual analysis indicates that all three channels affect the decline in market valuations after FAS 123-R, but the reduction in limited attention and changes to risk-taking are quantitatively most important (manipulation appears to only have a small impact). Overall, our two strategies rely on different assumptions but produce consistent evidence, which provides strong support for the limited attention hypothesis.

We return to the reduced-form framework to further explore analysts' and investors' learning processes. Some analysts covered firms that voluntarily expensed options before FAS 123-R, or that complied with the regulation early in calendar time. These analysts should have already learned to incorporate option costs at other firms by the time that they complied with FAS 123-R. Our evidence is consistent with this prediction. Among firms covered by numerous analysts with prior experience of option expensing, high-option firms were not more likely to miss EPS forecasts after FAS 123-R than low-option firms. Further, analysts who covered the earliest firms to comply with FAS 123-R quickly downgraded other high-option firms that had not yet complied. Overall tenure in the sell-side industry also helped analysts to overcome attention constraints.

In contrast, investors appear to have learned more slowly about option costs. First, high-option firms' cumulative abnormal returns (CARs) drifted down by −6.3% over the three months after the announcement of EPS for FQ1 that missed analysts' forecasts (low-option firms experienced no such drift). Second, high-option firms experienced similarly negative CARs following announcements of EPS for FQ1 that analysts forecasted correctly. Although analysts had fully learned about these firms' option expenses, investors still needed time to update their valuations.

Investors partially learned about option costs before FAS 123-R, from salient changes to shares outstanding. During the non-expensing regime, firms earned negative CARs after reporting an increase in shares outstanding, which provided new information about recent exercises of previously granted options. Yet, this occurred repeatedly, so investors did not fully learn about future option pay, leading to new overvaluation. This dynamic diminished after FAS 123-R, as option expensing allowed investors to incorporate future dilution.

We make four contributions to the limited attention literature. First, we provide novel evidence that sophisticated market participants face attention constraints. Second, we are the first to show how analysts learn to process information that is costly to access, and how they help to disseminate it to financial markets. Third, we are the first to quantify the prevalence of limited attention in financial markets, using structural estimation. Fourth, we document that low visibility of key financial expenses can lead to long-term misvaluation.

We relate to studies that examine whether market participants react differently to items recognized in financial statements versus disclosed in footnotes. Early work uses experiments to test whether participants focus on recognized or disclosed information (Maines and McDaniel, 2000; Hirst et al., 2004), while recent studies analyze the price impact of mandated recognition. Ahmed et al. (2006) show that banks' stock prices increasingly reflect derivative positions after FAS 133 required the recognition of derivative fair values. Yu (2013) studies the recognition of pension liabilities under FAS 158, showing that their value relevance rose among firms with low institutional ownership or analyst coverage. Bratten et al. (2013) find no impact of recognition for items that had already been disclosed in a salient manner. Niu and Xu (2009) examine the introduction of option expensing in Canada by reporting standard HB 3870. They find that option expenses were negatively related to returns when disclosed prior to HB 3870, and positively related when recognized afterward. They conclude that recognition increases financial reporting quality by mitigating CEO manipulation, but do not examine the role of limited attention.

We significantly extend these findings. First, we provide well-identified estimates of the value impact of recognized costs, accounting for shocks that may coincide with an accounting rule change. The results are obtained for a representative sample, and thus should have high external validity. Second, we show how information recognition at some firms allows analysts to learn from disclosures at others. Third, we document how investors learn to process information as reporting transitions to an expensing regime.[2]

Beyond these field-specific contributions, we add to a nascent literature showing various ways that empirical analysis can benefit from the integration of reduced-form and structural estimation (Whited, 2023), including to understand the determinants of an estimated reduced-form elasticity (Briggs et al., 2021). We are the first to show how this integration can help researchers to credibly interpret results when a natural experiment is reused, which is increasingly common in corporate finance research.

2. Conceptual framework and hypotheses

2.1. Institutional background and theoretical framework

Market participants should follow three steps to incorporate option pay into equity valuations (Damodaran, 2006). First, when calculating free cashflows to equity, the value of option pay should be deducted from earnings for each future period. The equity value is the discounted sum of these cashflows. Second, the value of previously granted, unexercised options should be subtracted from this equity value. Third, the per-share value should be calculated as the adjusted equity value (net of option grants) divided by shares outstanding.

Prior to FAS 123-R, accounting standards required firms to expense only the intrinsic value of option pay—the stock price on the grant date minus the strike price. Almost all firms chose to grant at-the-money options, and did not report option expenses in income statements. However, firms had to disclose the details of new and previously granted options in their statement footnotes (Choudhary et al., 2009; Balsam et al., 2008). Thus, financial reports contained the information that analysts needed to complete the three valuation steps, but did *not* present it in a highly visible format.

FAS 123-R required firms to deduct the cost of periodic option pay from quarterly earnings in the income statement. Option expenses equal the fair value of each new grant multiplied by the fraction of the grant that vests in the quarter. Firms also had to expense grants made prior to FAS 123-R that vested after the rule took effect. Both changes facilitated the projection of cashflows under step one of the valuation process. However, firms did not have to report expenses for previously granted options that had vested but were not yet exercised, which should be included in step two. Thus, FAS 123-R increased the visibility of many—but not all—option grants. Firms could not avoid expenses by adjusting CEO pay structure after FAS 123-R, since other pay components already had to be expensed under previous rules.

Fig. 1 shows that FAS 123-R required firms to start deducting option costs from the EPS realized in FQ1. At the start of FQ2, most analysts released their final forecasts of EPS for FQ1 and issued stock

[2] We also relate to work on exogenous changes in information visibility. Frydman and Wang (2020) document an increase in the disposition effect among retail traders after capital gains became more visible on trading screens. Fedyk (2024) shows that news posted on the front page of a Bloomberg terminal induces trading and short-term price drift. Boulland et al. (2017) document that investor attention increased after continental European firms started to disseminate news in English and electronically through a wire service. We show that information placement within 10-Ks impacts long-term misvaluation, which is important because 10-Ks are a primary way that firms communicate with investors.

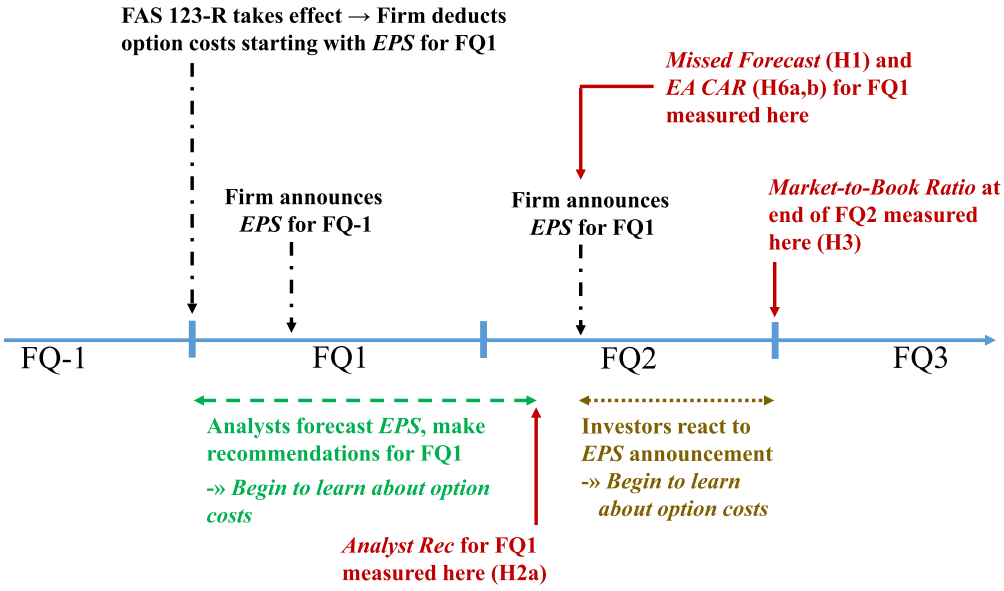

Fig. 1. Timing of variables to test hypotheses. This figure illustrates part of the timeline used to test our hypotheses. FQ stands for fiscal quarter. *Missed Forecast* equals 1 for fiscal quarters in which the firm's actual EPS for the fiscal quarter are below analysts' consensus (mean) estimate, and 0 otherwise. *Analyst Rec* is the consensus (mean) analyst stock recommendation for the fiscal quarter and ranges between 1 ("sell") and 5 ("strong buy"). *EA CAR* for FQ1 is the cumulative abnormal return (CAR) around the announcement of EPS for FQ1. *Market-to-Book Ratio* measures market valuations at the end of each fiscal quarter. The specific hypotheses tested by each variable are in parentheses.

recommendations. This is when we measure the consensus forecast and recommendation for FQ1. About 30 to 45 days into FQ2, the firm announced EPS for FQ1, which we compare to the consensus when measuring missed forecasts for FQ1. We measure investors' reactions upon this EPS announcement, and firm values at the end of FQ2.

HT study how two accounting treatments of option pay affect firm valuations. They model a non-expensing regime in which firms report information about option grants only in statement footnotes, as was the case prior to FAS 123-R. Market participants require significant time and cognitive resources to collect this information, and to calculate the impact of options on earnings and valuations. Participants constrained by limited attention overlook option grants or use simplified calculations that underestimate their cost. Thus, HT predict that market valuations overestimate firms' intrinsic values in the non-expensing regime, with greater overvaluation among firms that grant more option pay.

In the expensing regime, the fair value of options is deducted from earnings when the grants are awarded. In HT's model, this regime provides more salient information about options than do footnote disclosures, allowing market participants with limited attention to incorporate the grants into their valuations. Therefore, HT predict that market valuations in the expensing regime are lower than in the non-expensing regime.[3]

HT do not model *dynamics* of the transition between regimes, but we expect that market participants needed some time after FAS 123-R to learn about the full value impact of options. For example, they may have learned only gradually about unexercised vested options, as information about these grants continued to be reported only in footnotes. Hence, we expect that during FQ1, participants incorporated a larger fraction—but not all—of the firm's option grants than before FAS 123-R. This fraction should have increased in subsequent fiscal quarters, with various market participants potentially learning at different speeds.

2.2. Missed forecasts, recommendations, and valuations

We infer from HT that analysts constrained by limited attention should have incorporated only a fraction of option expenses into forecasts after FAS 123-R, and thus overestimated earnings for FQ1. If limited attention affected many analysts, then a firm's likelihood of reporting earnings below its consensus forecast increased, relative to the fiscal quarters before FAS 123-R.[4] This effect should have been larger among firms that relied more on option pay ("high-option" firms) than among those that relied less on it ("low-option" firms). Over subsequent fiscal quarters, analysts with limited attention should have learned to accurately estimate option expenses and their effect on earnings. Hence, the difference in the frequency of missed forecasts between high- and low-option firms should have disappeared over time.

H1: High-option firms experienced a bigger increase in the frequency of missed EPS forecasts for FQ1 than did low-option firms. In subsequent fiscal quarters the difference converged to zero.

Prior to FAS 123-R, analysts affected by limited attention should have calculated valuations that exceeded a firm's intrinsic value, by incorporating only a fraction of existing and future option pay. These analysts should have learned about options when the firm complied with FAS 123-R, as they had to devote more attention to option expenses when forecasting EPS for FQ1. During this process analysts should have lowered their valuations, especially of high-option firms, by projecting higher future option pay and deducting a larger value of outstanding grants.

Analysts' recommendations depend on the difference between their valuations and the firm's stock price. Hence, whether analysts downgrade a stock or not depends partly on investors' stock valuations in FQ1. Investors' valuations of high-option firms may have exceeded

[3] HT show that firms can be undervalued if they expense the full value of a lump-sum option grant as soon as it is made (rather than proportionally over the vesting period). Market participants with limited attention mistakenly interpret the total expense as the first installment in a stream of continuing option grants, and thus underestimate future cashflows. This prediction does not apply to our setting. FAS 123-R required firms to pro-rate option expenses over the vesting period, and most firms do grant option pay each year.

[4] Only 24% of firms provided earnings guidance in the mid-2000s (Anilowski et al., 2007), so most analysts did not receive sufficient information from firms to accurately forecast option expenses.

those of analysts, if investors also were constrained by limited attention and did not incorporate option expenses during FQ1 (e.g., as they did not have to forecast earnings). Therefore, analysts may have concluded that high-option firms' stocks were overpriced in FQ1, and these firms should have experienced relatively larger downgrades.

H2a: High-option firms experienced larger downgrades in their consensus recommendations for FQ1 than did low-option firms.

Recommendations for subsequent fiscal quarters should have depended on the relative extent to which analysts' and investors' valuations incorporated option costs. We expect that analysts and investors learned over time to fully incorporate option grants into valuations, but their learning speeds may have differed. If analysts incorporated a progressively larger amount of grants in each fiscal quarter than investors did, they would have concluded that the stock remained overpriced. The consensus rating then should have remained lowered relative to its level before FAS 123-R, especially at high-option firms.[5]

H2b. High-option firms' consensus recommendations remained lowered for FQ2 to FQ4 relative to those of low-option firms if analysts learned about options more quickly than investors.

HT predict that some investors lacked time and cognitive resources to read through statement footnotes and value options. Before FAS 123-R, such investors did not fully incorporate options into their valuations. Their attention toward option pay may have only begun to increase in the middle of FQ2, when firms started to report earnings for FQ1. If at that time investors observed high-option firms miss forecasts for FQ1 and receive downgrades, then they should have projected higher future option costs in their valuations. This would have led to a decrease in the market valuation of high-option firms relative to low-option firms.

H3: High-option firms experienced a larger decrease in market valuations at the end of FQ2 than did low-option firms.

H3 predicts that high-option firms experienced a larger decrease in market valuations than low-option firms at the end of FQ2. If this relative decline continued in FQ3 and FQ4, it would provide evidence that investors learned about option grants more slowly than analysts (especially if analysts' recommendations remained lowered, as H2b predicts).

2.3. Analyst and investor learning about option grants

2.3.1. Domain-specific and domain-general analyst learning

When a firm started to comply with FAS 123-R, some of its analysts may have already possessed domain-specific experience, which they accumulated by covering firms that had voluntarily adopted option expensing prior to FAS 123-R or that complied with it early in calendar time.[6] When these analysts forecasted the EPS of a non-voluntary adopter or late complier firm, they could have relied on their experience to calculate option expenses accurately already during FQ1. They also may have revised valuations of the firm even before it complied with FAS 123-R. Thus, among firms covered by numerous analysts with domain-specific experience ("high domain-specific coverage" firms), the frequency of missed forecasts and downgrades after FAS 123-R should have been similar for high- and low-option firms. (For low coverage firms, outcomes should be as in Section 2.2.)

H4a: Among high domain-specific coverage firms, high-option firms did not experience a bigger increase in the frequency of missed forecasts after FAS 123-R than did low-option firms.

H4b: Among high domain-specific coverage firms, high-option firms did not experience larger downgrades in their consensus recommendations after FAS 123-R than did low-option firms.

Analysts with significant sell-side industry experience should have had a good understanding of how new accounting rules affected firms. Such domain-general experience should have helped analysts with limited attention to more accurately calculate option expenses after FAS 123-R, and to incorporate a larger fraction of the grants' costs into valuations. However, analysts with domain-general experience may not have been able to learn quickly enough to fully incorporate option grants in FQ1. Therefore, firms covered by many analysts with domain-general experience ("high domain-general coverage" firms) may have experienced missed forecasts and downgrades after FAS 123-R, but at a lower rate than "low domain-general coverage" firms. (Outcomes among low coverage firms should be as in Section 2.2.)

H5a: Among high domain-general coverage firms, high-option firms experienced only a small increase in the frequency of missed forecasts after FAS 123-R compared to low-option firms.

H5b: Among high domain-general coverage firms, high-option firms experienced only a small decrease in consensus recommendations after FAS 123-R compared to low-option firms.

2.3.2. Investor learning from earnings announcements after FAS 123-R

Investors' speed of learning about option grants can be inferred from stock return dynamics around two types of earnings announcements: Those that miss the consensus analyst forecast for FQ1, and those that meet it.[7]

Before FAS 123-R, high- and low-option firms should have earned similarly negative CARs after announcing earnings that missed their consensus forecasts, since the missed forecasts occurred due to an unexpected decline in operating performance, rather than a rise in option expenses. H1 predicts that after FAS 123-R, numerous high-option firms missed their forecast for FQ1 because analysts underestimated option expenses. If investors had already fully learned about these firms' option grants, then they should have inferred that the missed forecasts were largely due to analyst mistakes, and should not have reduced high-option firms' valuations. To the contrary, if investors had *not* fully learned about option costs, then the missed forecasts should have conveyed new information about these costs. In this case, high-option firms' CARs after a missed forecast for FQ1 would have been more negative than low-option firms' CARs, and in particular may have drifted downward over time.

H6a. High-option firms' CARs were more negative after missing a forecast for FQ1 than low-option firms' CARs if investors had not fully learned about option costs.

The relative learning speed of investors and analysts can be inferred from the announcement of earnings for FQ1 that met analysts' forecasts. Since analysts correctly forecasted earnings, they likely had already

[5] Alternatively, if few investors were affected by limited attention, or those who were affected learned more quickly than analysts to incorporate option grants, then a firm's stock price would have decreased relative to analysts' valuations. Analysts should then have concluded that the stock was underpriced, and raised their recommendations above the value for FQ1.

[6] In psychology, "domain-specific" refers to experience related to a particular area or topic. In contrast, "domain-general" refers to experience that is broader and can be applied to a wide range of areas.

[7] We do not examine CARs around analyst recommendation changes, as recommendations were released at different times by individual analysts, and thus do not constitute a single highly visible event for the firm. We also do not examine earnings announcements for FQ2 through FQ4, since it is unclear whether these events conveyed new information about option grants. This is because earnings announcements for FQ1 should have drawn investors' attention, prompting them to gather information over time about option grants.

fully learned about these firms' option expenses. Yet, if investors lowered their valuations for high-option firms, this would indicate that they learned about option costs from these announcements. This could have occurred if investors' attention was drawn to the relatively lower earnings of high-option firms after FAS 123-R, or if firms provided new information on option expenses in their earnings announcements. Thus, more negative CARs for high- than low-option firms would indicate that investors learned more slowly than analysts.

H6b. High-option firms' CARs were more negative after meeting a forecast for FQ1 than low-option firms' CARs if investors learned about option costs more slowly than analysts.

2.3.3. Investor learning prior to FAS 123-R

In HT's model, investors with limited attention underestimate option costs in a non-expensing regime. However before FAS 123-R, investors occasionally received salient information related to option grants from previous years. In particular, firms reported total shares outstanding in quarterly earnings announcements, which conveyed new information about dilution from option exercises during the previous fiscal quarter. If investors partially learned from this information, then their valuations should have decreased when firms reported an (unexpected) increase in shares outstanding, leading to negative announcement-date CARs. Changes in shares outstanding conveyed no information about unexercised options or future grants, so investors may not have learned enough to fully incorporate these grants. Thus, over time high-option firms might have again become overvalued. After FAS 123-R, the price reaction to changes in shares outstanding should have diminished, as option expensing accounts for expected dilution (see Section 2.1).

H6c: High-option firms' CARs were more negative after a reported increase in shares outstanding than low-option firms' CARs. This reaction diminished after FAS 123-R.

3. Reduced-form identification strategy and data

3.1. Empirical methodology and identification

Our staggered DiD model uses calendar-time variation in FAS 123-R compliance based on firms' fiscal year-end months. This accounts for shocks that affected all firms at the same point in calendar time. We classify the sample into high- and low-option firms based on the amount of options granted to employees prior to FAS 123-R (details below). High-option firms faced a larger increase in expenses after FAS 123-R and should have experienced a bigger drop in earnings (regardless of whether they continued to grant options or switched to other forms of expensed pay). This comparison accounts for potential confounding effects of FAS 123-R that affected all firms. We sample each firm over the four fiscal quarters before versus after its FAS 123-R compliance date. We label this window as [-4;+4] fiscal quarters, with options expensed starting in FQ1. We estimate for firm f and fiscal quarter t:

$$\begin{aligned} \textit{Firm Outcome}_{f,t} = {} & \pi_1 \textit{Post FAS 123-R}_{f,t} \times \textit{High-Option Firm}_f \\ & + \pi_2 \textit{Post FAS 123-R}_{f,t} + \pi_3 \textit{High-Option Firm}_f \\ & + \delta X_{f,t-1} + \mu_f + \Theta_t + u_{f,t}. \end{aligned} \quad (1)$$

Our main goal is to estimate π_1, the reduced-form elasticity between *Firm Outcome* and the DiD interaction term. *Firm Outcome* varies with the hypothesis being tested. *Post FAS 123-R* equals 1 for fiscal quarters after a firm began to comply with FAS 123-R, and 0 otherwise. In most calendar months this indicator varies across our sample, as some firms had already complied with FAS 123-R while others had not yet. (Some tests replace *Post FAS 123-R* with indicators for each fiscal quarter following compliance.) *High-Option Firm* equals 1 in all fiscal quarters for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in fiscal year 2004 or 2005, and 0 for all other firms. We use pre-FAS 123-R grants so that estimates are not biased by subsequent changes to pay policies. $X_{f,t-1}$ contains controls, and standard errors are clustered at the firm level.

We use two fixed-effects specifications. The first contains fixed effects for each Fama-French 48 industry to account for shocks within a sector, along with fixed effects for each firm's fiscal year-end month to account for differences across firms with different fiscal year-ends. The second contains fixed effects for each firm, each fiscal quarter, and the three-month calendar period in which each fiscal quarter ends. Fiscal-quarter fixed effects account for business seasonality across a firm's fiscal year. They address that earnings are generally lowest in the first fiscal quarter, coinciding with the start of FAS 123-R compliance. Calendar-quarter fixed effects account for shocks that affect all firms at the same time.

Fig. 2 depicts FAS 123-R's staggered compliance rule. Firms with a June fiscal year-end had to begin expensing options in the fiscal quarter covering July to September 2005. For these firms, the sample contains all fiscal quarters that ended between September 2004 and June 2006. In contrast, firms with a May fiscal year-end began to expense options in the fiscal quarter covering June to August 2006, and the sample contains their fiscal quarters that ended between August 2005 and May 2007. In each month between July 2005 and June 2006 some firms began to expense options, while others had already (or not yet) complied.

A key identifying assumption for Eq. (1) is the parallel-trends condition: If FAS 123-R had not been adopted, then high- and low-option firms' outcome variables would have followed the same trend as before the regulation. This condition cannot be tested directly, but Section 3.2 reports evidence supporting it. Further, firms with deteriorating fundamentals could not selectively avoid treatment, as the precise FAS 123-R compliance schedule could not be anticipated (it was delayed just two months before the regulation took effect).[8]

Internet Appendix (IA) Section E shows that our main results are robust to different methods that address potential biases with staggered DiD models (Baker et al., 2022). IA Section F analyzes the multiple hypothesis testing problem that arises because prior studies also used FAS 123-R as an experimental setting (HRSW).

3.2. Sample, outcome measures, and summary statistics

Our initial sample contains all 5,556 U.S. firms in the intersection of the Compustat and IBES databases when FAS 123-R took effect. We exclude 1,395 financial and utilities firms and 47 firms that changed their fiscal year in 2005 or 2006, perhaps to delay option expensing. We further omit 208 firms that voluntarily expensed the fair value of options prior to FAS 123-R, as these firms' accounting expenses should not have changed when the regulation took effect (Aboody et al., 2004). The final sample contains 3,906 firms.

Our earnings measure is EPS, the diluted earnings per share that firms report for a fiscal quarter (net income divided by common shares outstanding and stock options). We also construct EBIT/Share, whereby we scale EBIT by shares outstanding at the end of the previous fiscal year (to ensure results are unaffected by changes in option exercises). Each measure is impacted by option expenses, because firms deduct employee compensation prior to calculating net income or EBIT. We use GAAP earnings that firms report in their 10-Ks as well as *pro forma* earnings that firms emphasize in reports to analysts and investors.[9]

[8] FAS 123-R originally required all firms to begin expensing options on June 15, 2005, independent of their fiscal year-ends. However, accountants worried about the difficulty of changing accounting standards in the middle of a fiscal year (McConnell et al., 2005). Therefore, in April 2005 the SEC changed the compliance timing to financial statements issued in the first fiscal year starting after June 15, 2005.

[9] Firms have broad leeway to define *pro forma* earnings as long as they are reported alongside GAAP earnings. Thus, firms and analysts could have coor-

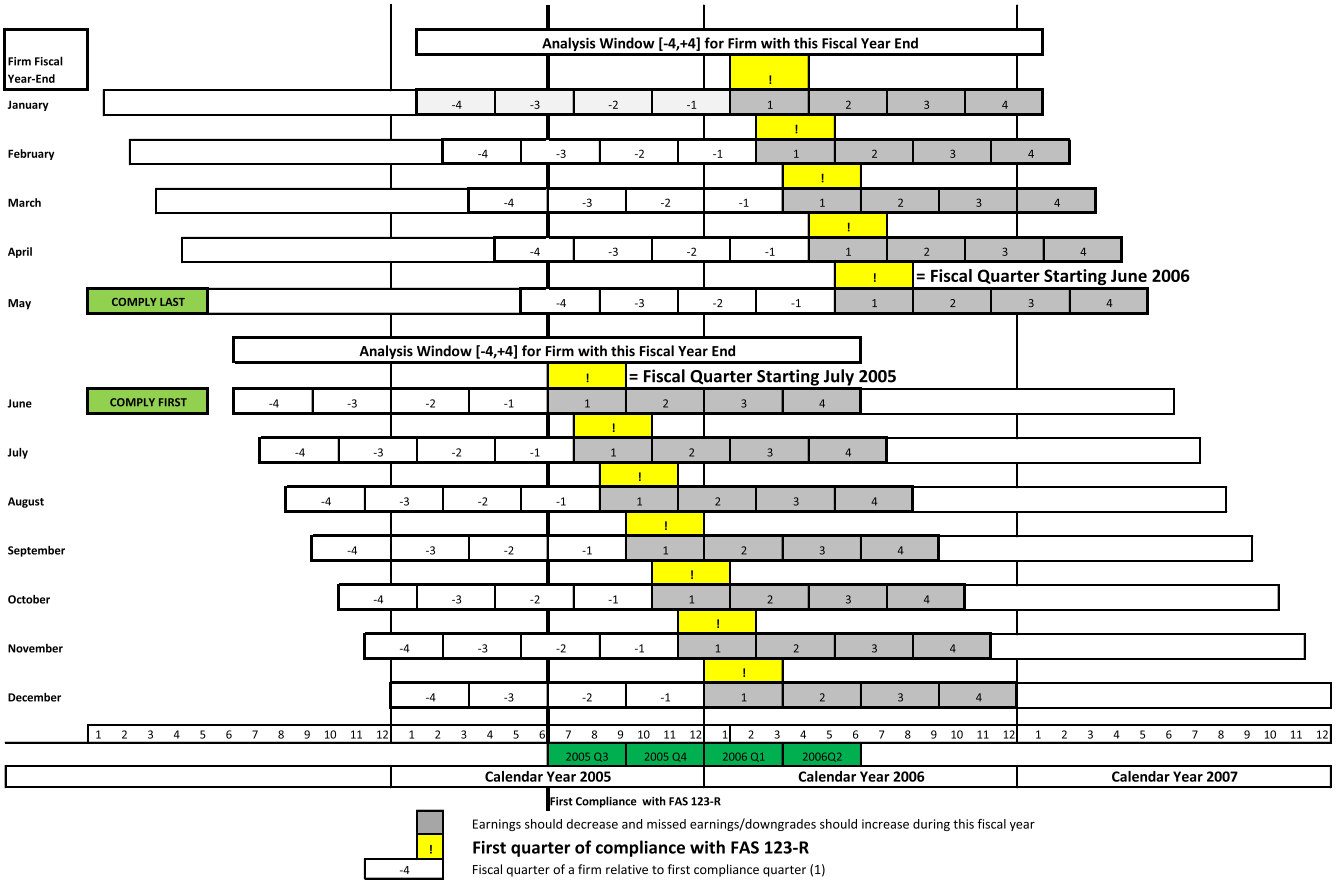

Fig. 2. Hypothesis testing using FAS 123-R compliance schedule. This figure shows how FAS 123-R compliance dates are staggered based on firms' fiscal year-ends, and how this variation should affect firms' earnings, missed forecasts, and analysts' recommendations.

Missed Forecast equals 1 when a firm's reported quarterly EPS fall below the consensus (mean) EPS estimate of its analysts, and 0 otherwise. EPS for fiscal quarter t are typically reported in the middle of fiscal quarter $t+1$. *Missed Forecast* for fiscal quarter t is measured by comparing these EPS to the analyst consensus immediately preceding the earnings announcement. We exclude 3% of firm-fiscal quarter observations with only stale forecasts. *Analyst Rec* is the consensus (mean) recommendation across analysts covering the firm. IBES categorizes recommendations on a five-point scale from "strong buy" to "sell", and we define *Analyst Rec* so that higher values reflect a better rating. We use the consensus immediately preceding the quarterly earnings announcement. *Pct. Buy Rec* is the percentage of analysts issuing "strong buy" or "buy" on a stock, and *Pct. Sell Rec* is the percentage of analysts issuing "sell" or "underperform." *Market-to-Book Ratio* measures market valuations at the end of each fiscal quarter. *EA CAR* is the cumulative abnormal return around an earnings announcement (risk-adjusted using the Fama-French 3-Factor model plus momentum).

Table 1, Panel A, shows that the median firm reports GAAP *EBIT/Share* of $0.170. On average 37.7% of firms miss their quarterly EPS forecast. About half of analysts (54.1%) issue "strong buy" or "buy" recommendations, while very few (6%) issue "underperform" or "sell" ratings. Statistics are also reported for control variables, including *Log Assets*, *Market-to-Book Ratio*, *Leverage*, and *Investment/Sales*.

Table 1, Panel B, follows Lemmon and Roberts (2010) by comparing growth rates in outcome variables between high- and low-option firms in the pre-FAS 123-R period. Most trends are statistically indistinguishable before FAS 123-R (the difference in *Analyst Rec* is marginally significant but small). Hence, high- and low-option firms' outcomes diverged only after FAS 123-R, which supports the parallel-trends condition for our DiD model.[10]

3.3. Effect of FAS 123-R on earnings

In Table 2, the coefficients on *Post FAS 123-R* × *High-Option Firm* estimate the difference in quarterly earnings averaged over the four fiscal quarters before and after FAS 123-R, for high- versus low-option firms. In Column 1, high-option firms' average *EPS* were 0.046 lower than those of low-option firms after FAS 123-R (10% of the standard deviation of *EPS*). Column 2 shows that high-option firms also reported relatively lower *EBIT/Share* following compliance. In Columns 3–4, these results are robust to including firm, fiscal-quarter, and calendar-quarter fixed effects. IA Table A.2 shows that high-option firms also reported relatively lower *pro forma* EPS after FAS 123-R, with magnitudes similar to those of GAAP earnings.

We verify that high-option firms' relatively lower earnings are not due to deteriorating fundamental profitability. First, IA Table A.3 shows that option expenses after FAS 123-R were large enough to explain high-option firms' relative earnings decline. Second, IA Table A.4 shows that

dinated to ignore option expenses in *pro forma* earnings after FAS 123-R, in which case the regulation would have had little impact on market participants' behavior. However only 19% of firms excluded option expenses from *pro forma* earnings after FAS 123-R (Barth et al., 2012).

[10] Our reduced-form identification strategy also requires variation in the timing of FAS 123-R compliance. IA Table A.1 shows that most sample firms have a fiscal year that overlaps with the calendar year, yet 30.9% of firms have a fiscal year that ends in another month.

Table 1
Summary statistics.

Panel A: Firm characteristics

	Mean	Median	25%	75%	St. Dev.	Obs.
GAAP Earnings						
$EPS_{f,t}$	0.131	0.070	-0.060	0.320	0.444	29,878
$EBIT/Share_{f,t}$	0.381	0.170	-0.036	0.625	0.717	28,049
$Sales/Share_{f,t}$	5.191	2.439	0.657	6.733	7.007	28,242
Pro Forma Earnings						
$EPS_{f,t}$	0.059	0.110	-0.050	0.330	0.737	27,050
$EBIT/Share_{f,t}$	0.399	0.214	-0.019	0.658	0.667	22,985
$Sales/Share_{f,t}$	5.378	2.705	0.786	7.054	6.936	26,048
$High\text{-}Option\ Firm_{f}$	0.500					26,157
$Missed\ Forecast_{f,t}$	0.377					19,658
$Analyst\ Rec_{f,t}$	3.739	3.750	3.330	4.100	0.617	19,454
$Pct.\ Buy\ Rec_{f,t}$	54.097	50.000	33.330	78.570	31.728	19,454
$Pct.\ Sell\ Rec_{f,t}$	6.042	0.000	0.000	6.670	13.656	19,454
$Log\ Assets_{f,t}$	5.510	5.467	4.083	6.869	1.975	28,864
$Market\text{-}to\text{-}Book\ Ratio_{f,t}$	2.363	1.785	1.303	2.724	1.671	27,423
$EA\ CAR_{f,t}$	-0.002	-0.002	-0.055	0.051	0.112	24,562
$Leverage_{f,t}$	0.198	0.134	0.001	0.315	0.222	28,093
$Investment/Sales_{f,t}$	0.102	0.022	0.007	0.058	0.247	26,537
$Analyst\ Coverage_{f,t}$	7.001	5.000	3.000	10.000	5.985	19,667

Panel B: Pre-trends in outcome measures before FAS 123-R

	Low-Option Firms			High-Option Firms			Test for Differences	
	Mean	Median	St. Dev.	Mean	Median	St. Dev.	Diff. in Mean	*t*-stat
$\Delta\ GAAP\ EPS_{f,t}$	0.015	0.010	0.432	0.011	0.010	0.298	0.004	(1.44)
$\Delta\ Pro\ Forma\ EPS_{f,t}$	0.013	0.010	0.450	0.012	0.005	0.461	0.001	(0.23)
$\Delta\ Missed\ Forecast_{f,t}$	0.003	0.000	0.607	0.004	0.000	0.618	-0.001	(-0.13)
$\Delta\ Analyst\ Rec_{f,t}$	-0.026	0.000	0.343	-0.034	0.000	0.457	0.008*	(1.70)
$\Delta\ Pct.\ Buy\ Rec_{f,t}$	-1.292	0.000	19.067	-1.401	0.000	25.694	0.110	(0.43)
$\Delta\ Pct.\ Sell\ Rec_{f,t}$	0.490	0.000	10.091	0.335	0.000	11.852	0.155	(1.23)
$\Delta\ Market\text{-}to\text{-}Book\ Ratio_{f,t}$	-0.001	0.006	0.415	0.009	0.000	0.864	-0.010	(-1.54)

Panel A shows summary statistics for the sample. The sample is 3,906 U.S. firms in the intersection of the Compustat and IBES databases. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level, for the four fiscal quarters before to four fiscal quarters after each firm's (staggered) FAS 123-R compliance date. Panel B follows Lemmon and Roberts (2010) and compares the growth rates in the key dependent variables across high- and low-option firms for the fiscal years before FAS 123-R took effect. Observations are at the firm-fiscal quarter level, for the sixteen fiscal quarters before to one fiscal quarter before each firm's (staggered) FAS 123-R compliance date. The panel also presents difference-in-means tests. High-option firms are defined as firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005. Low-option firms are all other firms. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

FAS 123-R did not have a confounding effect on fundamentals, because high- and low-option firms' total revenues followed the same trend after FAS 123-R.

4. Evidence on reduced-form effects of FAS 123-R

4.1. Effect of FAS 123-R on missed analyst forecasts

H1 predicts that high-option firms experienced a rise in the frequency of missed forecasts for FQ1 relative to low-option firms, and this difference converged in subsequent fiscal quarters. Table 3 tests these predictions by estimating Eq. (1) with *Missed Forecast* as the dependent variable. Tests in this and subsequent tables exclude firms that are covered by fewer than three analysts, to reduce the influence of outliers on the consensus outcomes. The sample is further restricted to firms that have quarterly observations both before and after FAS 123-R.

Columns 1–2 compare the frequency of missed forecasts averaged across all four fiscal quarters before versus after each firm's FAS 123-R compliance date, for high- versus low-option firms. The positive and highly significant coefficients on *Post FAS 123-R* × *High-Option Firm* indicate that analysts were relatively more likely to overestimate high-option firms' EPS after option expensing began. In Column 1, high-option firms' likelihood of missing an EPS forecast rose by 6.7 pp after FAS 123-R, relative to that of low-option firms (a 17.8% increase relative to the unconditional frequency of 37.7%). In Column 2, results are robust to using firm, fiscal-quarter, and calendar-quarter fixed effects.[11] To test for the time dynamics predicted in H1, we replace *Post FAS 123-R* with indicators for each fiscal quarter following FAS 123-R compliance. In Column 3, high-option firms were 12.7 pp more likely to miss an EPS forecast for FQ1, relative to low-option firms. Importantly, high-option firms' likelihood of missing a forecast was just 8.4 pp higher for FQ2, and indistinguishable from that of low-option firms for FQ3 and FQ4.

Overall, the evidence in Table 3 is consistent with H1: Some analysts' attention appears to have been constrained prior to FAS 123-R, leading them to incorporate only a fraction of option expenses into EPS forecasts when firms first began to comply with the regulation. Over subsequent fiscal quarters, these analysts learned to accurately estimate each firm's option expenses and their effect on its EPS.

[11] In IA Table A.5, results are similar when excluding firms with a December fiscal year-end, and in IA Table A.6 we show that results are not explained by a two-sided increase in the variance of analyst forecasts.

Table 2
Effect of FAS 123-R on GAAP earnings.

Dependent Variable	$EPS_{f,t}$	$EBIT/Share_{f,t}$	$EPS_{f,t}$	$EBIT/Share_{f,t}$
Estimation Window	[-4;+4] Fiscal Quarters around FAS 123-R			
	(1)	(2)	(3)	(4)
Post FAS 123-R$_{f,t}$ × *High-Option Firm*$_f$	-0.046***	-0.033***	-0.040***	-0.021*
	(-5.34)	(-2.72)	(-4.98)	(-1.83)
Post FAS 123-R$_{f,t}$	0.030***	0.006	0.170**	0.254*
	(4.39)	(0.62)	(1.98)	(1.88)
High-Option Firm$_f$	0.061***	0.100***		
	(4.69)	(4.84)		
Log Assets$_{f,t-1}$	0.094***	0.178***	-0.024*	0.079***
	(25.93)	(29.23)	(-1.82)	(4.45)
Market-to-Book Ratio$_{f,t-1}$	0.042***	0.046***	0.023***	0.031***
	(15.51)	(10.23)	(7.60)	(8.92)
Leverage$_{f,t-1}$	-0.190***	0.142***	0.006	0.130***
	(-7.32)	(3.67)	(0.15)	(2.75)
Investment/Sales$_{f,t-1}$	-0.286***	-0.370***	0.033	0.002
	(-13.81)	(-10.74)	(1.53)	(0.08)
Industry Fixed Effects	Yes	Yes	No	No
Fiscal-Year-End Fixed Effects	Yes	Yes	No	No
Firm Fixed Effects	No	No	Yes	Yes
Fiscal-Quarter Fixed Effects	No	No	Yes	Yes
Calendar-Quarter Fixed Effects	No	No	Yes	Yes
Obs.	22,849	22,542	22,849	22,542
Adj. R-sq.	0.281	0.400	0.011	0.024

The sample is 3,906 U.S. firms in the intersection of the Compustat and IBES databases. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level, for the four fiscal quarters before to four fiscal quarters after each firm's (staggered) FAS 123-R compliance date. We label the analysis window as [-4;+4] fiscal quarters, with option expenses recorded starting in fiscal quarter 1. *EPS* is quarterly diluted earnings per share. *EBIT/Share* is quarterly operating income divided by shares outstanding from the start of the fiscal year. *Post FAS 123-R* equals 1 for fiscal quarters after FAS 123-R takes effect, and 0 for fiscal quarters before. *High-Option Firm* equals 1 in all fiscal quarters for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, and 0 for all other firms. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

Two tests in IA Table A.7 show that our results are not due to unobservable differences between high- and low-option firms. The first test contains only firms that voluntarily expensed options in 2004 or earlier. Our limited attention hypothesis implies that these firms' EPS should not have fallen, and missed forecasts should not have risen, following compliance. Our evidence is consistent with these predictions. The second test shows no change in missed forecasts between high- and low-option firms for several placebo events before FAS 123-R.

4.2. Effect of FAS 123-R on analyst recommendations

H2a predicts that high-option firms experienced larger recommendation downgrades for FQ1 than did low-option firms. Table 4 tests this prediction by estimating Eq. (1) with the three recommendation measures as dependent variables. In Column 1, *Analyst Rec* for FQ1 declined by 0.060 for high-option firms, relative to low-option firms. This decline equals 10% of the standard deviation, which is economically meaningful since analysts typically resist downgrading firms (Jegadeesh and Kim, 2006). The magnitude is unchanged in Column 2 with the alternative fixed effects. In Columns 3–6, high-option firms experienced a relative decrease in the percentage of analysts recommending "strong buy" or "buy" for FQ1, and an increase in the percentage of those issuing a "sell" or "underperform." The 1.4 pp increase in *Pct. Sell Rec* in Column 6 equals 23% of the variable's mean and 10% of its standard deviation. Taken together, this evidence supports H2a.

If in subsequent fiscal quarters analysts learned about option costs faster than investors, then high-option firms' recommendations should have remained lowered relative to those of low-option firms (H2b). Table 4 supports this prediction: For all three analyst variables, high-option firms' recommendations remained lowered relative to those of low-option firms for FQ2 to FQ4. Further, each column shows that high-option firms experienced further downgrades of recommendations for FQ2, which suggests that analysts lowered high-option firms' valuations after observing them increasingly miss forecasts for FQ1.

4.3. Effect of FAS 123-R on investor valuations

Next we test H3, which predicts that market valuations of high-option firms declined relative to those of low-option firms starting in FQ2. Table 5 reports estimates of Eq. (1) with *Market-to-Book Ratio* as the dependent variable. Columns 1–2 examine valuation changes averaged across all four fiscal quarters after each firm's FAS 123-R compliance date, while Columns 3–4 analyze valuation changes at the end of each fiscal quarter. Column 1 indicates that high-option firms' market-to-book ratios declined by 0.160 on average after FAS 123-R, relative to those of low-option firms (10% of the standard deviation). Column 2 shows that the effect is robust to the inclusion of alternative fixed effects.

In Column 3, high-option firms' valuations did not decline relative to those of low-option firms immediately after FAS 123-R took effect. Instead, their market-to-book ratios dropped by 0.141 at the end of FQ2, relative to those of low-option firms. This timing is consistent with H3, which predicts that investors' attention toward option grants only began to increase in the middle of FQ2. This is when firms reported EPS

Table 3
Effect of FAS 123-R on missed earnings forecasts.

Dependent Variable	*Missed Forecast*$_{f,t}$			
Estimation Window	[-4;+4] Fiscal Quarters around FAS 123-R			
	(1)	(2)	(3)	(4)
Post FAS 123-R$_{f,t}$ × *High-Option Firm*$_f$	0.067***	0.060***		
	(3.53)	(3.11)		
Post FAS 123-R FQ1$_{f,t}$ × *High-Option Firm*$_f$			0.127***	0.122***
			(4.63)	(4.46)
Post FAS 123-R FQ2$_{f,t}$ × *High-Option Firm*$_f$			0.084***	0.067**
			(2.98)	(2.38)
Post FAS 123-R FQ3$_{f,t}$ × *High-Option Firm*$_f$			0.029	0.023
			(1.01)	(0.79)
Post FAS 123-R FQ4$_{f,t}$ × *High-Option Firm*$_f$			0.024	0.018
			(0.83)	(0.62)
Post FAS 123-R$_{f,t}$	-0.003	-0.988***		
	(-0.31)	(-5.11)		
Post FAS 123-R FQ1$_{f,t}$			-0.014	-1.009***
			(-0.92)	(-5.81)
Post FAS 123-R FQ2$_{f,t}$			-0.025	-1.036***
			(-1.51)	(-6.08)
Post FAS 123-R FQ3$_{f,t}$			0.012	-1.024***
			(0.71)	(-5.92)
Post FAS 123-R FQ4$_{f,t}$			0.015	-1.096***
			(0.86)	(-6.41)
High-Option Firm$_f$	-0.019		-0.019	
	(-0.99)		(-0.98)	
Log Assets$_{f,t-1}$	-0.037***	0.193***	-0.038***	0.192***
	(-6.10)	(5.83)	(-6.12)	(5.79)
Market-to-Book Ratio$_{f,t-1}$	-0.018***	0.026***	-0.018***	0.024**
	(-3.87)	(2.63)	(-3.91)	(2.37)
Leverage$_{f,t-1}$	0.127***	-0.134	0.128***	-0.124
	(3.66)	(-1.51)	(3.68)	(-1.40)
Investment/Sales$_{f,t-1}$	0.062*	-0.117	0.061*	-0.123
	(1.68)	(-1.35)	(1.65)	(-1.40)
Analyst Coverage$_{f,t}$	0.000	0.003	0.000	0.003
	(0.27)	(0.99)	(0.31)	(1.11)
Industry Fixed Effects	Yes	No	Yes	No
Fiscal-Year-End Fixed Effects	Yes	No	Yes	No
Firm Fixed Effects	No	Yes	No	Yes
Fiscal-Quarter Fixed Effects	No	Yes	No	Yes
Calendar-Quarter Fixed Effects	No	Yes	No	Yes
Obs.	11,789	11,789	11,789	11,789
Adj. R-sq.	0.028	0.008	0.029	0.010

The sample is 3,906 U.S. firms in the intersection of the Compustat and IBES databases. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level, for the four fiscal quarters before to four fiscal quarters after each firm's (staggered) FAS 123-R compliance date. We label the analysis window as [-4;+4] fiscal quarters, with option expenses recorded starting in fiscal quarter 1. Regressions are restricted to firms that are followed by at least three analysts and that are in the sample both before and after FAS 123-R. *Missed Forecast* equals 1 for fiscal quarters in which the firm's actual EPS for the fiscal quarter are below analysts' consensus (mean) estimate, and 0 otherwise. *Post FAS 123-R equals* 1 for fiscal quarters after FAS 123-R takes effect, and 0 for fiscal quarters before. *Post FAS 123-R FQ1* equals 1 for fiscal quarter 1 after FAS 123-R takes effect, and 0 for all other fiscal quarters. *Post FAS 123-R FQ2*, *Post FAS 123-R FQ3*, and *Post FAS 123-R FQ4* are defined accordingly but equal 1 in fiscal quarters 2, 3, and 4 after FAS 123-R takes effect, respectively. *High-Option Firm* equals 1 in all fiscal quarters for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, and 0 for all other firms. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

for FQ1 that contained option expenses for the first time, and investors observed high-option firms missing their forecasts and receiving recommendation downgrades. The valuation gap widened in subsequent fiscal quarters, suggesting that investors learned over time to incorporate more option grants into their valuations. At the end of FQ4, high-option firms' valuations had fallen by 0.310 relative to low-option firms, so investors required at least a year to learn about the full value impact of options. The evidence in Table 5 supports H3.

5. Accounting for confounding FAS 123-R channels

5.1. CER assumption and additional studies using FAS 123-R

5.1.1. CER assumption and FAS 123-R

When separate studies use the same natural experimental to document multiple outcomes, then each study relies on a CER assumption. Suppose that Study 1 uses FAS 123-R to obtain plausibly exogenous

Table 4
Effect of FAS 123-R on analyst recommendations.

Dependent Variable	*Analyst Rec*$_{f,t}$		*Pct. Buy Rec*$_{f,t}$		*Pct. Sell Rec*$_{f,t}$	
Estimation Window	[-4;+4] Fiscal Quarters around FAS 123-R					
	(1)	(2)	(3)	(4)	(5)	(6)
Post FAS 123-R FQ1$_{f,t}$ × *High-Option Firm*$_f$	-0.060***	-0.069***	-2.650***	-3.349***	1.100**	1.387***
	(-3.13)	(-3.73)	(-2.62)	(-3.40)	(2.51)	(3.18)
Post FAS 123-R FQ2$_{f,t}$ × *High-Option Firm*$_f$	-0.089***	-0.097***	-4.238***	-5.032***	1.657***	1.862***
	(-4.04)	(-4.45)	(-3.55)	(-4.31)	(3.29)	(3.67)
Post FAS 123-R FQ3$_{f,t}$ × *High-Option Firm*$_f$	-0.065***	-0.071***	-3.238**	-4.138***	1.340**	1.476***
	(-2.65)	(-2.98)	(-2.46)	(-3.21)	(2.46)	(2.68)
Post FAS 123-R FQ4$_{f,t}$ × *High-Option Firm*$_f$	-0.053**	-0.065**	-2.929**	-4.039***	1.293**	1.445**
	(-2.02)	(-2.52)	(-2.07)	(-2.90)	(2.16)	(2.38)
Post FAS 123-R FQ1$_{f,t}$	-0.011	0.668**	-1.050**	32.105***	-0.315	-11.434
	(-1.13)	(2.27)	(-2.09)	(4.75)	(-1.16)	(-0.84)
Post FAS 123-R FQ2$_{f,t}$	0.020*	0.666**	0.841	32.463***	-0.755**	-11.266
	(1.66)	(2.27)	(1.34)	(4.85)	(-2.26)	(-0.83)
Post FAS 123-R FQ3$_{f,t}$	0.007	0.649**	0.246	31.845***	-0.667*	-11.277
	(0.53)	(2.22)	(0.36)	(4.76)	(-1.85)	(-0.83)
Post FAS 123-R FQ4$_{f,t}$	-0.041***	0.652**	-1.969***	31.775***	-0.167	-12.139
	(-2.86)	(2.23)	(-2.61)	(4.87)	(-0.43)	(-0.89)
High-Option Firm$_f$	0.158***		8.514***		-2.548***	
	(4.83)		(5.03)		(-3.87)	
Log Assets$_{f,t-1}$	0.016	0.083**	1.210**	5.174***	-0.209	-1.786**
	(1.32)	(2.49)	(1.98)	(2.95)	(-0.70)	(-2.01)
Market-to-Book Ratio$_{f,t-1}$	0.054***	0.056***	3.112***	3.368***	-0.782***	-0.716***
	(6.66)	(6.13)	(7.56)	(6.86)	(-4.13)	(-3.47)
Leverage$_{f,t-1}$	-0.038	-0.033	-1.851	-0.323	1.655	3.404
	(-0.62)	(-0.33)	(-0.61)	(-0.07)	(1.08)	(1.00)
Investment/Sales$_{f,t-1}$	0.163***	0.110	12.139***	3.527	0.115	-0.864
	(2.67)	(1.50)	(3.85)	(1.08)	(0.08)	(-0.53)
Analyst Coverage$_{f,t}$	-0.007***	0.006**	-0.322***	0.387**	0.065	0.058
	(-3.42)	(2.11)	(-3.07)	(2.39)	(1.25)	(0.60)
Industry Fixed Effects	Yes	No	Yes	No	Yes	No
Fiscal-Year-End Fixed Effects	Yes	No	Yes	No	Yes	No
Firm Fixed Effects	No	Yes	No	Yes	No	Yes
Fiscal-Quarter Fixed Effects	No	Yes	No	Yes	No	Yes
Calendar-Quarter Fixed Effects	No	Yes	No	Yes	No	Yes
Obs.	11,820	11,820	11,820	11,820	11,820	11,820
Adj. R-sq.	0.095	0.031	0.105	0.034	0.050	0.010

The sample is 3,906 U.S. firms in the intersection of the Compustat and IBES databases. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level, for the four fiscal quarters before to four fiscal quarters after each firm's (staggered) FAS 123-R compliance date. We label the analysis window as [-4;+4] fiscal quarters, with option expenses recorded starting in fiscal quarter 1. Regressions are restricted to firms that are followed by at least three analysts and that are in the sample both before and after FAS 123-R. *Analyst Rec* is the consensus (mean) analyst stock recommendation for the fiscal quarter and ranges between 1 ("sell") and 5 ("strong buy"). *Pct. Buy Rec (Pct. Sell Rec)* is the percentage of analysts issuing a "strong buy" or "buy" ("sell" or "underperform") recommendation for the firm's stock for the fiscal quarter. *Post FAS 123-R FQ1* equals 1 for fiscal quarter 1 after FAS 123-R takes effect, and 0 for all other fiscal quarters. *Post FAS 123-R FQ2*, *Post FAS 123-R FQ3*, and *Post FAS 123-R FQ4* are defined accordingly but equal 1 in fiscal quarters 2, 3, and 4 after FAS 123-R takes effect, respectively. *High-Option Firm* equals 1 in all fiscal quarters for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, and 0 for all other firms. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

variation in variable X, and then estimates the resulting effect β_X on outcome Y_1 using a reduced-form model. In our paper, X is attention towards option expenses and Y_1 is *Missed Forecast*, *Analyst Rec*, or *Market-to-Book Ratio*. Further, suppose Study 2 shows that FAS 123-R led to a change in a different outcome Y_2. The validity of Study 1's estimates now depends on two conditions, that jointly constitute the CER: i) There must be no unobservable characteristic Z that affects both X and Y_1; ii) Y_2 must not affect Y_1. Condition i) is the standard exclusion restriction requiring FAS 123-R to affect Y_1 only through X (not through any other omitted variable). Condition ii) refers to a specific variable that is of particular concern, since Study 2 has already shown that FAS 123-R affects it.

For each study s that reuses FAS 123-R and identifies an additional outcome Y_s, the CER requires an additional condition. As the number of studies increases, it becomes progressively harder to verify whether the estimate $\hat{\beta}_X$ is a causal elasticity, or instead incorporates the simultaneous effect that any one of FAS 123-R's other outcomes Y_s may have on Y_1. Notably $\hat{\beta}_X$ is biased unless the CER conditions hold for *all* outcomes Y_s—in order for FAS 123-R to affect Y_1 only through X, no other outcome Y_s can also affect Y_1. Further, no information about the CER's validity can be gained from comparing treated and control firms' characteristics prior to FAS 123-R, because the regulation simultaneously changed treated firms in multiple ways.

5.1.2. Analysis of literature on FAS 123-R effects

HRSW briefly discuss this problem and recommend that researchers who reuse a natural experiment should *"reconcile their exclusion restrictions with existing empirical evidence"* (page 2354). They specifically advise researchers to acknowledge and discuss results from other studies. We followed this advice and searched Google Scholar for all studies

Table 5
Effect of FAS 123-R on stock market valuations.

Dependent Variable	*Market-to-Book Ratio*$_{f,t}$			
Estimation Window	[-4;+4] Fiscal Quarters around FAS 123-R			
	(1)	(2)	(3)	(4)
Post FAS 123-R$_{f,t}$ × *High-Option Firm*$_f$	-0.160***	-0.140***		
	(-3.33)	(-3.56)		
Post FAS 123-R FQ1$_{f,t}$ × *High-Option Firm*$_f$			-0.025	0.036
			(-0.53)	(0.89)
Post FAS 123-R FQ2$_{f,t}$ × *High-Option Firm*$_f$			-0.141**	-0.135***
			(-2.39)	(-2.85)
Post FAS 123-R FQ3$_{f,t}$ × *High-Option Firm*$_f$			-0.184***	-0.198***
			(-3.12)	(-4.14)
Post FAS 123-R FQ4$_{f,t}$ × *High-Option Firm*$_f$			-0.310***	-0.298***
			(-5.15)	(-5.94)
Post FAS 123-R$_{f,t}$	0.069***	1.309***		
	(4.15)	(2.76)		
Post FAS 123-R FQ1$_{f,t}$			0.133***	1.179**
			(7.67)	(2.27)
Post FAS 123-R FQ2$_{f,t}$			0.090***	1.135**
			(4.27)	(2.19)
Post FAS 123-R FQ3$_{f,t}$			0.016	1.173**
			(0.79)	(2.27)
Post FAS 123-R FQ4$_{f,t}$			0.033*	1.134**
			(1.65)	(2.20)
High-Option Firm$_f$	0.372***		0.375***	
	(3.85)		(3.89)	
Log Assets$_{f,t-1}$	-0.369***	-0.815***	-0.369***	-0.798***
	(-10.22)	(-9.46)	(-10.21)	(-9.38)
Leverage$_{f,t-1}$	-0.700***	-0.379**	-0.690***	-0.352*
	(-3.59)	(-2.04)	(-3.53)	(-1.90)
Investment/Sales$_{f,t-1}$	1.183***	0.037	1.162***	0.013
	(3.88)	(0.18)	(3.78)	(0.06)
EBITDA/Sales$_{f,t-1}$	2.701***	2.065***	2.646***	1.996***
	(4.70)	(5.54)	(4.59)	(5.38)
Analyst Coverage$_{f,t}$	0.081***	0.011***	0.082***	0.012***
	(12.59)	(3.02)	(12.63)	(3.13)
Industry Fixed Effects	Yes	No	Yes	No
Fiscal-Year-End Fixed Effects	Yes	No	Yes	No
Firm Fixed Effects	No	Yes	No	Yes
Fiscal-Quarter Fixed Effects	No	Yes	No	Yes
Calendar-Quarter Fixed Effects	No	Yes	No	Yes
Obs.	10,739	10,739	10,739	10,739
Adj. R-sq.	0.318	0.125	0.319	0.134

The sample is 3,906 U.S. firms in the intersection of the Compustat and IBES databases. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level, for the four fiscal quarters before to four fiscal quarters after each firm's (staggered) FAS 123-R compliance date. We label the analysis window as [-4,+4] fiscal quarters, with option expenses recorded starting in fiscal quarter 1. Regressions are restricted to firms that are followed by at least three analysts and that are in the sample both before and after FAS 123-R. *Market-to-Book Ratio* is measured at the end of the fiscal quarter as the market value of equity plus the book value of debt, divided by total capital. *Post FAS 123-R* equals 1 for fiscal quarters after FAS 123-R takes effect, and 0 for fiscal quarters before. *Post FAS 123-R FQ1* equals 1 for fiscal quarter 1 after FAS 123-R takes effect, and 0 for all other fiscal quarters. *Post FAS 123-R FQ2*, *Post FAS 123-R FQ3*, and *Post FAS 123-R FQ4* are defined accordingly but equal 1 in fiscal quarters 2, 3, and 4 after FAS 123-R takes effect, respectively. *High-Option Firm* equals 1 in all fiscal quarters for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, and 0 for all other firms. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

that i) contain the term "FAS 123-R", "FAS 123R", or "ASC 718" (the updated name for FAS 123-R) anywhere in their text; or ii) cite one of the first three papers that examine the regulation's effects (Skantz, 2012; Hayes et al., 2012; Cadman et al., 2013). Following BFMZ, who also conduct such a review to evaluate confounding factors affecting their natural experiment, we restrict the literature review to studies cited at least once in Google Scholar (as of July 2023). We read through each study that meets these criteria, and report in IA Table B.1 those 52 studies that empirically examine the impact of FAS 123-R on corporate financial policies.[12]

[12] Our approach is conservative as it includes any study that exploits variation in firm outcomes around FAS 123-R, even when the sample or methodology differ significantly from ours. We count 35 additional outcomes in these 52 studies. We try to compile a list that is as comprehensive and accurate as possible, but some subjective decisions were required (e.g., whether a study exploits

We structure IA Table B.1 similarly to Table B.1 of BFMZ, and categorize papers based on empirical methodology. The table provides for each study a synopsis, the proposed economic channel, the sample, whether effects are estimated separately for high- and low-option firms, and the date on which the paper was first disseminated online (ours was posted on June 9, 2016). We also map each study's analysis to one or more causal chains. HRSW recommend this as one step to address the multiple hypothesis testing problem (see IA Section F for details), and the process helps researchers to distinguish between primary and consequent effects of a natural experiment. In IA Figure F.1, we illustrate the different causal chains.

IA Table B.1 documents that FAS 123-R affected numerous firm outcomes, many of which change more among high- than low-option firms (the definition of these sets of firms varies across studies). Some outcomes may also negatively affect analyst outcomes or valuations (our Y_1 variables), so the CER may be violated in our setting. In this case, our reduced-form estimates would not identify the causal elasticity of the increased attention to option expenses. HRSW recommend that researchers reconcile their CER with potential confounding channels, but it is practically infeasible to verbally analyze all possible interactions with the outcomes in IA Table B.1. Instead, we combine reduced-form analysis and structural estimation to identify the effect of increased attention to option costs.

To implement this approach, we need to identify how FAS 123-R changed firms' economic environments. Most outcomes from IA Table B.1 can be classified into three channels, which are grounded upon different CEO pay incentives that boards adjusted in response to FAS 123-R. First, firms substituted stock options with restricted stock as FAS 123-R equalized the accounting treatment of these compensation forms. This reduced CEOs' risk-taking incentives, leading them to adopt more conservative firm policies (risk-taking channel). Second, the change in pay structure and the accelerated vesting of options at some firms due to FAS 123-R changed managerial manipulation incentives (manipulation channel). Third, option acceleration reduced retention incentives and increased CEO turnover (turnover channel).

5.2. Reduced-form analysis of possible confounding channels

5.2.1. Selecting outcomes for possible confounding channels

To examine the potentially confounding role of these three channels, we first use a two-step approach developed by BFMZ. For this approach, we select outcomes from IA Table B.1 that changed due to FAS 123-R. For the risk-taking channel, we select i) cashflow volatility (Bakke et al., 2016); ii) book leverage and cash holdings (Hayes et al., 2012); iii) segment sales concentration and stock volatility (Anderson and Core, 2018); iv) debt maturity and accruals (Chava and Purnanandam, 2010); and v) exchange rate exposure (Francis et al., 2017). For the manipulation channel, we select i) share repurchases and a dividend indicator (Golden and Kohlbeck, 2019); ii) discretionary SG&A expenses, accruals, and asset sales (Nienhaus, 2022); and iii) R&D/Capital and Capex/Capital (Ladika and Sautner, 2020). (Some papers argue that the investment measures also reflect risk-taking.) We use total and voluntary CEO turnover for the turnover channel (Jochem et al., 2018).[13]

We then construct each outcome variable for our sample firms using the original study's definition, except we replace annual with quarterly data where possible. For variables that can only be measured annually due to data limitations (e.g., CEO turnover), we estimate an annualized version of our staggered DiD model using just the final fiscal quarter in each year (FQ-1 and FQ4). Our tests should not be interpreted as replications of the original studies, as their samples and empirical methodologies differ from ours.

5.2.2. Reduced-form estimates for possible confounding channels

The first step of BFMZ's approach examines whether each selected outcome correlates with the variation in option expense visibility in our setting. To evaluate this, we repeatedly re-estimate our DiD model, each time using one of the selected outcomes as the dependent variable. The sample, the definitions of *Post FAS 123-R* and *High-Option Firm*, and the control variables are the same as in Section 4 (some outcomes are not available for all firms). The key insight of the BFMZ approach is that if the coefficient on *Post FAS 123-R* × *High-Option Firm* is small and insignificant, then the corresponding outcome did not change differentially for high- and low-option firms in our setting. This increases the likelihood that the CER condition pertaining to that outcome is not violated.

In Table 6, each row corresponds to one re-estimated model, and estimates for *Post FAS 123-R* × *High-Option Firm* are reported in columns. The tests include industry and fiscal-year-end fixed effects. We find that the interaction term is significant for two outcomes that relate to the risk-taking channels: Rows 1 to 3 indicate that *CF Volatility* and *Cash Holdings* decreased more among high- than low-option firms after FAS 123-R. IA Table A.8 reports tests with the alternative fixed effects. These regressions additionally provide some evidence for the manipulation channel (the interaction term is significant for models with *Share Repurchases*, *Disc. SGA* and *Disc. Accruals* as dependent variables). We find no evidence of a differential change in the CEO turnover variables.[14] This evidence indicates that FAS 123-R led to some additional changes among high-option firms alongside the rise in option expense visibility. However, the impact of these additional changes on recommendations or valuations is unclear. For example, a reduction in cashflow volatility could increase or decrease firm value, depending on whether the new volatility level after FAS 123-R is optimal or too conservative for shareholders. Furthermore, such additional changes may not fully explain the relative change in analyst outcomes or valuations for high-option firms.

5.2.3. Controlling for possible confounding channels

The second step of BFMZ's approach implies examining the explanatory power of the limited attention channel after accounting for FAS 123-R's additional effects. Therefore, we re-estimate the baseline DiD models in Tables 3–5, including as control variables those outcomes from Table 6 that changed differentially between high- and low-option firms. We regress analyst outcomes or valuations from quarter t on the additional controls from the same quarter, because some of FAS 123-R's additional outcomes may have occurred simultaneously with the increase in option expense visibility. (Results are highly similar using controls from quarter $t-1$.) A significant interaction term in these re-estimated models would indicate that FAS 123-R affects analyst outcomes and valuations, independently from any impact due to changes in risk-taking or manipulation. This would support our limited attention hypothesis.

variation due to FAS 123-R and thus should be listed, or instead only studies changes that happen to occur after the regulation takes effect). Also, when counting outcomes, it is not always clear whether an outcome is distinct from those identified by prior work.

[13] We exclude some outcomes that change for only a small set of firms (e.g., derivatives usage by Oil and Gas firms in Bakke et al., 2016) or for which data is not readily available. Several studies examine tertiary causal chains of FAS 123-R. These studies' hypotheses are motivated by the regulation's primary causal impact on CEO compensation incentives. For example, Chu et al. (2020) show that syndicated loan spreads decreased because firms reduced risk-taking after FAS 123-R. Because such outcomes are driven by the variables listed above, we do not analyze them further.

[14] The insignificant coefficients on investment and turnover variables may be due to methodological differences compared to the original studies. Ladika and Sautner (2020) and Jochem et al. (2018) use a 2SLS model that instruments for option acceleration, instead of a staggered DiD model comparing all high- and low-option firms.

Table 6
Effect of FAS 123-R on risk-taking, manipulation, and turnover outcomes.

Dependent Variable	Channel		*Post FAS 123-R*$_{f,t}$ × *High-Option Firm*$_f$		*Post FAS 123-R*$_{f,t}$		*High-Option Firm*$_f$		Controls	Industry Fixed Effects	Fiscal-Year-End Fixed Effects	Obs.	Adj. R-sq.
			Coeff.	*t*-stat	Coeff.	*t*-stat	Coeff.	*t*-stat					
CF Volatility$_{f,t}$	RT	(1)	-8.656***	(-5.30)	2.158	(1.59)	48.652***	(9.31)	Yes	Yes	Yes	11,771	0.515
Book Leverage$_{f,t}$	RT	(2)	0.001	(0.26)	0.001	(0.34)	-0.071***	(-5.44)	Yes	Yes	Yes	11,787	0.282
Cash Holdings$_{f,t}$	RT	(3)	-0.015***	(-2.75)	-0.000	(-0.02)	0.042***	(3.53)	Yes	Yes	Yes	11,789	0.584
Sales Concentration$_{f,t}$	RT	(4)	0.001	(0.10)	-0.000	(-0.03)	0.030*	(1.70)	Yes	Yes	Yes	2,681	0.285
Log Stock Volatility$_{f,t}$	RT	(5)	-0.016	(-0.70)	0.043***	(3.37)	0.028	(0.83)	Yes	Yes	Yes	11,769	0.423
Debt Maturity$_{f,t}$	RT	(6)	0.033	(1.35)	0.004	(0.36)	-0.068**	(-2.19)	Yes	Yes	Yes	2,069	0.293
Accruals 1$_{f,t}$	RT	(7)	0.014	(0.70)	0.005	(0.76)	-0.008	(-0.46)	Yes	Yes	Yes	11,537	0.413
Accruals 2$_{f,t}$	RT	(8)	0.004	(0.24)	-0.009	(-1.45)	0.000	(0.00)	Yes	Yes	Yes	9,475	0.432
FX Exposure$_{f,t}$	RT	(9)	-0.026	(-0.86)	0.268***	(16.05)	-0.004	(-0.15)	Yes	Yes	Yes	11,767	0.112
Share Repurchases$_{f,t}$	MA	(10)	-0.598	(-1.25)	1.058***	(2.93)	2.152***	(3.21)	Yes	Yes	Yes	10,580	0.155
Dividend Payer$_{f,t}$	MA	(11)	-0.002	(-0.21)	-0.005	(-0.95)	-0.046*	(-1.70)	Yes	Yes	Yes	11,789	0.331
Disc. SGA$_{f,t}$	MA	(12)	-0.015	(-1.40)	0.010	(1.55)	0.015	(1.40)	Yes	Yes	Yes	10,485	0.001
Disc. Accruals$_{f,t}$	MA	(13)	0.000	(0.02)	0.002***	(2.65)	-0.006*	(-1.90)	Yes	Yes	Yes	9,588	0.088
Disc. Asset Sales$_{f,t}$	MA	(14)	-0.000	(-1.20)	-0.000**	(-2.56)	-0.000	(-0.36)	Yes	Yes	Yes	7,557	0.033
R&D/Capital$_{f,t}$	RT, MA	(15)	0.001	(1.02)	0.000	(0.44)	0.006***	(4.15)	Yes	Yes	Yes	11,066	0.503
Capex/Capital$_{f,t}$	RT, MA	(16)	0.005	(1.30)	-0.000	(-0.03)	-0.017	(-1.19)	Yes	Yes	Yes	11,059	0.528
CEO Turnover$_{f,t}$	TO	(17)	0.019	(0.69)	-0.042**	(-2.44)	-0.036	(-1.45)	Yes	Yes	Yes	2,820	0.010
Vol. CEO Turnover$_{f,t}$	TO	(18)	0.005	(0.19)	-0.027*	(-1.69)	-0.024	(-1.03)	Yes	Yes	Yes	2,820	0.002

This table examines the effect of FAS 123-R on outcome variables related to the risk-taking channel (RT), the manipulation channel (MA), and the turnover channel (TO). Which channel is tested is indicated in the table. The sample is U.S. firms in the intersection of the Compustat and IBES databases for which the outcome variables are available. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level, for the four fiscal quarters before to four fiscal quarters after each firm's (staggered) FAS 123-R compliance date (except in Rows 4, 6, 17, and 18, where we use outcome variables measured at the annual level). We label the analysis window as [-4;+4] fiscal quarters, with option expenses recorded starting in fiscal quarter 1. *CF Volatility* is the standard deviation of net cashflows from operating activities over the previous 8 fiscal quarters; *Book Leverage* is debt over assets; *Cash Holdings* is cash over assets; *Sales Concentration* is the sum of the square annual sales of a firm's segments divided by the square of the firm's annual total sales; *Log Stock Volatility* is the natural logarithm of the variance of daily stock returns over the 230 trading days before the end of the fiscal quarter; *Debt Maturity* is long-term debt over total debt; *Accruals 1* and *Accruals 2* are measures of accruals; *FX Exposure* is a trade-weighted index of the real bilateral exchange rates between the U.S. dollar and the major currencies that trade freely outside of their country of issue and the currencies of several developing economies; *Share Repurchases* is open market repurchases of common stock divided by market value of equity; *Dividend Payer* is a dummy indicating whether a firm pays dividends; *Disc. SGA* is a measure of discretionary SG&A; *Disc Accruals* is a measure of discretionary accruals; *Disc Asset Sales* is a measure of discretionary asset sales; *R&D/Capital* is R&D over lagged capital; *Capex/Capital* is capex over lagged capital; *CEO Turnover* is a dummy indicating whether a firm experiences a CEO departure; and *Vol. CEO Turnover* is a dummy that indicates whether a firm experiences a voluntary CEO departure. *Sales Concentration*, *Debt Maturity*, *CEO Turnover*, and *Vol. CEO Turnover* are only available on an annual basis. All regressions control for lagged values of *Log Assets*, *Market-to-Book Ratio*, *Leverage* (not Row 2), *Investment/Sales* (not Row 15 and 16), and *Analyst Coverage* (all not reported). *Post FAS 123-R* equals 1 for fiscal quarters after FAS 123-R takes effect, and 0 for fiscal quarters before. *High-Option Firm* equals 1 in all fiscal quarters for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, and 0 for all other firms. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in the Data Appendix A.

Table 7 reports the results, using *Missed Forecast* in Column 1, *Analyst Rec* in Column 2, and *Market-to-Book Ratio* in Column 3. Each model now additionally controls for *CF Volatility* and *Cash Holdings*. We interact the additional controls with *High-Option Firm* to account for differential effects between high- and low-option firms. We include industry and fiscal-year-end fixed effects. In each column, *Post FAS 123-R* × *High-Option Firm* is statistically significant, matching the sign from the baseline tests.[15] Results using the alternative fixed effects are in IA Table A.9. In these regressions, we additionally control for *Share Repurchases*, *Disc. SGA*, and *Disc. Accruals*, and we continue to find that *Post FAS 123-R* × *High-Option Firm* is statistically significant (coefficient signs match those from the baseline).

The BFMZ analysis supports our limited attention hypothesis. FAS 123-R caused some differential changes to high- versus low-option firms besides an increase in option expense visibility, but these additional effects explain little of the change in analyst outcomes or firm values. Key advantages of the BFMZ approach are that it does not require additional modeling assumptions, and it directly incorporates evidence documented by additional studies of FAS 123-R. The approach also provides structure to the empirical analysis, by obliging researchers to carefully consider which fundamental economic parameters changed during a natural experiment. As we have shown, this process can narrow a large body of evidence about an experiment's outcomes down to a few primary channels. This makes it feasible for researchers to write down and estimate a model of the experiment's effects, as we do next.

5.3. Quantifying causal effects using structural estimation

5.3.1. Motivation for using structural estimation

Reduced-form tests of the CER possess limitations. One is that the precise sequence of FAS 123-R's outcomes is hard to determine. As such, Study 1's dependent variable Y_1 may impact some outcomes Y_s of the additional studies, instead of the other way around, biasing estimates from the second step of BFMZ's approach.[16] Another limitation

[15] The magnitudes differ slightly from the baseline estimates in Section 4, due to changes in sample size. For comparison, Table 7 reports the interaction term coefficient obtained by re-estimating the baseline tests on the revised sample (without the additional controls).

[16] For example, a CEO may adjust risk after observing a stock price decline, in which case the dependent variable *Market-to-Book Ratio* would impact controls such as *Book Leverage* in the same quarter. Such reverse causality could be avoided by using lagged values of control variables. But such tests then could not verify whether the CER holds, since they would not account for the possibility that changes in firm risk at the start of FQ1 affect firm valuations later in the same quarter.

Table 7
Effect of FAS 123-R: Controlling for risk-taking and manipulation outcomes.

Dependent Variable	*Missed Forecast*$_{f,t}$	*Analyst Rec*$_{f,t}$	*Market-to-Book Ratio*$_{f,t}$
Estimation Window	[-4;+4] Fiscal Quarters around FAS 123-R		
	(1)	(2)	(3)
Post FAS 123-R$_{f,t}$ × *High-Option Firm*$_f$	0.068***	-0.062***	-0.100**
	(3.54)	(-3.14)	(-2.01)
Post FAS 123-R$_{f,t}$	-0.004	-0.011	0.062***
	(-0.38)	(-1.01)	(3.77)
High-Option Firm$_f$	-0.045*	0.221***	0.087
	(-1.65)	(4.84)	(0.72)
Log Assets$_{f,t-1}$	-0.059***	-0.001	-0.350***
	(-7.36)	(-0.04)	(-7.79)
Market-to-Book Ratio$_{f,t-1}$	-0.015***	0.060***	
	(-3.15)	(7.42)	
Leverage$_{f,t-1}$	0.108***	-0.052	-0.287
	(3.08)	(-0.86)	(-1.56)
Investment/Sales$_{f,t-1}$	0.103***	0.220***	0.866***
	(2.86)	(3.47)	(2.96)
EBITDA/Sales$_{f,t-1}$			3.428***
			(6.09)
Analyst Coverage$_{f,t}$	0.002	-0.005**	0.068***
	(1.26)	(-2.32)	(11.01)
CF Volatility$_{f,t}$ × *High-Option Firm*$_f$	-0.000	-0.006***	0.005
	(-0.32)	(-3.85)	(1.00)
Cash Holdings$_{f,t}$ × *High-Option Firm*$_f$	0.110*	0.065	0.298
	(1.95)	(0.61)	(0.85)
CF Volatility$_{f,t}$	0.000***	0.000	0.001***
	(3.27)	(0.67)	(3.25)
Cash Holdings$_{f,t}$	-0.250***	-0.352***	1.650***
	(-5.28)	(-3.71)	(5.84)
Corresponding Estimate: Same Sample, w/o Add. Controls			
Post FAS 123-R$_{f,t}$ × *High-Option Firm*$_f$	0.066***	-0.066***	-0.161***
	(3.49)	(-3.35)	(-3.33)
Industry Fixed Effects	Yes	Yes	Yes
Fiscal-Year-End Fixed Effects	Yes	Yes	Yes
Obs.	11,769	11,715	10,714
Adj. R-sq.	0.033	0.108	0.362

This table examines the effect of FAS 123-R on missed earnings forecasts, analyst recommendations, and stock market valuations after adding control variables for alternative channels. The sample is U.S. firms in the intersection of the Compustat and IBES databases for which the outcome variables are available. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level, for the four fiscal quarters before to four fiscal quarters after each firm's (staggered) FAS 123-R compliance date. We label the analysis window as [-4;+4] fiscal quarters, with option expenses recorded starting in fiscal quarter 1. *Missed Forecast* equals 1 for fiscal quarters in which the firm's actual EPS for the fiscal quarter are below analysts' consensus (mean) estimate, and 0 otherwise. *Analyst Rec* is the consensus (mean) analyst stock recommendation for the fiscal quarter and ranges between 1 ("sell") and 5 ("strong buy"). *Market-to-Book Ratio* is measured at the end of the fiscal quarter as the market value of equity plus the book value of debt, divided by total capital. *Post FAS 123-R* equals 1 for fiscal quarters after FAS 123-R takes effect, and 0 for fiscal quarters before. *High-Option Firm* equals 1 in all fiscal quarters for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, and 0 for all other firms. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

is that when Y_1 is a market-based measure, it may incorporate market participants' unobservable expectations about FAS 123-R's additional outcomes Y_s. This could lead to omitted variable bias in either step of the BFMZ approach. Further, many outcomes Y_s contain measurement error, such as empirical proxies for pay incentives which theoretically depend on the CEO's (unobservable) utility function. Thus, if a study's CER is violated, reduced-form regressions may be insufficient to evaluate the relative importance of different economic channels.

In such cases, combining reduced-form with structural estimation can increase the credibility of results. We therefore build a model that integrates FAS 123-R's impact on pay expense visibility with simultaneous changes to CEO risk-taking and manipulation incentives. Estimation of the model allows us to quantify the prevalence of limited attention before and after FAS 123-R. Importantly, the estimation uses from Eq. (1) the reduced-form estimate of the elasticity π_1 between *Market-to-Book Ratio* and *Post FAS 123-R* × *High-Option Firm* as a data feature that the model aims to reproduce. This integration can provide useful identifying information for estimating the model parameters (Whited, 2023), and it decomposes the reduced-form estimate into the individual effects from FAS 123-R's main economic channels.

5.3.2. Summary of model setup and solution

We summarize the model setup in this subsection, and provide details, proofs, and solutions in IA Sections C and D. The model extends the dynamic principal-agent framework of MV, who derive optimal CEO pay in the presence of manipulation. A dynamic contracting model is more complex to analyze than a setting with exogenously specified compensation. Yet, it allows for CEO pay to evolve endogenously as investor attention changes due to FAS 123-R. This is necessary to disentangle the direct effect of limited attention from the indirect effects due to chang-

ing compensation incentives.[17] We also follow MV's framework since the optimal contract may encourage some manipulation, and this does not arise in other dynamic CEO pay models (e.g., Edmans et al., 2012).

The setup includes a CEO (agent) and a board (principal) who work for a firm owned by investors. In each period t, the CEO chooses effort a_t, risk σ_t, and manipulation m_t. The expected cashflow process is:

$$dY_t = (a_t\sigma_t + m_t\sigma_t - \theta M_t\sigma_t + \varpi\sigma_t^2)\,dt + \sigma_t\,dB_t,$$

where B_t is a standard Brownian motion. Risk-taking incentives are modeled in a similar spirit to Sung (1995) (for tractability, the mean and variance of the cashflow process scale with the level of risk). When the CEO chooses higher σ_t, she increases the expected value of cashflows but also amplifies the diffusion process.[18] The marginal effect of risk on (volatility-scaled) cashflows is ϖ. Following MV, M_t is the stock of accumulated manipulation between time 0 and t, and it reduces cashflows at the marginal rate θ. In this formulation, the CEO can boost immediate cashflows by increasing m_t, but in future times $t' > t$ this reduces cashflows $dY_{t'}$ through a build-up in $M_{t'}$. This stock depreciates at rate κ, so recent manipulation choices have more impact than those made in the distant past.

The CEO has exponential utility that increases with consumption c_t and decreases with cost functions for a_t, m_t, and σ_t. Following MV, the CEO works until a finite retirement date T, but continues to be paid until time $T + \tau$, where $\tau \geq 0$ is the length of time during which the board can enforce compensation clawbacks. She can also save privately, which means that the CEO consumes the full compensation provided by the contract (compensation is equal to c_t).

The model incorporates FAS 123-R by specifying that the firm is in one of three states, denoted as $g_t = \{N, E^-, E\}$: N is the non-expensing state; E^- is the interim state that begins with the announcement of the policy requiring expensing; and E is the expensing state. To capture shocks associated with either the policy's announcement or actual compliance, the firm switches from one state g_{t^-} to another state s over the time interval Δ with probability $\zeta_{g_{t^-},s}\Delta$ (t^- is the state in the period preceding time t). The extent to which the firm's market valuation impounds CEO compensation costs depends on the amount of limited attention α in the economy, which depends on the expensing state, i.e., $\alpha(g_t) \equiv \alpha_{g_t}$. We model limited attention in a reduced-form way, by focusing on its average level in the market. This can be motivated as a fraction f_{g_t} of investors who are inattentive to a fraction η_{g_t} of CEO pay, so on average the market is inattentive to a fraction $f_{g_t} \times \eta_{g_t} = \alpha_{g_t}$ of compensation costs.[19]

The board is aware of this inattention, and, accordingly, chooses compensation at each time t based on i) the incentives conveyed to the CEO; and ii) the amount of investor inattention in state g_t.[20] Formally, the board chooses a contract to maximize the firm's market valuation, which equals the expected value of cashflows net of CEO pay, both discounted at rate r. One motivation for the board's objective function is that a CEO typically sells equity as soon as it vests, so its market value at that time determines her consumption. The contract accounts for CEO incentive compatibility by eliciting optimal choices of a_t, m_t, and σ_t:

$$V(c,a,m,\sigma,g) = \mathbb{E}^{(a,m,\sigma)}\left[\int_0^\infty e^{-rt}\underbrace{\left(dY_t - c_t(1-\alpha_{g_t})\mathbf{1}_{t<T+\tau}dt\right)}_{\text{Cashflows net of CEO pay}} - \underbrace{e^{-r(T+\tau)}\frac{c_{T+\tau}}{r}(1-\alpha_{g_t})}_{\text{Post-retirement pay}}\right]$$

As in MV, the optimal contract has a general form. The CEO receives a continuous stream of payments which is sensitive to cashflow shock realizations. In the presence of manipulation, the optimal contract is nonlinear. It conveys both short- and long-term incentives, which are determined by the sensitivity of CEO payments to firm performance over different horizons. Overall, the contract resembles equity pay with time-varying vesting periods.

The model can only be solved numerically.[21] In brief, we solve for a stochastic control problem that requires keeping track of two state variables: i) The CEO's continuation utility W_t, which is the expected discounted utility that the contract provides the CEO from t to $T + \tau$; and ii) the contract's long-term incentives p_t, which are given by the expected discounted future sensitivity of W_t to cashflows (the contract's future pay-performance sensitivity, PPS). CARA preferences, the possibility of private savings, and the scalability of the cashflow process with volatility allow us to work with a single state variable $z_t \equiv -p_t/W_t$, which captures the importance of long-term incentives. A reduction in z_t ($\Delta z_t \mathbf{1}_{\Delta z_t<0}$) is equivalent to the vesting of equity incentives.

5.3.3. Model estimation

We estimate the model using SMM, which attempts to recover unknown parameters corresponding to limited attention and CEO incentives. SMM numerically searches over many possible values of these parameters, to find the combination that produces the closest possible fit between model-generated moments and moments observed in the data. The estimation period covers 1998–2009, and starts in 1998 as this was on average the first year in office for those CEOs that are in our sample at the time of FAS 123-R compliance. The estimation sample is based on the baseline sample (see Section 3.2), but further restricted to firms with available data for the entire estimation period (to reliably estimate the moments). We use annual data as we do not model cross-sectional variation in fiscal-year ends or quarterly seasonality.

We set $r = 10\%$ based on long-term average cost of capital estimates, and set CEO contract length to $T = 13$ years (average CEO tenure in our sample). The clawback period is $\tau = 1$ year, the maximum period following the release of incorrect financials that a clawback provision can be applied (Section 304 of the Sarbanes-Oxley Act). Following MV, the CARA risk aversion coefficient is $\gamma = 1$. The average transition intensity between the interim state E^- and the expensing state E is $\zeta_{E^-,E} = 0.637$ so as to match the average length of time between FAS 123-R's announcement and its compliance date among sample firms of 1.57 years.

We attempt to recover a vector of eight unknown parameters, $\nu = \{\varpi, \theta, l, \kappa, \alpha_N, \alpha_{E^-}, \alpha_E, \zeta_{N,E^-}\}$, which mostly relate to limited attention, risk-taking, and manipulation (the channels that are supported

[17] An alternative approach would be to calibrate FAS 123-R's impact on compensation incentives using observed changes to CEO pay in the data (e.g., Glover and Levine, 2017). While simpler, this approach would not account for the simultaneity or measurement error problems discussed in Section 5.3.1.

[18] This allows risk-taking to affect firm value (e.g., projects with greater risk earn higher expected cashflows, holding NPV constant, or risk management makes the firm safer but also reduces expected profits).

[19] For tractability, the model does not distinguish between different pay components, such as restricted stock or stock options. The distinction is not particularly relevant prior to FAS 123-R, since the vast majority of CEO equity pay was in the form of options. Moreover, the risk-taking channel in the model is captured in a more general way via the chosen cashflow volatility, which depends on the pay-for-performance sensitivity and risk aversion. A shift in the data from options to stocks would be revealed by a decline in cashflow volatility, which is a moment we match in the estimation. Accounting for the fixed portion of pay does not make a difference since the fixed salary would not show up in optimality conditions.

[20] Firms vocally opposed option expensing and lobbied intensely against it during the 1990s and early 2000s, especially those that relied heavily on option pay. Thus, boards appeared to believe that market participants exhibited limited attention towards compensation costs disclosed only in footnotes.

[21] In IA Section C.1, an analytical solution can be obtained in the absence of manipulation. This simpler setup yields similar results for the relationships between limited attention, risk-taking, and valuations.

in Section 5.2, yet are hard to identify using reduced-form analysis). Specifically, ν contains the marginal effect of volatility on cashflows ϖ; the marginal effect of manipulation on cashflows θ; the CEO's cost of manipulation l; the depreciation rate of accumulated manipulation κ; investor inattention during the three states (α_N, α_{E^-}, α_E); and the transition intensity between the non-expensing and interim state ζ_{N,E^-}.

To estimate these values, we choose 17 moments that are sensitive to changes to the unknown parameters in ν (IA Section C.3.3 contains definitions and motivation for each moment). To integrate the SMM estimation with our reduced-form analysis, some key moments correspond to coefficients from a regression that is similar to the one in Table 5, Column 1. The regression uses *Market-to-Book Ratio* as the dependent variable, and we estimate it in both actual data and simulated data using an annual frequency. The regression's key interaction term is labeled *Treated* $\times$ I^E. The term I^E is analogous to *Post FAS 123-R* and reflects the change from the interim state E^- to the expensing state E.[22]

Comparative statics exercises in IA Figure C.1 suggest that $\beta^{Treated\times I^E}_{M/B\ Ratio}$ —the elasticity of *Market-to-Book Ratio* to the switch from the interim to the expensing state—is sensitive to the limited attention parameter α_N, which highlights its usefulness in identification. This elasticity decreases monotonically (in absolute terms) as the limited attention parameter goes to 0. Other moments include coefficients from different regressions, where the dependent variables are based on key model outcomes (e.g., cashflow volatility or incentive duration).

5.3.4. Model estimation results

Table 8 reports the results of the structural estimation. In Panel A, we report estimates of each parameter from vector ν. The limited attention parameter is $\alpha_N = 8.6\%$ in the non-expensing state, declines to $\alpha_{E^-} = 6.2\%$ in the interim state, and equals $\alpha_E = 1.7\%$ in the expensing state (all significant at the 1% level). This indicates that investors overlooked 8.6% of CEO pay when option expenses were reported in footnotes (non-expensing state), gradually began to learn about the grants' economic costs after FAS 123-R was announced, and incorporated most costs after FAS 123-R took effect.[23]

Other parameter estimates indicate that the manipulation channel did *not* detrimentally affect cashflows. The estimates imply that $\theta < (r + \kappa)$, which means that the marginal effect of manipulation on cashflows is small relative to the speed at which the stock of manipulation depreciates (in this case manipulation does not destroy firm value in the long-term, see MV). The estimated manipulation cost parameter l equals 5.291—much larger than the value of 1 used in MV's calibration—which suggests that the CEO is deterred from manipulation because the associated cost is too high. These results are unsurprising, given that only a small fraction of firms accelerated option vesting due to FAS 123-R (Ladika and Sautner, 2020). The estimated marginal effect of volatility on cashflows ϖ is positive at 0.161 and significant.

In Panel B, we list the 17 chosen moments, and compare their values in the data to the simulated moments based on model outcomes (given the parameter estimates from Panel A). The model matches well $\beta^{Treated\times I^E}_{M/B\ Ratio}$, the regression elasticity between *Market-to-Book Ratio* and the FAS 123-R compliance dummy.[24] The model estimation shows that the market value declines 8.4% when option expensing begins (close to the 9.1% in the annual data, and consistent with Table 5). The model captures the decline in the duration of CEO incentives upon the switch to both the interim and expensing states ($\beta^{Treated\times I^{E^-}}_{z}$ and $\beta^{Treated\times I^{E}}_{z}$). The value of the moment related to the interim state, $\beta^{Treated\times I^{E^-}}_{z}$, is lower in absolute terms than the data moment, likely because CEO pay structure is more general in the model than in the data (vesting and duration of incentives in the data refer specifically to option pay). The model also does not capture the data well on $\beta^{Treated\times I^{E^-}}_{M/B\ Ratio}$; valuations increase in the data, which is not matched in the simulated moments. The persistence of profitability $\beta^{Y_{t-1}}_{Y}$ in the model is high at 0.198, but less than half its value in the data (0.543); this is expected since cashflow persistence in the model arises only through accumulated manipulation (exogenous cashflow persistence would allow for a better match to the data, but at the cost of added complexity).

In Panel C, we use three counterfactual analyses to quantify how each channel affects $\beta^{Treated\times I^E}_{M/B\ Ratio}$, the elasticity of market valuations to the start of the expensing regime. First, we shut down the manipulation channel (we set the manipulation cost l to infinity). The elasticity now falls slightly from −0.084 to −0.073, indicating that only a small part of the decline in valuations—once expensing took effect—was due to manipulation. Second, we shut down the risk-taking channel (by setting the marginal effect of volatility on cashflows ϖ close to zero). This has a greater impact on the elasticity, reducing it to −0.052; this confirms the importance of the risk-taking channel.[25] Third, when both channels are shut down, the elasticity falls further but remains large at −0.047. The combined effect is marginally smaller than the sum of the individual effects. This is because in the absence of both costly manipulation and costly risk-taking, the optimal levels of effort are higher compared to the levels chosen in the presence of either channel; hence, there is a smaller sensitivity to a change in expensing state. Overall, these results show that market valuations would have fallen almost 5% after FAS 123-R, even if boards did not adjust CEO pay.

5.4. Comparing reduced-form and structural estimation results

The results in Sections 5.2 and 5.3 are reassuring: They both show that confounding channels likely do not explain most of the decline in market valuations after FAS 123-R. The reduced-form BFMZ approach shows that valuations fell about 10% for high- relative to low-option firms, after controlling for various proxies for risk-taking and manipulation (Section 5.2.3). The estimation of the economic model shows that investors overlooked 8.6% of CEO pay expenses before FAS 123-R, and that the limited attention channel accounts for a 4.7% decline in valuations after option expensing begins (Section 5.3.4). While changes to risk-taking after FAS 123-R are an important determinant of firm value changes, consistent with Hayes et al. (2012) or Bakke et al. (2016), the limited attention channel emerges as another, quantitatively important factor. Sections 5.2 and 5.3 rely on different assumptions and possess distinct limitations. The BFMZ approach uses empirical proxies that could be measured with error, and it may not adequately capture simultaneous changes after FAS 123-R. The structural estimation uses a particular model of CEO contracting, and its results may be affected by unmodeled channels. Yet, that results are consistent across approaches is evidence that limited attention to option costs led to firms being overvalued before FAS 123-R.

[22] In the actual data, *Treated* equals 1 in all fiscal years for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in fiscal year 2004 or 2005, and 0 for all other firms. In the simulated data, all firms are identical (*Treated* equals 1 for all firms). Different from Table 5, we add to the regression the interaction term *Treated* $\times$ I^{E^-}, to provide identifying information on the transition intensity ζ_{N,E^-} and the interim-state limited attention parameter α_{E^-}.

[23] The market did not fully learn about CEO pay expenses, perhaps because firms did not have to expense previously granted options that had already vested; see Section 2.

[24] In the model, we use the market valuation as the dependent variable in these regressions. Different from the actual data, the market-to-book ratio cannot be computed, as there is no investment and capital stock in the framework we consider. However, the framework can be considered in terms of an AK technology where investment decisions have been maximized.

[25] Setting $\varpi = 0$ yields no optimal solution for the choice of volatility in the presence of manipulation, so the scenario instead considers a 99.9% decline in the ϖ parameter.

Table 8
Structural estimation: SMM estimation results.

Panel A: Parameter estimates

Parameter	α_N	α_{E^-}	α_E	ζ_{N,E^-}	l	κ	θ	ϖ
Value	0.086***	0.062***	0.017***	0.471***	5.148***	0.111***	0.130***	0.161***
	(0.000005)	(0.000001)	(0.000002)	(0.000001)	(0.00017)	(0.000004)	(0.000001)	(0.000005)

Panel B: Moments

Moment Specification	Actual	Model
$\beta^{Treated\times I^E}_{M/B\ Ratio}$	-0.091	-0.084
$\beta^{Treated\times I^E}_{CF\ Volatility}$	-0.001	0.000
$\beta^{I^E}_{\Delta z}$	0.007	-0.003
$\beta^{I^E}_{Y}$	0.011	0.000
$\beta^{Treated\times I^E}_{z}$	-0.169	-0.160
$\beta^{Treated\times I^{E^-}}_{M/B\ Ratio}$	0.283	-0.027
$\beta^{Treated\times I^{E^-}}_{CF\ Volatility}$	-0.003	-0.001
$\beta^{I^{E^-}}_{\Delta z}$	0.002	-0.001
$\beta^{I^{E^-}}_{Y}$	0.014	0.000
$\beta^{Treated\times I^{E^-}}_{z}$	-0.225	-0.033
$\beta^{Intercept}_{M/B\ Ratio}$	0.109	0.036
$\beta^{Intercept}_{CF\ Volatility}$	0.001	0.000
$\beta^{Intercept}_{Y}$	-0.002	0.000
$\beta^{Intercept}_{z}$	0.126	0.067
$\beta^{Y_{t-1}}_{Y}$	0.543	0.198
Cov(Y, z)	-0.001	0.001
Cov(M/B Ratio, CF Volatility)	0.001	0.000

Test of Overidentifying Restrictions

χ^2	5,092
p-value	0.000

Panel C: Counterfactual analysis

	$l=\infty$	99.9% decline in ϖ	$l=\infty$ and 99.9% decline in ϖ
$\beta^{Treated\times I^{E^-,E}}_{M/B\ Ratio}$	-0.073	-0.052	-0.047

This table reports parameter estimates from the SMM procedure (Panel A) and simulated moments from the model (Panel B). In Panel A, α_N, α_{E^-} and α_E are the limited attention parameters in the non-expensing state (N), interim state (E^-), and expensing state (E), respectively. ζ_{N,E^-} denotes the transition intensity from the non-expensing state (N) to the interim state (E^-), l represents the personal cost of manipulation, κ denotes the rate of depreciation of the stock of manipulation, θ captures the marginal effect of manipulation on cashflows, and ϖ captures the marginal effect of volatility on cashflows. In Panel B, regression coefficients that serve as moments are denoted by β. The dependent variables are indicated as subscripts in each β coefficient, while the independent variables are indicated with superscripts. Dependent variables in these regressions include the market-to-book ratio (*M/B Ratio*), cashflow volatility (*CF Volatility*), the vesting of incentives (Δz), operating cashflows (Y), and the duration of CEO incentives (z). The key independent variables include interaction terms between *Treated* and indicators for the expensing state (I^E) and for the interim state (I^{E^-}). In the actual data, *Treated* equals 1 in all fiscal years for firms with above-median ratio of *Fair Value of Options Granted/Total Assets* in fiscal year 2004 or 2005, and 0 for all other firms. In the simulated data, all firms are identical (*Treated* equals 1 for all firms). The superscript *Intercept* denotes the regression intercept. Standard errors are presented in parentheses (GMM standard errors using the delta method). In Panel C, we report the results of counterfactual analysis, whereby we consider the effect that each scenario regarding model parameters has on the elasticity of the market-to-book ratio to a change in the expensing state from E^- to E in the model ($\beta^{Treated\times I^E}_{M/B\ Ratio}$).

6. Relative learning speed of analysts and investors

6.1. Evidence on domain-specific analyst learning

Having established limited attention towards option costs, we return to the reduced-form setting to study how various market participants learned to overcome attention constraints. We first examine how analysts' prior experience with option expensing affected their learning around FAS 123-R. H4a and H4b predict that in a high domain-specific coverage subsample, high-option firms should *not* have experienced an increase in missed forecast frequency or downgrades after FAS 123-R, relative to low-option firms. In a low domain-specific coverage subsample, effects should be similar to Sections 4.1 and 4.2.

Table 9, Panel A, examines the impact of domain-specific experience that analysts acquired while observing voluntary adoption of option expenses prior to FAS 123-R. Such experience should have helped analysts learn about the option costs of firms complying earliest with FAS 123-R, so the tests focus on 605 firms with fiscal years ending in June to September. For each firm, we calculate the fraction of its analysts who had previously covered multiple voluntary adopters (and covered the firm for FQ1). Firms are then split into high coverage (HC) and low coverage (LC) groups depending on whether this fraction is above or below the median. Thus, the HC group contains firms that were covered by relatively many analysts who had previous experience with option expensing, while the LC group contains firms that had few analysts with prior expensing experience.[26]

[26] Testing how investors learned from voluntary adopters is difficult. To construct investor-equivalent versions of the HC and LC groups, we would need to measure the extent to which a firm's investors at the time of FAS 123-R

Table 9
Effects of domain-specific analyst learning.

	Panel A: Firms with fiscal years ending in June–Sept				Panel B: Firms with fiscal years ending in Oct–Dec			
Dependent Variable	*Missed Forecast*$_{f,t}$		*Analyst Rec*$_{f,t}$		*Missed Forecast*$_{f,t}$		*Analyst Rec*$_{f,t}$	
Sample	Previous Analyst Coverage of Voluntary Adopters				Previous Analyst Coverage of Early Compliers			
	High Coverage	Low Coverage	High Coverage	Low Coverage	High Coverage	Low Coverage	High Coverage	Low Coverage
Estimation Window	[-4;+4] Fiscal Quarters around FAS 123-R				[-4;+4] Fiscal Quarters around FAS 123-R			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post FAS 123-R$_{f,t}$ × *High-Option Firm*$_f$	-0.065	0.281***	0.017	-0.139*	0.017	0.071**	-0.054*	-0.118***
	(-0.67)	(4.07)	(0.20)	(-1.86)	(0.51)	(2.31)	(-1.67)	(-3.76)
Post FAS 123-R$_{f,t}$	-0.018	-0.106**	-0.067**	0.051	0.008	-0.005	0.005	-0.010
	(-0.47)	(-2.17)	(-2.21)	(1.11)	(0.41)	(-0.29)	(0.27)	(-0.52)
High-Option Firm$_f$	0.016	-0.203***	0.150	0.053	0.033	-0.019	0.148***	0.114**
	(0.20)	(-3.11)	(1.22)	(0.50)	(1.02)	(-0.61)	(2.99)	(2.08)
Log Assets$_{f,t-1}$	-0.032	-0.052	0.042	-0.029	-0.044***	-0.026**	0.033*	-0.015
	(-1.08)	(-1.62)	(1.14)	(-0.54)	(-4.27)	(-2.33)	(1.83)	(-0.76)
Market-to-Book Ratio$_{f,t-1}$	-0.049**	0.006	0.082**	0.124***	-0.024***	-0.017**	0.044***	0.050***
	(-2.18)	(0.28)	(2.44)	(3.48)	(-3.06)	(-2.32)	(3.12)	(4.78)
Leverage$_{f,t-1}$	0.087	0.172	-0.427*	0.219	0.086	0.103**	0.078	-0.012
	(0.51)	(1.02)	(-1.86)	(0.71)	(1.43)	(2.08)	(0.86)	(-0.14)
Investment/Sales$_{f,t-1}$	-0.593	-0.222**	0.957	-0.478	0.124	0.065	-0.054	0.211***
	(-0.67)	(-2.54)	(0.89)	(-1.33)	(0.96)	(1.54)	(-0.38)	(3.38)
Analyst Coverage$_{f,t}$	0.000	-0.006	-0.015**	-0.021**	0.000	0.000	-0.006*	-0.001
	(0.03)	(-1.43)	(-2.25)	(-2.37)	(0.14)	(0.05)	(-1.87)	(-0.39)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fiscal-Year-End Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	827	835	825	833	3,955	4,430	3,937	4,413
Adj. R-sq.	0.014	0.041	0.202	0.163	0.030	0.032	0.090	0.155

In Panel A, the sample is 605 firms with a fiscal year ending in June to September. For each firm, we measure the number of analysts who previously covered more than one voluntary adopter, divided by the total number of analysts covering the firm when it began to comply with FAS 123-R. (Voluntary adopters are firms that voluntarily adopted stock option expensing prior to FAS 123-R compliance.) Firms are split into high coverage and low coverage groups, depending on whether this ratio is above or below the sample median. In Panel B, the sample is 2,811 firms with a fiscal year ending in October to December. For each firm, we calculate the number of analysts who previously covered more than one early complier, divided by the total number of analysts covering the firm when it began to comply with FAS 123-R. Firms are split into high and low coverage groups depending on whether this ratio is above or below the sample median. In both panels, the sample contains U.S. firms in the intersection of the Compustat and IBES databases. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. In both panels, observations are at the firm-fiscal quarter level, for the four fiscal quarters before to four fiscal quarters after each firm's (staggered) FAS 123-R compliance date. We label the analysis window as [-4;+4] fiscal quarters, with option expenses recorded starting in fiscal quarter 1. Regressions are restricted to firms that are followed by at least three analysts and that are in the sample both before and after FAS 123-R. *Missed Forecast* equals 1 for fiscal quarters in which the firm's actual EPS for the fiscal quarter are below analysts' consensus (mean) estimate, and 0 otherwise. *Analyst Rec* is the consensus (mean) analyst stock recommendation for the fiscal quarter and ranges between 1 ("sell") and 5 ("strong buy"). *Post FAS 123-R* equals 1 for fiscal quarters after FAS 123-R takes effect, and 0 for fiscal quarters before. *High-Option Firm* equals 1 in all fiscal quarters for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, and 0 for all other firms. In Panel A, industry fixed effects are based on the Fama French 12-industry classification due to the limited number of observations. In Panel B, industry fixed effects are based on the Fama French 48 classification. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

In the HC group in Column 1, high-option firms did not experience an increase in *Missed Forecast* after FAS 123-R, relative to low-option firms. In contrast, in the LC group in Column 2, high-option firms experienced a large and significant rise in *Missed Forecast* (as in Table 3). All tests exclude calendar-quarter fixed effects, which absorb almost all variation in *Post FAS 123-R*. In the HC group in Column 3, high-option firms did not experience recommendation downgrades after FAS 123-R, relative to low-option firms. However, in the LC group in Column 4, high-option firms experienced downgrades (as in Table 4, but less significant due to the smaller sample). Hence, in support of H4a and H4b, analysts who acquired domain-specific experience of voluntary option expensing were able to correctly incorporate options into their forecasts and valuations of firms that complied earliest with FAS 123-R.

Panel B examines domain-specific experience that analysts acquired by covering the 605 early compliers (firms with June to September fiscal year-ends). We study how this experience impacted forecasts and recommendations for 2,811 firms that complied next (October to December fiscal year-ends).[27] For each of these 2,811 firms, we calculate the fraction of analysts who had previously covered more than one early complier (and covered the firm for FQ1). We define the HC group as firms that were covered by an above-median fraction of analysts who acquired experience with option expensing by covering early compliers.

As in Panel A, high-option firms in the HC group in Column 5 experienced no relative rise in *Missed Forecast*, which supports H4a. In contrast, in the LC group in Column 6, high-option firms experienced a relative increase. In Columns 7–8, high-option firms saw relative downgrades in recommendations in both groups, but the interaction term is almost twice as large in the LC group. This is consistent with analysts beginning to downgrade high-coverage, high-option firms before FAS 123-R, as predicted by H4b.

compliance were previously exposed to voluntary adopters elsewhere in their portfolios.

[27] We do not examine effects among firms with a fiscal year ending in January to May, which complied with FAS 123-R even later in calendar time. By the time these firms complied, most analysts had already covered the adoption of FAS 123-R by multiple firms, and little variation existed in their domain-specific experiences.

Table 10
Effects of domain-general analyst learning.

Dependent Variable	*Missed Forecast*$_{f,t}$		*Analyst Rec*$_{f,t}$	
Sample	Previous Analyst Experience		Previous Analyst Experience	
	High Coverage	Low Coverage	High Coverage	Low Coverage
Estimation Window	[-4;+4] Fiscal Quarters around FAS 123-R		[-4;+4] Fiscal Quarters around FAS 123-R	
	(1)	(2)	(3)	(4)
Post FAS 123-R$_{f,t}$ × *High-Option Firm*$_f$	0.033	0.097***	-0.039	-0.098***
	(1.21)	(3.56)	(-1.42)	(-3.49)
Post FAS 123-R$_{f,t}$	0.023	-0.026*	-0.028*	0.017
	(1.34)	(-1.75)	(-1.83)	(1.10)
High-Option Firm$_f$	0.003	-0.037	0.129***	0.189***
	(0.10)	(-1.35)	(2.68)	(4.20)
Log Assets$_{f,t-1}$	-0.035***	-0.035***	0.014	0.018
	(-3.93)	(-4.13)	(0.85)	(1.07)
Market-to-Book Ratio$_{f,t-1}$	0.136**	0.114**	0.101	-0.112
	(2.48)	(2.45)	(1.15)	(-1.29)
Leverage$_{f,t-1}$	0.070	0.058	0.204***	0.137
	(1.37)	(1.09)	(3.00)	(1.41)
Investment/Sales$_{f,t-1}$	-0.020***	-0.010	0.060***	0.049***
	(-2.98)	(-1.46)	(5.03)	(4.26)
Analyst Coverage$_{f,t}$	0.000	-0.001	-0.006**	-0.009***
	(0.22)	(-0.40)	(-2.02)	(-3.14)
Industry Fixed Effects	Yes	Yes	Yes	Yes
Fiscal-Year-End Fixed Effects	Yes	Yes	Yes	Yes
Obs.	5,694	5,983	5,671	5,953
Adj. R-sq.	0.035	0.033	0.112	0.112

The sample is 3,906 U.S. firms in the intersection of the Compustat and IBES databases. For each firm, we measure the number of years between the median analyst's first earnings forecast or stock recommendation in IBES and the analyst's last forecast or recommendation for the firm before it complied with FAS 123-R. Firms are split into high and low coverage groups depending on whether this value is above or below the sample median. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level, for the four fiscal quarters before to four fiscal quarters after each firm's (staggered) FAS 123-R compliance date. We label the analysis window as [-4;+4] fiscal quarters, with option expenses recorded starting in fiscal quarter 1. Regressions are restricted to firms that are followed by at least three analysts and that are in the sample both before and after FAS 123-R. *Missed Forecast* equals 1 for fiscal quarters in which the firm's actual EPS for the fiscal quarter are below analysts' consensus (mean) estimate, and 0 otherwise. *Analyst Rec* is the consensus (mean) analyst stock recommendation for the fiscal quarter and ranges between 1 ("sell") and 5 ("strong buy"). *Post FAS 123-R* equals 1 for fiscal quarters after FAS 123-R takes effect, and 0 for fiscal quarters before. *High-Option Firm* equals 1 in all fiscal quarters for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, and 0 for all other firms. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

IA Table A.10 examines how quickly analysts learned to incorporate options into their valuations.[28] In the HC group, high-option firms experienced recommendation downgrades in the last two fiscal quarters before FAS 123-R compliance (FQ-2 and FQ-1), relative to low-option firms. This indicates that after analysts observed the impact of FAS 123-R among early compliers, they almost immediately adjusted recommendations of other firms they covered—June fiscal year-end firms reported EPS for FQ1 around October 2005, precisely when analysts made FQ-2 recommendations for December fiscal year-end firms. In the LC group, high-option firms only experienced downgrades after complying with FAS 123-R.

6.2. Evidence on domain-general analyst learning

H5a and H5b predict that in a high domain-general experience subsample, high-option firms experienced only a small rise in missed forecasts and a small decrease in recommendations after FAS 123-R, relative to low-option firms. Table 10 tests these predictions using analysts' tenure in the sell-side industry. For each firm, we calculate the number of years that its median analyst was listed in the IBES database before FAS 123-R first took effect in mid-2005. Firms are then split into HC and LC groups depending on whether their median analyst's tenure is above or below the sample median. In the HC group in Column 1, high-option firms were 3.3 pp more likely to experience a missed forecast after FAS 123-R, relative to low-option firms. While positive, this coefficient is statistically insignificant. In contrast, in the LC group in Column 2, the relative increase in missed forecasts among high-option firms was almost three times as large and statistically significant. In Columns 3–4, high-option firms in the HC group experienced a small but marginally insignificant decline in recommendations (relative to low-option firms), while high-option firms in the LC group experienced much larger relative downgrades. The evidence supports H5a and H5b: Domain-general experience can help analysts to overcome attention constraints.

6.3. Evidence on investor learning after FAS 123-R

H6a predicts that high-option firms experienced more negative CARs after a missed forecast for FQ1 than did low-option firms. Table 11, Panel A tests this using firms whose EPS for FQ1 missed the consensus analyst forecast. It compares the average CARs of high- and low-option firms, for various trading-day windows around the announcement of these EPS. High-option firms' stocks fell by −3.72% on average on the announcement, which is slightly larger (but statistically indistinguishable) than the decline for low-option firms. Importantly, high-option firms' CARs drifted down by a further −6.27% over the [+4,+60] trading day window (approximately three months) after the announcement,

[28] We do not examine how experience with voluntary option expensing affected recommendations before FAS 123-R. Most voluntary adoption events took place two years before any firm's compliance, so analysts may have gradually adjusted recommendations (and tests would lack statistical power).

Table 11
Investor learning: Market reactions to missed and met earnings forecasts.

Panel A: Announcement of EPS for FQ1 that miss forecast			
	Pre-Announcement Period	Announcement Period	Post-Announcement Period
Estimation Window (Trading Days around Announcement):	[-20,-4]	[-3,+3]	[+4,+60]
High-Option Firms	-1.72%	-3.72%	-6.27%
Low-Option Firms	-1.12%	-2.95%	-0.33%
Δ High-Option vs. Low-Option Firms	-0.60%	-0.77%	-5.94%
	(-0.82)	(-1.16)	(-3.95)***
Obs.	828	828	815
Panel B: Announcement of EPS for FQ1 that meet forecast			
	Pre-Announcement Period	Announcement Period	Post-Announcement Period
Estimation Window (Trading Days around Announcement):	[-20,-4]	[-3,+3]	[+4,+60]
High-Option Firms	0.78%	0.95%	-5.12%
Low-Option Firms	0.36%	1.45%	-0.49%
Δ High-Option vs. Low-Option Firms	0.42%	-0.50%	-4.63%
	(0.66)	(-0.79)	(-3.32)***
Obs.	882	882	878

The table reports stock returns around various EPS announcements after FAS 123-R. Panel A examines *EA CAR* following announcements of EPS for fiscal quarter 1 that missed the consensus analyst forecast. *EA CAR* is reported for various trading-day windows around the announcement. Panel B examines *EA CAR* following announcements of EPS for fiscal quarter 1 that were between $0 and $0.05 higher than the consensus forecast. The sample is 3,906 U.S. firms in the intersection of the Compustat and IBES databases. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level. *EA CAR* is adjusted for risk using the Fama-French 3-Factor model plus momentum. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

while low-option firms' stocks fell by just −0.33%. These results indicate that investors had not fully learned about option costs before FAS 123-R, and also that learning occurred for several months after compliance.

H6b predicts that if investors learned more slowly than analysts, high-option firms would have earned more negative CARs than low-option firms after announcements of EPS that analysts had forecasted correctly. Table 11, Panel B, compares CARs of high- and low-option firms around announcements of EPS for FQ1 that were $0–$0.05 higher than the consensus forecast. On these announcements, both high- and low-option firms earned small positive CARs, consistent with investors reacting positively when firms met their forecasts. However, in the [+4,+60] trading day window after the announcement, high-option firms' CARs drifted down by −5.12%, again a much larger decline than for low-option firms.

Notably, the drift of high-option firms in Panel A is only 1.3 pp more negative than in Panel B. This indicates that investors learned slightly more from EPS announcements when analysts also made mistakes (by forecasting EPS that were too high) than when analysts had already fully learned about option expenses (and correctly forecasted EPS). IA Table A.11 further shows that high-option firms experienced no drift relative to low-option firms for EPS announcements before FAS 123-R (whether or not firms missed their forecasts).

6.4. Evidence on investor learning prior to FAS 123-R

H6c predicts that prior to FAS 123-R, investors with limited attention occasionally updated their valuations after observing an increase in shares outstanding. In Table 12, we regress *EA CAR* for fiscal quarter t on Δ *Shares Out*, the fractional change in reported shares outstanding from $t-1$ to t.[29] We estimate this relation over the [-12;-1] fiscal quarters before each firm's FAS 123-R compliance date (non-expensing regime), and over the [+1;+8] fiscal quarters after it (expensing regime).[30] We separately analyze high- and low-option firms, to examine whether changes in shares outstanding during the non-expensing regime conveyed more information about high-option firms' dilution.

In Panel A, a reported increase in shares outstanding at high-option firms during the non-expensing regime led to a negative return reaction. The market did not react to changes in shares outstanding during the expensing regime. In Panel B, effects are much smaller for low-option firms during the non-expensing regime. This evidence is consistent with H6c: Investors occasionally learned about option costs during the non-expensing regime, but inattention toward subsequent option grants led to new overvaluation.[31]

7. Conclusion

This paper integrates reduced-form and structural estimation to show that limited attention affects the decisions of sophisticated market participants and leads to long-term misvaluation. Analysts and investors reduced their valuations when firms' option compensation costs became more visible in financial statements, due to accounting standard FAS

[29] Earnings announcements include consolidated statements of operations that reports shares outstanding as of the end of the most recent fiscal quarter, and at the end of some previous fiscal quarters. Market participants usually do not receive information about shares outstanding in between earnings announcements, and changes to shares outstanding cannot be estimated accurately (Kaplan et al., 2022). We control for *Shares Repurchased* during the fiscal quarter and *Convertible Debt/Assets* at the start of the quarter, as both variables can affect the number of shares outstanding. *Stock Return* controls for previously available information that investors could use to forecast option exercises.

[30] Cai et al. (2008) test a similar hypothesis as H6c, by examining the CARs of portfolios of firms with high and low forecasted option exercises. We differentiate by examining the market's reaction to new information about dilution, and also by using a longer estimation window for the expensing regime.

[31] IA Table A.12 shows that investors repeatedly overvalued individual high-option firms during the non-expensing regime. The market reacted negatively to information about new dilution before FAS 123-R, even after accounting for prior changes in shares outstanding at the same firm.

Table 12
Option-related return dynamics: Non-expensing vs. expensing regime.

	Panel A: High-option firms		Panel B: Low-option firms	
Dependent Variable	$EA\ CAR_{f,t}$	$EA\ CAR_{f,t}$	$EA\ CAR_{f,t}$	$EA\ CAR_{f,t}$
Estimation Window	[-12;-1] Fiscal Quarters before FAS 123-R	[+1;+8] Fiscal Quarters after FAS 123-R	[-12;-1] Fiscal Quarters before FAS 123-R	[+1;+8] Fiscal Quarters after FAS 123-R
	(1)	(2)	(3)	(4)
Δ *Shares Out*$_{f,t}$	-0.092***	0.024	-0.051***	-0.019
	(-5.24)	(1.26)	(-3.25)	(-0.72)
Log Assets$_{f,t-1}$	-0.004**	0.004***	0.001*	0.002**
	(-2.47)	(3.39)	(1.66)	(2.52)
Market-to-Book Ratio$_{f,t-1}$	-0.007***	-0.001	-0.003***	-0.001
	(-7.75)	(-1.40)	(-3.27)	(-0.94)
Leverage$_{f,t-1}$	0.013	-0.012	0.002	-0.017**
	(1.24)	(-1.23)	(0.37)	(-2.28)
Investment/Sales$_{f,t-1}$	-0.008	-0.005	0.004	-0.011
	(-1.14)	(-0.84)	(0.41)	(-1.06)
Shares Repurchased$_{f,t}$	0.644***	0.402**	0.103	0.247***
	(3.49)	(2.29)	(1.12)	(2.59)
Convertible Debt/Assets$_{f,t-1}$	-0.011	-0.010	-0.028**	0.022
	(-0.65)	(-0.65)	(-2.25)	(1.39)
Stock Return$_{f,t-1}$	-0.023***	-0.020***	-0.022***	-0.023***
	(-4.63)	(-3.11)	(-4.35)	(-2.96)
Industry Fixed Effects	Yes	Yes	Yes	Yes
Fiscal-Year-End Fixed Effects	Yes	Yes	Yes	Yes
Obs.	12,734	8,889	13,858	8,794
Adj. R-sq.	0.016	0.006	0.007	0.008

Panel A examines the market reaction to changes in shares outstanding among high-option firms, while Panel B examines the reaction among low-option firms. High-option firms are firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, while all other firms are low-option firms. The sample is 3,906 U.S. firms in the intersection of the Compustat and IBES databases. The sample excludes financials and utilities, firms that voluntarily adopted option expensing, and firms that changed their fiscal year-end in 2005 or 2006. Observations are at the firm-fiscal quarter level, for the 12 fiscal quarters before to eight fiscal quarters after each firm's (staggered) FAS 123-R compliance date. We use separate analysis windows of [-12,-1] fiscal quarters before FAS 123-R and [+1,+8] fiscal quarters after FAS 123-R, with option expenses recorded starting in fiscal quarter 1. *EA CAR* is the cumulative abnormal daily stock return in a [-3;+3] day window around firms' quarterly earnings announcements, which typically report total shares outstanding as of the end of the most recent fiscal quarter. Stock returns are adjusted for risk using the Fama-French 3-Factor model plus momentum. Δ *Shares Out* is the fractional change in the number of shares outstanding from the end of the previous quarter to the end of the current quarter. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Variable definitions are in Data Appendix A.

123-R. FAS 123-R required firms to expense option pay in their income statements, but information about the grants had previously been disclosed in statement footnotes. Market participants' responses to this change indicate that option costs were underestimated, and firms were overvalued, before FAS 123-R. This is consistent with theoretical predictions that information visibility affects market valuations. Experienced analysts incorporated option costs into their forecasts and ratings before FAS 123-R took effect. Investors incorporated option grants after FAS 123-R, but they learned more slowly than analysts. As we reuse the FAS 123-R setting, we address alternative channels within reduced-form regressions and through structural estimation.

CRediT authorship contribution statement

Henrik Cronqvist: Conceptualization. **Tomislav Ladika:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Elisa Pazaj:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Zacharias Sautner:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

Henrik Cronqvist
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Data Appendix A. Variable definitions

Variable	Definition	Data Source
1. FAS 123-R compliance variables		
Post FAS 123-R	Dummy variable that equals 1 for fiscal quarters after FAS 123-R takes effect, and 0 for quarters before. In IA Table A.3 only, the variable equals 1 for the fiscal year after FAS 123-R takes effect, and 0 for the fiscal year before.	Compustat
Post FAS 123-R FQ1	Dummy variable that equals 1 for the first fiscal quarter (FQ1) after FAS 123-R takes effect, and 0 for all other quarters. *Post FAS 123-R FQ2*, *Post FAS 123-R FQ3*, and *Post FAS 123-R FQ4* are defined accordingly but equal 1 in FQ2, FQ3, and FQ4 after FAS 123-R takes effect, respectively.	Compustat
Pre FAS 123-R FQ-1	Dummy variable that equals 1 for last fiscal quarter (FQ-1) before FAS 123-R takes effect, and 0 for fiscal quarters −8 through −5. *Pre FAS 123-R FQ-2*, *Pre FAS 123-R FQ-3*, and *Pre FAS 123-R FQ-4* are defined accordingly but equal 1 in FQ-2, FQ-3, and FQ-4 before FAS 123-R takes effect, respectively.	Compustat
Post Placebo	Dummy variable that equals 1 for the fifth through eight fiscal quarters of a placebo analysis window, and 0 for the first through fourth fiscal quarters. Placebo analysis windows are various periods of eight fiscal quarters that precede each firm's actual FAS 123-R compliance date.	Compustat
2. Earnings, compensation expense, and sales variables		
EPS	Diluted earnings per share realized during a fiscal quarter. For GAAP earnings, it is Compustat data item EPSFXQ. For *pro forma* earnings, it is the value of IBES data item VALUE when IBES data item MEASURE equals "EPS". IBES data items are from the Detail History-Actuals table, with Periodicity restricted to "QTR". IBES excludes option expenses from *pro forma* earnings only when the majority of the firm's analysts also do so in their forecasts. The measure is scaled by common shares outstanding and stock options. This variable is winsorized at the 2.5% level.	Compustat / IBES
EBIT/Share	Operating income (earnings before interest and taxes) realized during a fiscal quarter, divided by the number of shares outstanding from the start of the fiscal year. For GAAP earnings, operating income is Compustat data item OIADPQ. For *pro forma* earnings, operating income is the value of IBES data item VALUE when IBES data item MEASURE equals "EBI". IBES data items are from the Detail History-Actuals table, with Periodicity restricted to "QTR". For both types of earnings, shares outstanding is Compustat data item CSHO. This variable is winsorized at the 2.5% level.	Compustat / IBES
Comp. Expense/Share	The annual accounting expense from total equity compensation to employees, scaled by the number of shares outstanding. Prior to FAS 123-R compliance, the numerator equals the compensation expense associated with stock grants (Compustat data item STKCO). After FAS 123-R compliance, the numerator equals this value plus an estimate of the expense associated with stock option grants. We estimate option expenses because data item STKCO excludes employee stock option plans, and expenses associated with option grants are not directly reported in Compustat after FAS 123-R. Following accounting rules, we estimate option expenses as the grant-date fair value of annual option grants to employees (data item OPTFVGR) pro-rated over each grant's vesting period. We assume a three-year linear vesting period for all grants. Therefore, option expenses equal one third of the fair value of options granted in the year after FAS 123-R compliance, one third of the fair value granted in the year before FAS 123-R compliance, and one third of the fair value granted two years before FAS 123-R compliance. Estimation can only be done annually, because Compustat does not report quarterly data on option grants prior to FAS 123-R. Winsorized at the 2.5% level.	Compustat
Sales/Share	Sales revenue realized during a fiscal quarter, divided by the number of shares outstanding from the start of the fiscal year. For GAAP earnings, sales is Compustat data item SALEQ. For *pro forma* earnings, sales is the value of IBES data item VALUE when IBES data item MEASURE equals "SAL". IBES data items are from the Detail History-Actuals table, with Periodicity restricted to "QTR". For both types of earnings, shares outstanding is Compustat data item CSHO. This variable is winsorized at the 2.5% level.	Compustat / IBES
3. Analyst variables		
Missed Forecast	Dummy variable that equals 1 for fiscal quarter t if the firm's EPS for the quarter are below analysts' consensus EPS forecast, and 0 otherwise. EPS are the value of IBES data item VALUE when IBES data item MEASURE equals "EPS" (from the Detail History-Actuals table with Periodicity restricted to "QTR"). The consensus EPS forecast is the mean value of individual analysts' estimates of EPS for fiscal quarter t. It is the value of IBES data item MEANEST when IBES data item MEASURE equals "EPS" (from the Summary History-Summary Statistics table with Periodicity restricted to "QTR" and Forecast Period Indicator restricted to "Quarter 1"). Throughout the paper, the consensus EPS forecast for fiscal quarter t is measured as the most recent consensus prior to the announcement of EPS for fiscal quarter t, which usually occurs during the middle of fiscal quarter $t+1$. Before identifying the most recent consensus, we first exclude consensus estimates that are reported i) less than 3 days before the EPS announcement; ii) more than 90 days before the EPS announcement; iii) more than 30 days before the end of fiscal quarter t; or iv) more than 60 days after the end of fiscal quarter t.	IBES
Analyst Coverage	Number of analysts whose individual forecasts are included in the consensus EPS forecast (for regressions with *Missed Forecast* as dependent variable) or whose individual recommendations are included in the consensus recommendation for a stock (for regressions with *Analyst Rec*, *Pct. Buy Rec*, or *Pct. Sell Rec* as dependent variable) for fiscal quarter t. The number of forecasts is the value of IBES data item NUMEST when IBES data item MEASURE equals "EPS" (from the Summary History-Summary Statistics table with Periodicity restricted to "QTR" and Forecast Period Indicator restricted to "Quarter 1"). The number of recommendations is the value of IBES data item NUMREC from the Recommendations-Summary Statistics (Consensus Recommendations) table, measured on the same date as the consensus recommendation.	IBES
Analyst Rec	Consensus analyst recommendation for a stock for fiscal quarter t. The consensus recommendation is the mean value of individual analysts' stock recommendations. It is IBES data item MEANREC from the Recommendations-Summary Statistics (Consensus Recommendations) table. The variable ranges between 1 ("sell") and 5 ("strong buy"); this is the inverse of the original values in IBES. Throughout the paper, the consensus recommendation for fiscal quarter t is measured on the same date as the consensus EPS forecast. Thus, it is the most recent consensus prior to the announcement of EPS for fiscal quarter t, which usually occurs during the middle of fiscal quarter $t+1$.	IBES
Pct. Buy Rec	Percentage of analysts issuing a "strong buy" or "buy" recommendation for the firm's stock for fiscal quarter t. It is IBES data item BUYPCT from the Recommendations-Summary Statistics (Consensus Recommendations) table, measured on the same date as the consensus recommendation.	IBES
Pct. Sell Rec	Percentage of analysts issuing a "sell" or "underperform" recommendation for the firm's stock for fiscal quarter t. It is IBES data item SELLPCT from the Recommendations-Summary Statistics (Consensus Recommendations) table, measured on the same date as the consensus recommendation.	IBES

(*continued on next page*)

Variable	Definition	Data Source
Forecast Error	Analysts' consensus EPS forecast minus a firm's EPS for fiscal quarter t, scaled by the absolute value of the consensus EPS forecast. The consensus EPS forecast is the value of IBES data item MEANEST when IBES data item MEASURE equals "EPS" (from the Summary History-Summary Statistics table with Periodicity restricted to "QTR" and Forecast Period Indicator restricted to "Quarter 1"). EPS are the value of IBES data item VALUE when IBES data item MEASURE equals "EPS" (from the Detail History-Actuals table, with Periodicity restricted to "QTR"). Winsorized at the 1% level.	Compustat / IBES
Earnings Surprise	Dummy variable that equals 1 for fiscal quarter t if the firm's EPS are above analysts' consensus EPS forecast by more than $0.001, and 0 otherwise. The consensus EPS forecast is the value of IBES data item MEANEST when IBES data item MEASURE equals "EPS" (from the Summary History-Summary Statistics table with Periodicity restricted to "QTR" and Forecast Period Indicator restricted to "Quarter 1"). EPS are the value of IBES data item VALUE when IBES data item MEASURE equals "EPS" (from the Detail History-Actuals table, with Periodicity restricted to "QTR").	Compustat / IBES
4. Option variables		
High-Option Firm	Dummy variable that equals 1 in each fiscal quarter t for firms with an above-median ratio of *Fair Value of Options Granted/Total Assets* in either fiscal year 2004 or fiscal year 2005, and 0 for all other firms. *Fair Value of Options Granted* is the annual Black-Scholes value of stock options granted to employees during the fiscal year (Compustat data item OPTFVGR). *Total Assets* is data item AT, measured at the end of the fiscal year.	Compustat
5. Firm valuation variables		
Market-to-Book Ratio	Market value of equity (Compustat data items PRCCQ x CSHOQ) plus the book value of total debt (data item LTQ), all divided by total assets (data item ATQ). Measured at the end of each fiscal quarter t. Winsorized at the 2.5% level.	Compustat
EA CAR	Cumulative abnormal return (CAR) around the announcement of EPS for fiscal quarter t, measured over various trading-day windows. CARs are calculated using Eventus Basic Event Study (Daily) from Wharton Research Data Services. Daily stock returns are from CRSP, and are adjusted for risk using the Fama-French 3-Factor model plus momentum. Factor loadings are calculated over a period of 255 trading days (approximately one year) before each EPS announcement, which ends 20 trading days (approximately one month) before the announcement. Firms with fewer than 60 daily returns over this period are excluded. The earnings announcement date is IBES data item ANNDATS from the Detail History-Actuals table.	CRSP, IBES
6. Firm characteristics		
Log Assets	The natural logarithm of 0.001 plus total assets (Compustat data item ATQ). Winsorized at the 2.5% level.	Compustat
Leverage	Book value of debt (Compustat data items DLTTQ + DLCQ) divided by total assets (data item ATQ), all measured in fiscal quarter t. Winsorized at the 2.5% level.	Compustat
Investment/Sales	Capital expenditures plus R&D spending (Compustat data items CAPXQ + XRDQ) for fiscal quarter t divided by sales (data item SALEQ) for fiscal quarter $t-1$. Missing values of XRDQ are set to 0. Winsorized at the 2.5% level.	Compustat
EBITDA/Sales	EBITDA (Compustat data items SALEQ – COGSQ – XSGAQ) for fiscal quarter t divided by annual sales (data item SALE) for the previous fiscal year. Winsorized at the 2.5% level.	Compustat
Δ *Shares Out*	The difference between common shares outstanding at the end of fiscal quarter t and shares outstanding at the end of fiscal quarter $t-1$, divided by shares outstanding at the end of fiscal quarter $t-1$. Common shares outstanding is Compustat data item CSHOQ, adjusted for stock splits using data item AJEXQ. Winsorized at the 1% level.	Compustat
Shares Repurchased	The number of common shares repurchased during fiscal quarter t, divided by the number of common shares outstanding at the end of fiscal quarter $t-1$. Common shares repurchased is the value of total share repurchases in fiscal quarter t (Compustat data item PRSTKCQ) minus the value of preferred share repurchases in fiscal quarter t, divided by the average share price in fiscal quarter t. Preferred share repurchases is the year-to-date value of data item PRSTKPCY for fiscal quarter t minus the year-to-date value of PRSTKPCY for fiscal quarter $t-1$. PRSTKPCY is set to 0 when it is missing. The average share price is the mean of the stock price at end of fiscal quarter t and stock price at end of fiscal quarter $t-1$. The stock price is data item PRCCQ, adjusted for stock splits using data item AJEXQ. Common shares outstanding is Compustat data item CSHOQ, adjusted for stock splits using data item AJEXQ. Winsorized at the 1% level.	Compustat
Convertible Debt/Assets	The amount of long-term debt that is convertible to common or preferred shares (Compustat data item DCVT), divided by total assets (data item AT), all measured at the end of the fiscal year. Compustat does not contain data on convertible debt at the fiscal quarter level. This variable is set to 1 for any values that are above 1.	Compustat
Stock Return	The stock price at the end of fiscal quarter t plus dividends per share paid during fiscal quarter t, minus the stock price at the end of fiscal quarter $t-1$, divided by the stock price at the end of fiscal quarter $t-1$. The stock price is Compustat data item PRCCQ, adjusted for stock splits using data item AJEXQ. Dividends per share is data item DVPSXQ. Winsorized at the 2.5% level.	Compustat
Avg. Δ *Shares Out*	The mean of Δ *Shares Out* measured over fiscal quarters $t-1$ through $t-8$.	Compustat
7. Additional outcomes of FAS 123-R		
CF Volatility	The standard deviation of net cashflows from operating activities (Compustat data item OANCFQ) measured over fiscal quarters $t-1$ through $t-8$. Outcome is from Bakke et al. (2016). Winsorized at the 2.5% level.	Compustat
Book Leverage	Book value of debt (Compustat data items DLTTQ + DLCQ) divided by total assets (data item ATQ), all measured in fiscal quarter t. Outcome is from Hayes et al. (2012). Winsorized at the 2.5% level.	Compustat
Cash Holdings	Cash and short-term investments (Compustat data item CHEQ) divided by total assets (data item ATQ), all measured in fiscal quarter t. Outcome is from Hayes et al. (2012). Winsorized at the 2.5% level.	Compustat
Sales Concentration	The sum of squared annual sales for each of a firm's operating segments in fiscal year t, divided by the squared total annual sales of the firm. Annual sales for a segment is Compustat data item SALES, from the Segments-Historical table with Segment Type restricted to "BUSSEG". Total annual sales is the sum of data item SALES for all segments in fiscal year t. Compustat does not contain data on segment sales at the fiscal quarter level. Outcome is from Anderson and Core (2018). Winsorized at the 2.5% level.	Compustat
Log Stock Volatility	The natural logarithm of the variance of daily stock returns (CRSP data item RET from the Daily Stock File table). The variance is measured over the 120 trading days before the end of fiscal quarter t. Outcome is from Anderson and Core (2018). Winsorized at the 2.5% level.	CRSP
Debt Maturity	Long-term debt (Compustat data items DLTT − DD2 − DD3) divided by total debt (data items DLTT + DLC), all for fiscal quarter t. Outcome is from Chava and Purnanandam (2010). Winsorized at the 2.5% level.	Compustat
Accruals 1	The absolute value of the scaled difference between accounting income and operating cashflows. The scaled difference is measured as (Compustat data items IBCQ − OANCFQ + XIDOCQ) for fiscal quarter t divided by SALEQ for fiscal quarter $t-1$. Outcome is from Chava and Purnanandam (2010). Winsorized at the 2.5% level.	Compustat

Variable	Definition	Data Source
Accruals 2	The absolute value of total accruals based on balance sheet data. Total accruals is measured as (quarterly change in Compustat data item ACTQ) − (quarterly change in CHEQ) − (quarterly change in LCTQ) + (quarterly change in DLCQ) + (quarterly change in DLCQ) − DPQ for fiscal quarter t, all divided by SALEQ for fiscal quarter $t-1$. Each quarterly change is measured as the value of the data item for fiscal quarter t minus the value of the data item for fiscal quarter $t-1$. Outcome is from Chava and Purnanandam (2010). Winsorized at the 2.5% level.	Compustat
FX Exposure	The absolute value of the beta between a firm's daily stock returns and changes to an index of currency exchange rates. Daily stock returns are based on continuous compounding, and measured as the natural logarithm of (CRSP data item PRC for day d divided by PRC for day $d-1$), where PRC is from the Daily Stock File table. These returns are winsorized at the 1% level. The currency exchange rate index is the Federal Reserve Nominal Broad Dollar Index, a trade-weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of major U.S. trading partners. It is published at *https://www.federalreserve.gov/releases/h10/summary/*. Daily index values are only published in nominal terms. We measure changes to the index as the natural logarithm of (index value for day d divided by index value for day $d-1$). Next, for each firm and fiscal quarter t, an OLS regression is estimated with daily stock returns as dependent variable and changes in the currency exchange index as explanatory variable. Each regression is estimated using data for 120 trading days before the end of fiscal quarter $t-1$. Beta is the regression coefficient on changes in the currency exchange index. It is set to missing when the regression has 20 or fewer observations. Outcome is from Francis et al. (2017). Winsorized at the 2.5% level.	Federal Reserve, CRSP
Share Repurchases	Open market purchases of common stock divided by the market value of equity (Compustat data items PRCCQ × CSHOQ), measured in fiscal quarter t. Open market purchases is data item PRSTKCQ minus preferred stock redemptions. Preferred stock redemptions are the difference between data item PSTKRQ in fiscal quarter $t-1$ and PSTKRQ in fiscal quarter t, with the difference set to 0 when negative. Outcome is from Golden and Kohlbeck (2019). Winsorized at the 2.5% level.	Compustat
Dividend Payer	Dummy variable that equals 1 in fiscal quarter t for firms with positive dividend payments, and 0 for all other firms. Dividend payments are Compustat data item DVPSXQ. Outcome is from Golden and Kohlbeck (2019).	Compustat
Disc. SGA	The residual from an OLS regression that models non-discretionary SG&A spending. SG&A spending is Compustat data item XSGAQ for fiscal quarter t divided by data item ATQ for fiscal quarter $t-1$. The determinants of SG&A spending are i) scaled assets, measured as 1 divided by data item ATQ for fiscal quarter $t-1$; ii) log market value, measured as the natural logarithm of data items PRCCQ × CSHOQ for fiscal quarter t; iii) Tobin's Q, measured as data items (PRCCQ × CSHOQ + PSTKQ + DLCQ + DLTTQ) divided by ATQ, all measured in fiscal quarter t; iv) internal funds, measured as data items (DPQ + IBQ + XRDQ) for fiscal quarter t divided by ATQ for fiscal quarter $t-1$; v) the quarterly change in sales, measured as data items (SALEQ for fiscal quarter t − SALEQ for fiscal quarter $t-1$), divided by ATQ for fiscal quarter $t-1$; and vi) the quarterly decrease in sales, measured as the quarterly change in sales when SALEQ for fiscal quarter t is smaller than SALEQ for fiscal quarter $t-1$, and 0 otherwise. Missing values of XRDQ are set to 0. The OLS regression has observations at the firm-fiscal quarter level, and is estimated separately for each 2-digit SIC industry and each fiscal quarter t. SG&A spending is the dependent variable and the determinants of SG&A spending are explanatory variables. The residual is calculated separately for each regression, as the difference between each firm's SG&A spending for fiscal quarter and the linear prediction of SG&A spending. Outcome is from Nienhaus (2022). Winsorized at the 2.5% level.	Compustat
Disc. Accruals	The match-adjusted residual from an OLS regression that models non-discretionary total accruals. Total accruals is (quarterly change in Compustat data item ACTQ) − (quarterly change in CHEQ) − (quarterly change in LCTQ) + (quarterly change in DLCQ) − DPQ for fiscal quarter t, all divided by ATQ for fiscal quarter $t-1$. Each quarterly change is measured as the value of the data item for fiscal quarter t minus the value of the data item for fiscal quarter $t-1$. The determinants of total accruals are i) scaled assets, measured as 1 divided by data item ATQ for fiscal quarter $t-1$; ii) the quarterly change in sales, measured as data items (SALEQ for fiscal quarter t − SALEQ for fiscal quarter $t-1$), divided by ATQ for fiscal quarter $t-1$; and iii) property, plant, and equipment, measured as data item PPENTQ for fiscal quarter t divided by ATQ for fiscal quarter $t-1$. The OLS regression has observations at the firm-fiscal quarter level, and is estimated separately for each 2-digit SIC industry and each fiscal quarter t. Total accruals is the dependent variable and the determinants of total accruals are explanatory variables. The residual is calculated separately for each regression, as the difference between each firm's total accruals and the linear prediction of total accruals. Outcome is from Nienhaus (2022). Next, each firm-fiscal quarter t observation is matched to another firm in the same 2-digit industry with the closest return on assets in fiscal quarter t. Return on assets is measured as data item NIQ for fiscal quarter t divided by ATQ for fiscal quarter $t-1$. The match-adjusted residual is the difference between the residuals of the two observations. Winsorized at the 2.5% level.	Compustat
Disc. Asset Sales	The residual from an OLS regression that models non-discretionary gains from asset sales. Gains from asset sales is −1 × Compustat data item SPPIVQ for fiscal quarter t, divided by ATQ for fiscal quarter $t-1$. The determinants of gains from asset sales are i) scaled assets, measured as 1 divided by data item ATQ for fiscal quarter $t-1$; ii) log market value, measured as the natural logarithm of data items PRCCQ × CSHOQ for fiscal quarter t; iii) Tobin's Q, measured as data items (PRCCQ × CSHOQ + PSTKQ + DLCQ + DLTTQ) divided by ATQ, all measured in fiscal quarter t; iv) internal funds, measured as data items (DPQ + IBQ + XRDQ) for fiscal quarter t divided by ATQ for fiscal quarter $t-1$; v) sales of long-lived assets, measured as data item SPPEQ for fiscal quarter t divided by ATQ for fiscal quarter $t-1$; and vi) sales of long-lived investments, data item SIVQ for fiscal quarter t divided by ATQ for fiscal quarter $t-1$. The OLS regression has observations at the firm-fiscal quarter level, and is estimated separately for each 2-digit SIC industry and each fiscal quarter t. Gains from asset sales is the dependent variable and the determinants of gains from asset sales are explanatory variables. The residual is calculated separately for each regression, as the difference between each firm's gains from asset sales and the linear prediction of gains from asset sales. Outcome is from Nienhaus (2022). Winsorized at the 2.5% level.	Compustat
R&D/Capital	R&D spending (Compustat data item XRDQ) for fiscal quarter t divided by total capital at the end of the previous fiscal year. Total capital is Compustat data item PPENT + Peters and Taylor Total Q data item K_INT. Missing values of XRDQ are set to 0. Outcome is from Ladika and Sautner (2020). Winsorized at the 2.5% level.	Compustat, Peters and Taylor Total Q
Capex/Capital	Capital expenditures (Compustat data item CAPXQ) for fiscal quarter t divided by total capital at the end of the previous fiscal year. Total capital is Compustat data item PPENT + Peters and Taylor Total Q data item K_INT. Outcome is from Ladika and Sautner (2020). Winsorized at the 2.5% level.	Compustat, Peters and Taylor Total Q
CEO Turnover	Dummy variable that equals 1 if a firm experiences a CEO departure during fiscal year t, and 0 for all other firm-fiscal year observations. A turnover event occurs in year t when an executive is at the firm at the end of year $t-1$, but not at the end of year t. The measure excludes departures of interim or acting CEOs and executives who are not actively involved in the firm's management, such as former or emeritus CEOs. The measure is only available at the annual level. Outcome is from Jochem et al. (2018).	ExecuComp, BoardEx

(*continued on next page*)

Variable	Definition	Data Source
Vol. CEO Turnover	Dummy that equals 1 if a firm experiences a voluntary CEO departure during fiscal year *t*, and 0 for all other firm-fiscal year observations. For ExecuComp firms, voluntary CEO departures are all CEO departure that are not listed in the CEO Turnover Database constructed by Jenter and Kanaan (2015) and Peters and Wagner (2014). For BoardEx firms, the variable is extrapolated using a predictive model for forced CEO turnover, which is described in the Appendix of Jochem et al. (2018). Outcome is from Jochem et al. (2018)	Jochem et al. (2018), CEO Turnover Database

Appendix B. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jfineco.2024.103811.

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