Measuring Disclosure Investment Strategy: A Data Envelopment Analysis Approach†

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MEASURING DISCLOSURE INVESTMENT STRATEGY: A DATA ENVELOPMENT ANALYSIS APPROACH

Abstract

This paper develops a measure of disclosure investment strategy using data envelopment analysis (DEA) to apply a production formulation to firms' investments in mandatory and voluntary disclosures. Conceptually, the "disclosure production" of a firm consists of a variety of disclosure choices (as the production inputs) corresponding to a variety of outcomes of disclosure (as the production outputs). In our setting, the primary advantage of DEA is that it allows us to incorporate multiple disclosure inputs in the estimation (e.g., press releases, earnings forecasts), allowing firms to select a portfolio of disclosures that maximizes the aggregate benefits of those disclosures on their information environment. We find that the resulting measures of disclosure investment strategy vary predictably with proxies for both costs and benefits of disclosure and yield new evidence on variation in disclosure investments around changes in proprietary costs, seasoned equity offerings, and securities class action lawsuits.

Keywords: *data envelopment analysis; investment; voluntary disclosure; mandatory disclosure; proprietary costs; equity issuance; lawsuit*

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1 Introduction

An extensive literature examines how firms' disclosure choices vary in response to proposed costs and benefits of revealing information (see Beyer et al., 2010 for a review of this literature). The majority of these studies focus on a single aspect of either mandatory disclosure, such as the length of a firms' annual 10-K report filed with the U.S. Securities and Exchange Commission (SEC), or on a single voluntary disclosure medium, such as management earnings forecasts, in conducting their empirical tests. Further, the recent availability of new datasets has broadened the focus of this literature to include an array of new disclosure formats, including firm-initiated press releases and textual features of firms' annual reports, among others. The upshot from this literature is that while we have evidence on firms' use of various forms of disclosure in partial equilibrium settings, our understanding of how firms structure their portfolio of disclosures across multiple mediums to optimize the benefits of their *overall* disclosure strategy remains limited.

One challenge in understanding and analyzing firms' disclosure practices is the wide discretion that firms have in providing disclosures. For voluntary disclosures, firms must decide both *whether* to provide the disclosure and if so, *how much* information to provide. For example, management earnings forecasts could include just earnings per share (EPS) or could include other economically meaningful figures, such as revenue or long-term earnings growth forecasts. Mandatory disclosures are by definition required, but the firm has discretion as to how much information to provide. For example, risk factor disclosures in the 10-K can be substantive and provide information to users or they can be boilerplate.

This set of managerial choices, which we term *disclosure investment strategy*, entails a complex set of tradeoffs. Given a firm's information environment, management must develop a

disclosure investment strategy that provides the maximum benefit at the minimum cost. This will mean trading off one disclosure for another and calibrating the amount of information included in each disclosure. Given the range and diversity of decisions, an additional challenge in measuring firms' disclosure strategies is rationalizing all these decisions and tradeoffs into a parsimonious measure of disclosure investment strategy that allows the optimal mix of disclosures to vary across firms and economic conditions, thereby avoiding strong assumptions on the "right" disclosure mix across firms.[1] Having such a measure, however, would allow researchers to test hypotheses on the effects of firm investments in disclosure without focusing on specific disclosure mediums.

In this study we develop measures of disclosure investment strategy using a measurement method from operations research: data envelopment analysis (DEA). DEA is a non-parametric optimization technique developed as a means to calculate efficiency in a production framework, generating a relative score between zero (least efficient) and one (observations on the efficient frontier) for a given set of production inputs and outputs. We do not use DEA to calculate the efficiency of disclosure *per se*, but rather exploit its flexibility in developing our measures of disclosure investment strategy. Because DEA allows for multiple inputs and outputs, we use firm disclosures as the "inputs" and various measures of the quality of a firm's information environment as "outputs" of the disclosure production function. This allows our measure to capture the broad range of decisions that go into a disclosure investment strategy, and the wide swath of possible benefits to that strategy.

Further, the DEA optimization program generates *observation-specific* weights on inputs and outputs. In developing our score, this feature is critical, as this allows for firm-to-firm variation in the optimal level of information to disclose (and the form of that disclosure) based on the

[1] This requirement precludes methods often used in disclosure research, such as regression analysis, which implicitly assumes a constant (and linear) marginal effect of disclosures across all firms.

specific (and likely unobservable) features of the firm. For example, one firm may seek to enhance their information environment by issuing detailed forecasts of EPS and long-run sales growth, while another chooses not to provide such detailed forecasts because their business is complex and making accurate forecasts is difficult. This latter firm may instead opt to disclose narrative information via press releases. Rather than applying researcher imposed "values" on different forms of disclosure (i.e., forecasts vs. press releases), the DEA program *infers* the relative value of different disclosures by examining disclosure choices at the observation level. That is, the program assumes that if a firm opts to issue an EPS forecast, it is because such a forecast is valuable in their disclosure production function.[2]

We develop two measures of disclosure investment strategy, one for mandatory disclosures and one for voluntary disclosures. The mandatory disclosures we include as inputs into the DEA program capture aspects of the firm's required 10-K filing: readability, reporting lag, and file size. The voluntary disclosures we include as DEA inputs capture the issuance of management EPS forecasts, EPS forecast precision, the issuance of voluntary 8-Ks, and issuance of press releases. We use the same set of information environment variables (as DEA outputs) for the mandatory and voluntary scores: price illiquidity measured following Amihud (2002), analyst following, and institutional ownership. These measures of the information environment reflect the informativeness of current prices (via liquidity), the presence of key information intermediaries (via sell-side equity analysts), and the sophistication of the investor base (via institutional ownership). Although neither the list of disclosures nor information environment variables are exhaustive, we believe they capture many of the measurable and important aspects of disclosure and its consequences.

[2] We provide detail on our implementation of DEA in Section 2.

In terms of interpretation, our scores reflect a continuum of firms' investments in disclosure, holding constant the information environment output. On one end of the continuum, firms with the lowest scores (observations furthest from the frontier) have adopted high-volume, low average benefit disclosure investment strategies, where each given disclosure (or unit of disclosure) has a small association with the quality of the information environment. At the other end of the continuum are firms with high scores (observations forming the frontier) that display low-volume, high marginal benefit disclosure strategies, where each disclosure is associated with a relatively large information environment benefit. Given this, we expect that firms with relatively higher marginal costs of issuing a given set of disclosures will adopt low volume, high average benefit strategies that result in scores closer to one. In contrast, we expect that firms with relatively higher potential benefits from disclosing in a given period should adopt relatively high volume, low average benefit disclosure strategies. This leads us to predict that to the extent firms experience higher costs (benefits) to issuing a given set of disclosures, we will observe scores closer to one (zero) as firms adopt disclosure strategies that set the marginal benefit equal to the marginal cost of their disclosure investments.

We begin by empirically validating our measures of disclosure investment strategy. To do so, we first document the determinants and auto-correlation of our disclosure investment scores. These tests show the following. First, we find less variation in our measure of mandatory disclosure investment when compared to our measure of voluntary disclosure investment, consistent with substantial fixed costs and lack of discretion in producing mandatory disclosures. Second, we find significant persistence in our disclosure investment scores, suggesting that features of firms' investments in disclosure are stable over time. This is consistent with firms building expertise in their institutions that support disclosure, such as the investor relations function. Third, we find that

mandatory and voluntary disclosure investment scores are positively correlated, suggesting economies of scope in producing disclosures. Further, we find that higher mandatory disclosure investment scores are incrementally useful in predicting voluntary disclosure scores in the next period but not vice versa, pointing to spill-overs in investments in mandatory disclosure for voluntary disclosure channels.

Next, we examine whether increases in the marginal cost of disclosures are associated with firms shifting toward low volume, high average benefit disclosure strategies. In particular, we examine whether the presence of requests for confidential treatment of disclosures filed with the SEC is associated with movements in our DEA scores toward one. Prior literature finds that confidential treatment orders reflect the presence of proprietary information that is associated with more limited mandatory disclosure (e.g., Boone et al., 2016). Results from our models that include firm-fixed effects show that periods with confidential treatment orders are associated with significantly higher (lower) mandatory (voluntary) disclosure investment scores. These results suggest that in the presence of proprietary costs of disclosure, firms adopt low volume mandatory disclosure strategies combined with high volume voluntary disclosure strategies. This inference echoes recent evidence of elevated voluntary disclosures at firms with proprietary costs in studies that examine specific disclosure formats, such as management earnings forecasts (e.g., Glaeser, 2018; Barth et al., 2017).

In addition to variation in the marginal costs of disclosure, we also examine variation in the expected marginal benefit of disclosure. With respect to disclosure investment strategies, Merton (1987, pg. 503) posits a rationale for firms to engage in activities (such as disclosure) designed to enhance awareness with prospective investors, particularly during periods of capital raising. This points to a potential benefit of a high-volume disclosure investment strategy around

equity issuances. Given this, we use firms with a seasoned equity offering (SEO) during the year to reflect incentives to alter the disclosure production function as documented in prior literature (e.g., Lang and Lundholm, 2000). These tests show that firms that sell equity via an SEO display investments in both mandatory and voluntary disclosure in the year of the offering that are associated with larger improvements in the information environment per unit of disclosure relative to matched control firms. This evidence is consistent with firms issuing fewer public disclosures that are more informative (on average) than in surrounding periods and accords with evidence of increased voluntary disclosure that effectively reduces information asymmetry for SEOs following the passage of the 2005 Securities Offering Reform (SOR) designed to relax pre-offering restrictions on disclosure (e.g., Shroff et al. 2013; Clinton et al. 2014) and accords with evidence of increased voluntary disclosure that effectively reduces information asymmetry for SEOs following the passage of the 2005 Securities Offering Reform (SOR) designed to relax pre-offering restrictions on disclosure (e.g., Shroff et al. 2013; Clinton et al. 2014).[3] Our approach to modeling disclosure *conditional* on the features of the information environment finds that shifts in disclosure investment actually carry a higher marginal benefit during the offering period.

As an alternative setting that prior research finds is associated with significant changes in the information environment, we examine the extent of disclosure investment patterns surrounding the occurrence of disclosure-related securities class action litigation. Prior research documents mixed evidence on the effect of litigation events on firm disclosure behavior. Rogers and Van Buskirk (2009) show that sued firms reduce the amount of information provided to capital markets by curtailing management earnings forecasts and earnings conference calls in the post-litigation

[3] Alternatively, SEO firms may invest more in disclosures that are unobservable in publicly-available data (i.e., private meetings with analysts/institutions), which are associated with significant improvements in the information environment. We are unable to empirically evaluate this alternative explanation given our public data sources.

period, while Billings, Cedergren, and Dube (2016) find that only earnings warnings increase in frequency and timeliness following litigation. More broadly, this area of research suggests potential benefits to low-volume, high-impact disclosure strategies as a way to shield firms from litigation (Cutler et al., 2019). For our sample of firms with securities class action lawsuits, tests show that the lawsuit filing year is associated with substantially lower voluntary disclosure investment scores, consistent with sued firms having a significantly *less* informative portfolio of voluntary disclosures relative to matched peers. In contrast, sued firms display similar voluntary disclosure investment scores in the year following a lawsuit relative to matched peers. Importantly, our evidence suggests that rather than firms curtailing disclosure following a lawsuit, these firms return to a more typical voluntary disclosure investment strategy following the abnormal disclosure investment patterns immediately surrounding a lawsuit filing.

Our study makes several contributions to research examining determinants of variation in firm disclosure. First, we introduce a novel measure of disclosure investment strategy using DEA. This method allows us to integrate multiple forms of disclosure and multiple capital market consequences into a single measure, thereby more fully capturing firms' cost-benefit analysis when selecting their disclosure investment strategy. This approach makes progress on the observation made by Beyer et al. (2010, p.335) in their survey of the disclosure literature: "We conclude that one of the biggest challenges and opportunities facing researchers is considering the interactions among the various information sources. To date, little is known about the relations between firms' voluntary disclosure policies, mandatory disclosure requirements, and the information produced by security analysts." We find that our measures of disclosure investment strategy vary with fundamental disclosure determinants, including proxies for proprietary costs of disclosure, in ways that are consistent with our expectations. As a result, we expect our disclosure investment strategy

measures will be useful in alternative settings that require measuring the portfolio of firm disclosures rather than focusing on a particular disclosure medium in isolation.

Second, we contribute to research examining variation in firm disclosure around capital structure changes. Our evidence shows that voluntary disclosure investment is significantly more informative per unit of disclosure in the year of an SEO, consistent with firms significantly altering their voluntary disclosure strategies around equity sales. These result contrasts with inferences from small-sample evidence in earlier studies of increases in some forms of voluntary disclosure ahead of SEOs that are potentially used to "hype" the stock (Lang and Lundholm, 2000).[4] Additionally, we contribute to the literature on disclosure around securities class action lawsuits. In contrast to existing studies (e.g., Rogers and Van Buskirk, 2009), our measures of disclosure investment strategy highlight that the year of a lawsuit displays unusually low information content per unit of firms' voluntary disclosure portfolio, suggesting relatively high cost voluntary disclosure investments (relative to the benefits of these disclosures) in the year of a suit.

Finally, our study provides new evidence on the relation between voluntary and mandatory disclosure. Existing studies examining various aspects of mandatory and voluntary disclosure document support for using these differing disclosure channels as complements (e.g., Ball et al., 2012; Li and Yang, 2015) and substitutes (e.g., Guay et al., 2016; Noh et al., 2017). In contrast to existing evidence, our measures of disclosure investment strategy incorporate a portfolio of mandatory and voluntary disclosures. This comprehensive approach shows that firms with more efficient investments in mandatory disclosure also tend to make more efficient investments in voluntary disclosure, pointing to complementary relations. In contrast, we find insignificant spill-overs from investments in voluntary disclosure for subsequent mandatory disclosure investment

[4] Lang and Lundholm (2000) examine a matched sample of 41 firms issuing equity via seasoned equity offerings.

strategy.

2 Background

2.1 Conceptual framework

Companies make investments in disclosure to provide information to users outside of the firm. There are a wide range of disclosures that a company can make. Some, like SEC filings, are mandatory.[5] Others, like forecasts, are voluntary. There is also variation in the amount of information that is provided, conditional on a disclosure. For example, a company could make information in the mandatory 10-K informative or boilerplate. Similarly, a company can disclose just EPS in a forecast, or a broader range of projections such as sales or longer-range earnings.

There are costs and benefits to providing information in disclosures. In terms of benefits, disclosures that reduce information asymmetry should improve the liquidity of a company's stock, reduce volatility in stock prices, and attract the attention of analysts and institutional investors. These benefits, however, are balanced by costs. First, the actual production of information is costly; for example, producing an earnings forecast requires effort and resources that could be applied to other purposes. Second, there are costly potential consequences of making forecasts. For one, issuing a forecast may reveal valuable proprietary information about the company, allowing competitors to benefit. Additionally, issuing a forecast puts an added burden on the company to successfully achieve that forecast; evidence shows significant penalties for missing earnings forecasts (e.g., Bartov et al., 2002; Kasznik and McNichols, 2002). We also expect the relative costs and benefits to vary across firms and over time.

Our objective is to measure companies' overall investments in disclosure, which we term *disclosure investment strategy*. Conceptually, this construct captures the disclosure choices that a

[5] Our sample, which we describe in Section 3, consists of publicly-traded US firms, rendering SEC filings as mandatory.

company makes to effect a certain information environment outcome. A comprehensive measure of disclosure investment strategy captures the disclosure choices that a company makes, the amount of disclosure conditional on its use, and a quantification of tradeoffs that firms face in choosing their disclosure forms and content to be disclosed. Such a measure requires three things. First, the measure must quantify a broad range of disclosures, as much as possible spanning the company's decision setting in making disclosures; this includes both the decision to make a disclosure as well as the decision of how much information to disclose.

Second, because the assessment of investment in disclosure is made conditional on the firm's information environment, we need to measure and quantify information environment. A company has many possible objectives in developing a disclosure investment strategy. They may seek to better inform investors to reduce adverse selection costs and/or enhance stock liquidity. Alternatively, they may use disclosure to attract the attention of institutional investors or intermediaries such as analysts. Like the disclosure decision, a firm's information environment is multi-faceted and likely subject to trade-offs.

Third, we need a method that rationalizes the range of disclosure choices and information environment outcomes into a parsimonious measure that allows for inferences regarding disclosure strategy (i.e., is interpretable). The measurement method must allow for differences in the mix of disclosures and information environment outcomes across firms. For example, one firm may opt to issue earnings forecasts because they can do so accurately. Another firm may choose not to issue a forecast because their business is complex and making accurate projections is difficult. This second company instead issues a press release providing narrative detail while omitting numeric forecasts. The key issue is that there is no single best disclosure investment strategy that can be applied to all firms. Rather, firms are going to select the strategy that optimizes the net

benefits of disclosure conditional on the firm's specific features.

2.2 DEA overview

We use data envelopment analysis (DEA) to measure disclosure investment strategy. DEA is a non-parametric frontier optimization program that is typically used to measure efficiency. The program calculates a ratio of weighted outputs to weighted inputs; it takes the general form:

$$\max_{\boldsymbol{u},\boldsymbol{v}} \theta = \frac{\sum_{r=1}^{s} \boldsymbol{u}_r y_{rn}}{\sum_{i=1}^{m} \boldsymbol{v}_i x_{in}}$$

subject to:

$$\frac{\sum_{r=1}^{s} \boldsymbol{u}_r y_{rj}}{\sum_{i=1}^{m} \boldsymbol{v}_i x_{ij}} \leq 1 \qquad \forall\, j = 1,\ldots,\text{n}$$

$$\boldsymbol{u}_1,\ldots, \boldsymbol{u}_\text{s} \geq 0$$

$$\boldsymbol{v}_1,\ldots, \boldsymbol{v}_\text{m} \geq 0$$

In the objective function, there are *n* firms, *s* outputs and *m* inputs. The vectors *y* and *x* are the firm-level quantities of the outputs and inputs respectively. The vectors $\boldsymbol{u}$ and $\boldsymbol{v}$ are the weights applied to the vectors of outputs and inputs in the calculation of efficiency. The optimization program solves for weight vectors that maximize the objective function. Specifically, for each firm *n*, the program selects sets of weights $\boldsymbol{u}$ and $\boldsymbol{v}$ and applies these weights to the output and input quantities to all firms in the group (i.e., firm *n* plus the other *n-1* firms not under study) and calculates θ. If firm *n* has the highest value of θ for the given weights, it is on the frontier. If not, the program selects a new set of weights $\boldsymbol{u}$ and $\boldsymbol{v}$ and applies these to all firms. The program iterates and ultimately finds the set of weight vectors that provides the highest measured θ. Then, the same procedure is run for each of the *n* firms; the program thus generates a set of firm-specific weights and a relative score for each observation.

The first constraint in the program serves as a scalar, limiting the values of θ to be between

zero and one. Firms on the frontier are scaled to a value of one with other efficiency scores getting similar scaling. For example, if firm *n* has an unadjusted efficiency score of 3.5 and the highest unadjusted score is 4, the firm *n*'s score is 3.5 / 4 = 0.875. The second and third constraints require that the output and input weights must be zero or larger (with at least one of each strictly positive).

Using DEA presents a number of advantages in our setting. First, because it easily admits multiple inputs and outputs, it allows us to incorporate multiple measures of firm information environment (as "outputs") and disclosure choices (as "inputs"). This obviates the need for arbitrary aggregations which would be necessary when using regression. Second, DEA allows for flexibility in the weights applied to our measures of disclosure and information environment. Considering an example from above, if a firm opts to issue an EPS forecast, they are implicitly doing so because the forecast provides value for them; as such, DEA will apply a high weight to the forecast. If another firm does not issue a forecast but rather issues a press release, DEA will place a higher weight on press releases than forecasts *for that firm*. The scores that result from DEA reflect relative costs and benefits of disclosure on firm information environment in a revealed-preferences sense: that is, if the disclosure is net beneficial, the firm will make it.

Despite the fact that DEA scores are typically interpreted as efficiency metrics—that is, the firm's efficiency in producing outputs for a given set of inputs—we adopt a different interpretation that recognizes our focus on variation in disclosure investment strategy. In our formulation, which is termed *input-oriented DEA*, we interpret the score as a reflection of the firm's investment in disclosure conditional on its information environment. A high score means that a firm, conditional on its information environment, is making a relatively small investment in disclosure. This, of course, is a good thing; it can be viewed as having a high "return on investment" for the disclosure policy, in that the firm is getting the benefits of disclosure while

revealing relatively little information (or providing information at a relatively low cost). A low score, similarly, means the firm is making relatively large investments in disclosure, again conditional on its information environment. In this case, the firm's return on disclosure investment is low, suggesting that peer firms attain the same "level" of information environment at a lower cost.

Using our input-oriented DEA scores, we focus on the factors that explain variation in the adoption of low cost vs. high cost disclosure strategies. As a result, our empirical analysis differs fundamentally from prior disclosure studies in two key respects. First, we do not focus on a particular form of disclosure, such as management earnings forecasts, in isolation. This allows us to capture broader measures of disclosure investment strategy across firms. Second, we condition our measures of disclosure investment strategy directly on the information environment. This allows us to examine shifts in disclosure *investment per unit* of information environment in response to capital market events, rather than examining the amount or precision of disclosure. For example, consider a firm with a small sell-side analyst following. This firm may make relatively few quantitative earnings forecasts, opting instead for detailed narrative discussions in press releases. If this firm experiences a substantial increase in its analyst following, the firm may optimally shift its disclosure portfolio to include quantitative earnings forecasts. In this case, while the relation between disclosure investment and the quality of the information environment will remain unchanged (in an input-oriented DEA sense), a linear regression examining the likelihood of issuing a quantitative forecast will show that disclosure increases with analyst following. These conclusions are fundamentally different. The first says something about the disclosure production function, while the second inference (which is the focus of prior literature) tells us about the use (and potential benefit) of a particular form of disclosure.

2.3 Prior literature on the determinants of firm disclosure

The bulk of the existing literature on disclosure consists of studies that each focus on analyzing determinants of a single channel of disclosure in isolation. For example, Waymire (1985) finds that firms with more volatile earnings processes tend to issue management earnings forecasts less frequently than those firms with less volatile earnings streams, but that the accuracy of the forecasts do not differ between the two groups. Baginski and Hassell (1997) study the determinants of management earnings forecast precision for annual earnings and find that precision is positively associated with a firm's analyst following and negatively associated with firm size. More recently, He and Plumlee (2019) examine disclosure proxies constructed based on firms' 8-K filings and find these are positively associated with firm size, expectations of future equity issuance, and historical losses.

Studies also examine the determinants of a given voluntary attribute of mandatory financial statement disclosures, again largely in isolation from remaining disclosure attributes. Li (2008) examines the readability of firms' 10-K filings and finds that readability is increasing in both a firm's level and persistence of earnings. Bowen et al. (1992) find that the timing of a firm's quarterly earnings announcements is associated with its earnings news, which the authors infer is an attempt by firms to influence stakeholder perceptions of firms' earnings performance.

Given existing studies that focus on individual aspects of firms' disclosures, there are three areas of the disclosure literature that are particularly relevant for our tests that we survey in more detail in the following sections: disclosure at firms with elevated proprietary costs (Section 2.3.1); disclosure around equity issuances (Section 2.3.2); and disclosure around securities class action litigation (Section 2.3.3).

2.3.1 Prior literature examining firm disclosure in response to proprietary costs

Existing literature examining the relation between proprietary costs of revealing information to potential rivals and firm disclosure focuses on measures of product market competition. For example, Ali et al. (2014) find that firms in concentrated industries disclose less, which they attribute to proprietary costs. Broadly, studies in this area document mixed evidence with respect to the relation between proprietary costs and firm disclosure patterns, noting that disclosure of proprietary information and product market competition are likely to be endogenously related in a non-linear fashion (see Beyer et al., 2010, Section 3.1.1 for a discussion) and citing the difficulty of accurately measuring product market competition (Ali et al., 2014). More recently, studies examine whether measures of proprietary disclosure costs differentially influence disclosure in regulatory documents, such as the annual 10-K report, and voluntary disclosures, such as management earnings forecasts. Barth et al. (2017) find that in an initial public offering (IPO) setting, firms with characteristics suggesting elevated proprietary costs of disclosure tend to limit the amount of information included in their IPO prospectus while providing enhanced voluntary disclosures in the form of management earnings guidance and 8-K filings to reduce post-IPO uncertainty. Similarly, Glaeser (2018) finds that firms relying on trade secrecy tend to substitute increased management earnings guidance for more limited disclosure of proprietary information. Broadly, this area of research suggests that while firms tend to curtail information provided in regulatory filings in response to proprietary costs, certain forms of voluntary disclosure act as substitutes for reducing information asymmetry.

2.3.2 Prior literature examining firm disclosure around equity issuances

Several studies examine disclosure surrounding issuance of equity. Frankel, McNichols, and Wilson (1995) find evidence that firms that tend to regularly access capital markets are more likely to issue management earnings forecasts. Similarly, Marquardt and Wiedman (1998) find

increased voluntary disclosure, in the form of the number of management earnings forecasts, prior to secondary equity offerings of managers' stock. From a time-series perspective, Healy, Hutton, and Palepu (1999) find that years of increased disclosure coincide with increases in issuance of public debt and equity.

Lang and Lundholm (2000) find that for a small sample of 41 firms with seasoned equity offerings, these firms increase the frequency, detail, and tone of disclosures, particularly those most subject to manager discretion, in the six months prior to the offering. The authors interpret their evidence as supporting the idea that firms increase disclosure in anticipation of the future equity issuances. As a consequence of increasing disclosure, these firms experience price increases prior to the announcement of the issuance, the bulk of which reverses following the announcement. More recently, Shroff et al. (2013) and Clinton, White, and Woidtke (2014) examine firms' information environments prior to seasoned equity offerings (SEOs) following the SEC's Securities Offering Reform (SOR) in 2005. These studies find that in the periods leading up to SEOs, firms release more frequent and more accurate management earnings forecasts as well as more 8-K filings following the reform, with corresponding reductions in information asymmetry for firms conducting SEOs.

2.3.3 Prior literature examining firm disclosure around securities class action litigation

A number of existing studies examine the *ex ante* effects of the risk of shareholder litigation on firm disclosure behavior (e.g., Skinner, 1994; see Beyer et al., 2010 for a review of this area of research). Inferences across these studies display mixed evidence on whether disclosure (particularly of bad news) shields firms from securities litigation. For example, Francis, Philbrick, and Schipper (1994) find no evidence that early disclosure of poor earnings news deters litigation or that a lack of preemptive disclosure provokes it. Similarly, Skinner (1997) finds that voluntary

disclosure of bad earnings news does not preclude shareholder litigation but does find that the timeliness of such disclosure is associated with lower settlement amounts, suggesting that managers disclose early to reduce the financial impacts of litigation. Field, Lowry, and Shu (2005) find a negative relation between disclosure and certain types of litigation, and Donelson et al. (2012) find a negative relation between the timeliness of disclosure and the likelihood of litigation. These studies suggest that firm disclosure behavior does impact shareholder litigation.

A more limited set of studies examine the *ex post* effect of litigation itself on disclosure. These studies present conflicting evidence on the effect of litigation events on firm disclosure behavior. Rogers and Van Buskirk (2009) examine the disclosure behavior for a sample of firms that are the target of a disclosure-related securities class action lawsuit filed under Rule 10b-5. These authors find that sued firms reduce the amount of information provided to capital markets via a reduction in the likelihood of issuing earnings forecasts, less precise earnings forecasts when they are issued, and fewer earnings conference calls in the post-litigation period. In view of these results, the authors voice concerns that litigation causes managers at sued firms to adopt "…the belief that plaintiff attorneys will use voluntary disclosures to accuse managers of misconduct…" (Rogers and Van Buskirk, 2009, p.137). Subsequent research by Billings, Cedergren, and Dube (2016) finds that a reduction in information provided to capital markets by sued firms is predominantly a drop in forecasts of positive news. In contrast, these authors find that earnings warnings increase in frequency and timeliness following litigation, which the authors infer is due in part to reputational costs imposed by enhanced capital market scrutiny as evidenced by greater media coverage post-lawsuit. Broadly, this area of research raises the question of how shareholder litigation alters investments in both voluntary and mandatory disclosures, where the latter channel is relatively unexamined in this existing literature.

3 Sample and data sources

We source data from *Compustat* for financial statement data, the Center for Research in Security Prices (*CRSP*) for stock market data, Institutional Brokers' Estimate System (*I/B/E/S*) for management and analyst forecast data, *Ravenpack* for press release data, and the Thomson Reuters Institutional (13f) Holdings database for data on institutional ownership. We obtain Bog Index data on the readability of firms' 10-K reports from Brian Miller's website (see Bonsall et al., 2017 for further details on measurement) and data on the file size of 10-K report's from the *SEC Analytics* database available via Wharton Research Database Services (WRDS).

Table 1 presents our sample selection criteria applied to the population of firm-year observations appearing on *Compustat*'s annual file. DEA requires non-missing data for all inputs and outputs, so this forms the first limitation on our dataset.[6] In terms of the temporal aspects of measurement, we measure inputs and outputs concurrently for each fiscal year *t* (beginning with fiscal years ending December 31, 2000 and later to allow for a full 12 months of coverage in *Ravenpack*'s Dow Jones Edition) in order to reflect the relatively immediate effects on the information environment of issuing firm-level disclosures documented in prior research. (See Beyer et al., 2010 for a review of this literature). We further require observations to have non-missing market value of equity at the start of the period and data to compute key control variables in our later tests, including book-to-market ratios and financial leverage. Additionally, we exclude observations in which the sum of inputs equals zero. These are firms with no disclosure investment (per our definition), which are also likely to lack coverage by *I/B/E/S* or *Ravenpack*.[7] Our final sample comprises of 69,288 firm-year observations over the 2000 – 2017 period. We provide the

[6] We describe the variables used as inputs and outputs in Section 4.1. Definitions and data sources for all variables appear in Appendix A.

[7] Having a firm-year with zero values of all inputs also creates an infinitely efficient decision making unit (DMU), assuming there is at least one non-zero output.

frequency of sample observations by year in Panel B of Table 1.

4 Calculating disclosure efficiency

4.1 Variables and program design

When designing the DEA program to measure disclosure investment strategy, we use multiple inputs and outputs to capture the multi-dimensional nature of disclosure costs and benefits. We consider a broad range of possibilities for each and develop a parsimonious set of inputs for voluntary and mandatory disclosures that we believe is representative and spans a broad range of the disclosure decision set.[8] We describe each input and output in detail below, with detailed definitions and data sources provided in Appendix A.

For our measure of voluntary disclosure investment strategy, we consider four disclosure decisions that serve as inputs. First, we consider the number of management earnings per share (EPS) forecasts issued by the firm. This key voluntary disclosure allows firms to provide information to capital market participants about future earnings, thus alleviating information asymmetry prior to the formal, required release of earnings. In using the count of forecasts, we seek to capture the amount (or extensive margin) of disclosure provided. We measure *LOG_MEFS* using the natural logarithm of the count of management EPS forecasts issued during the 12-month period ending 3 months after the end of the current fiscal year to include the fourth-quarter earnings announcement.

Second, we use the precision of management EPS forecasts. Li and Zhang (2015) find that managers respond to exogenous short selling pressure by varying the precision of management

[8] Although DEA allows unlimited inputs and outputs, there are advantages to maintain circumscribed input and output sets. Most important, as detailed in Demerjian (2018), is that a large number of inputs and outputs leads to a lack of variation in the measured DEA. This is because the frontier will be formed by firms that optimize on each individual input and output, but also on linear combinations of inputs and outputs. As a consequence, as inputs and outputs are added, the number of frontier observations increases exponentially. This leads to less variation in measured DEA scores, and thus a loss in the ability to discriminate between efficient and relatively inefficient firms.

earnings forecasts rather than the number of forecasts issued. This evidence suggests that disclosures vary on the intensive margin (via the precision of a given forecast) in addition to the extensive margin (via the decision of whether to issue a forecast at all). We calculate forecast precision using *FCAST_PREC*, the management EPS forecast width divided by price and multiplied by negative one; the resulting score is increasing in precision, meaning the higher the value, the costlier the forecast. This results in a score that ranges between negative one (least precise forecasts) and zero (most precise). Since DEA does not admit negative input value, we add one so that *FCAST_PREC* ranges between zero and one. We also code observations lacking management forecasts as zero.

For our third voluntary input, we use the natural logarithm of the number of press releases issued by the firm in the 12-month period ending 3 months after the fiscal year end (*LOG_PRS*). Press releases can provide a broad range of information to external stakeholders, including financial and non-financial information. Similarly, our last voluntary input is the natural logarithm of the count of 8-K filings issued by the firm that include an item falling under the "Other Events" category (Item 8.01) over the 12-month period ending 3 months after the fiscal year end (*LOG_VOL8KS*). These 8-K filings are considered voluntary and have no associated filing deadline imposed by the SEC (Lerman and Livnat, 2010). As a result, recent studies (e.g., Noh et al., 2017) rely on these 8-K filings to reflect voluntary disclosure. In contrast, remaining 8-K items are considered mandatory and have an associated filing deadline, typically within four business days of the event. Similar to press releases, voluntary 8-K filings can provide a broad range of information, including financial and non-financial information. As such, press releases and voluntary 8-Ks are likely complementary to management earnings forecasts and able to provide incremental information.

For our measure of mandatory disclosure investment strategy, we rely on three inputs to capture the amount, timeliness, and readability of mandatory disclosure. For these inputs, we draw on the substantial literature examining 10-K reports filed with the U.S. Securities and Exchange Commission (SEC) as a key regulatory filing required each fiscal year. First, we follow Loughran and McDonald (2014, p.1645) to use the document size of the 10-K filing to measure "how effectively managers convey valuation-relevant information to investors and analysts." These authors note that 10-K file size is less prone to measurement error relative to traditional readability scores (such as the Fog Index) and is strongly correlated with alternative readability measures. The variable *FILESIZE* is the natural logarithm of one plus the 10-K file size (in megabytes) as uploaded to SEC's EDGAR website.

Second, we follow recent research by Bonsall et al. (2017) examining readability indexes for 10-K reports. These authors advocate using the Bog Index to measure whether the 10-K employs the attributes of plain English as part of a readable document, e.g., active voice, lack of hidden verbs or superfluous words, where higher Bog Index values reflect *less* readable disclosure. Consistent with this, we use the inverse of the *BOGINDEX* (i.e., 100 / *BOGINDEX*) as the input in our DEA program. For our third input, we use the number of days between a firm's fiscal period-end and the filing of the 10-K report to proxy for the firm's investment in reporting technology designed to facilitate the timely filing of audited financial reports. We define *FILELAG* as the inverse of the number of days between the fiscal period end date and the filing date of the 10-K (i.e., 100 / number of days since fiscal year-end) as the final input in our DEA program for mandatory disclosure.

For each of these sets of disclosure inputs, we consider three outputs, each representing a consequence or outcome of the firm's efforts in making disclosures. The first of these is the firm's

equity price liquidity based on a version of Amihud's (2002) illiquidity measure that captures the price impact of trading. We use this measure to capture the broad features of the information environment that give rise to adverse selection concerns following a substantial theoretical (e.g., Diamond and Verrecchia, 1991) and empirical (see Section 3.2.2.2 of Beyer et al., 2010 for a review) literature relating disclosure to reductions in information asymmetry and corresponding improvements in liquidity. We measure *LIQ* as the negative natural logarithm of Amihud's (2002) illiquidity measure computed as the annual average of the absolute daily stock return divided by daily dollar trading volume.

Our second output for the DEA program is analyst following. Evidence shows that firms can encourage more analysts to follow their firm by providing a transparent information environment (Lang and Lundholm, 1996). Analyst following, in turn, has a number of beneficial features for the firm, including lower cost of equity capital (Leuz and Verrecchia, 2000), lower cost of debt (Mansi, Maxwell, and Miller, 2011), and increased equity liquidity (Roulstone, 2003). We define *NUM_ANALYST* as the count of unique analysts making forecasts of quarterly earnings per share in the 90 days prior to each quarterly earnings announcement.

Our third and final output for the DEA program is the number of institutional owners in the firm's equity. Institutional ownership is associated with benefits to firms, including increased monitoring and value (Burns et al., 2010; McConnell and Servaes, 1990). Further, Bushee and Noe (2000) find that high-quality disclosure increases the number of institutions investing in a firm's stock. We measure *NUM_INSTOWN* as the average number of institutional owners over the four quarterly reporting periods during the current fiscal year.

In Table 2, Panel A, we present descriptive statistics for all input and output variables. Several aspects of the data stand out. First, most of the variables are distributed fairly

symmetrically, with similar mean and median values. Exceptions include *LOG_MEFS* and *FCAST_PREC*, both of which have zero median values (reflecting observations with no management forecasts during the year) and positive means. Second, most of the variables display a wide range of values, consistent with substantial variation across firms in both the amount of disclosure and features of the information environment. For example, *NUM_ANALYST* ranges from zero up to approximately 44 analysts following the firm. We exploit this cross-firm variation when computing disclosure investment scores via our DEA program.

In Table 2, Panel B, we present the correlation matrix. The table shows significant positive correlations among most of the input and output variables. The most striking exception is the inverse of the Bog Index, which displays negative correlations with many of the other inputs and outputs. This suggests that producing a more readable 10-K likely entails tradeoffs with the amount and timing of disclosure, consistent with relatively longer filing times (*FILELAG*) and larger file sizes (*FILESIZE*) for firms with more readable 10-K filings (100/*BOGINDEX*). More broadly, the imperfect correlations suggest that each input and output captures distinct dimensions of disclosure and the information environment.

4.2 Program design

We calculate separate scores for voluntary and mandatory disclosure investments, respectively. The DEA program for voluntary disclosure investment (*DISCINV_VOL*, our measure of voluntary disclosure strategy) solves the constrained optimization problem:

$$\max_{\boldsymbol{u},\boldsymbol{v}} \theta_{VOL} = \frac{u_1 \ln(NUM\_ANALYST) + u_2 \ln(NUM\_INSTOWN) + u_3 LIQ}{v_1 LOG\_MEFS + v_2 FCAST\_PREC + v_3 LOG\_PRS + v_4 LOG\_VOL8KS}$$

The program for mandatory disclosure investment (*DISCINV_MAN*) solves the constrained optimization:

$$\max_{\boldsymbol{u},\boldsymbol{v}} \theta_{MAN} = \frac{u_1 \ln(NUM\_ANALYST) + u_2 \ln(NUM\_INSTOWN) + u_3 LIQ}{v_1 FILESIZE + v_2(\frac{100}{BOGINDEX}) + v_3 FILELAG}$$

Each of these programs is subject to the constraints described in detail in Section 2.2. Briefly, the efficiency scores (θ_{VOL} and θ_{MAN}) are constrained to be between zero and one, and for each program the vectors of input and output weights (***v*** and ***u***) must have all non-negative elements and at least one element that is strictly positive.

Demerjian (2018) notes several important assumptions that go into calculating efficiency-type scores using DEA. Chief among these is the selection of the *calculation group* for the optimization. Since DEA is a relative efficiency metric, the calculated score for any individual decision making unit (DMU) will be sensitive to the other DMUs included in the group. Following DEA's historical basis as a method to measure production efficiency, our objective in grouping is to collect DMUs that are as similar as possible with respect to the underlying disclosure production function, reflecting commonality in the conversion of disclosure inputs into our defined disclosure outputs. We also must balance additional considerations to generate scores that will provide valid inferences. One, as described in Demerjian (2018), is the size of the calculation group. This paper shows that relatively small calculation groups, coupled with multiple inputs or outputs, can lead to many DMUs on the frontier and a compression of variation in the distribution of DEA scores. This suggests that partitions must be large enough to permit sufficient variation in the resulting scores. Another consideration is potential look-ahead bias. If DMUs are grouped across time, data from future periods will be used to calculate prior periods' efficiency scores; depending on the application, this can lead to biased inferences.

Balancing the above considerations, we group our firm-year observations by fiscal year and, within fiscal year, the decile of size based on beginning market capitalization. Grouping by

year allows us to avoid potential look ahead bias, and naturally controls for changes in the economics of disclosure over time. We use firm size to capture differing information environments (and incentives) that likely influence the disclosure production function across firms.[9] Further, using size deciles provides groupings of approximately the same size for our DEA program, varying only to the extent of yearly variation.

We present descriptive statistics for voluntary and mandatory measures of disclosure investment in Table 3, Panel A. The results reveal substantial differences in the level of variation between the mandatory and voluntary disclosure investment scores. *DISCINV_MAN* ranges from 0.540 to 1.000 and has an interquartile range of only 0.097. This low variability is reflected in the mean (median) score of 0.889 (0.887), suggesting most firms are near the frontier in our DEA estimation. In contrast, *DISCINV_VOL* has a range of 0.079 to 1.000 with an interquartile range of 0.313 and a corresponding mean (median) score of 0.442 (0.379), reflecting a distribution centered near the midpoint of 0.5. The differences in the distributions of the disclosure investment scores reflect the fundamentally different natures of mandatory and voluntary disclosure; while there is some room for discretion in mandatory disclosure, the presence of regulation and enforcement policies across firms are relatively consistent. Voluntary disclosure, in contrast, allows for much greater discretion in the use and amount of disclosure provided, resulting in considerably more variation.

In Table 3, Panel B, we report descriptive statistics on *DISCINV_MAN* and *DISCINV_VOL*

[9] An alternative candidate for sorting is by industry. This is a commonly used sorting, largely due to DEA's basis in production calculations; researchers often argue that industry similarity correlates with production similarity (e.g., Demerjian et al., 2012). Industry sorting, however, brings certain downsides. For one, there is a large range of sizes (in terms of number of firms) across industries. This can lead to small calculation groups and their attendant inference issues. Additionally, there is no assurance that firms within the same industry necessarily face the same costs and benefits when it comes to disclosure. For example, a relatively small, new firm with a short track record in the market is likely to face different incentives than a large, established firm with a long history of public information. Consistent with this, we believe that firms of similar size but in different industries face more similar tradeoffs in their disclosure decisions than firms in the same industry but of different sizes.

by industry (based on Fama-French 17 industries). Consistent with the results in Panel A, the range of *DISCINV_MAN* varies little across industries, from a low of 0.859 (Finance) to a high of 0.924 (Consumer Goods and Utilities). *DISCINV_VOL* reveals considerably more cross-industry variation, ranging from 0.396 (Steel) to 0.547 (Cars). For both scores, industry-level standard deviation is similar to that reported for the full sample in Panel A.

5 Empirical Design and Results

5.1 Basic determinants of disclosure efficiency

Our first set of empirical results examine the determinants of our disclosure investment scores. We estimate regressions for mandatory and voluntary disclosure, respectively:

$$DISCINV\_MAN_t = \alpha + \beta_1 DISCINV\_MAN_{t-1} + \beta_2 DISCINV\_VOL_{t-1} + \tau + \iota + \varepsilon \quad (1)$$

$$DISCINV\_VOL_t = \alpha + \beta_1 DISCINV\_VOL_{t-1} + \beta_2 DISCINV\_MAN_{t-1} + \tau + \iota + \varepsilon \quad (2)$$

In these regression, τ represents year-fixed effects and ι represents either firm- or industry-fixed effects (using Fama-French 17 industries) depending on the specification. The objective of this test is two-fold. First, the inclusion of the lagged efficiency score allows us to assess the persistence of disclosure efficiency over time. Second, the inclusion of lagged $DISCINV\_VOL_{t-1}$ (in Eq. 1) and $DISCINV\_MAN_{t-1}$ (in Eq. 2) allows us to examine whether investments in voluntary or mandatory disclosure display spill-overs (in the following period) for investments in the alternative disclosure portfolio.

In addition to the above specifications, we run two additional tests decomposing the outputs and inputs of DEA:

$$DISCINV\_MAN_t = \alpha + \Gamma_1 Outputs + \Gamma_2 Man\_Inputs + \delta Size + \tau + \iota + \varepsilon \quad (3)$$

$$DISCINV\_VOL_t = \alpha + \Gamma_1 Outputs + \Gamma_2 Vol\_Inputs + \delta Size + \tau + \iota + \varepsilon \quad (4)$$

In these regressions, *Outputs* reflects the vector of DEA outputs [*LIQ*, *ln(NUM_INSTOWN)*,

ln(NUM_ANALYST)], *Man_Inputs* is the vector of DEA inputs from the mandatory model [*(100/BOGINDEX)*, *FILESIZE*, *FILELAG*], *Vol_Inputs* is the vector of DEA inputs from the voluntary model (*LOG_PRS*, *LOG_VOL8KS*, *LOG_MEFS*, *FCAST_PREC*), and *Size* is the natural log of beginning-of-year market value of equity. These tests allow us to understand whether specific inputs or outputs are driving our measures of disclosure investment. These specifications include year- and firm-fixed effects in the estimation, as well.

Table 4 reports results of estimating Eq. (3) [(4)] in Panel A (B) for mandatory (voluntary) disclosure investment scores. In the first three specifications, we examine the persistence of *DISCINV_MAN* without fixed effects in model (1) and with year- and industry-fixed effects in models (2) and (3). Results in these initial models show that mandatory disclosure is persistent, with a coefficient on $DISCINV\_MAN_{t-1}$ between 0.638 and 0.668 in models (1) – (3) (p-values < 0.01).[10] In contrast, model (3) shows that lagged $DISCINV\_VOL_{t-1}$ scores are insignificant both statistically and in economic terms in predicting following year *DISCINV_MAN*. This suggests that after controlling for persistence in mandatory disclosure investment scores, voluntary disclosure investments display limited spill-overs for investments in mandatory disclosure. Turning to model (4) in Panel A shows that *DISCINV_MAN* contains a significant time-invariant, firm-specific component as indicated by the increase in adjusted R^2 when adding firm-fixed effects in place of industry (increase from 47.2% in model 2 to 53.2% in model 4). This evidence leads us to examine firm-fixed effects models in our subsequent tests for variation around capital market events. The fifth and final column reports results including individual outputs and inputs from the DEA program (in place of $DISCINV\_MAN_{t-1}$) along with industry- and year-fixed effects. Consistent with expectations, each output loads positively and each input negatively. This suggests

[10] All p-values reported in the text are based on two-tailed significance tests.

that each input and output contributes significantly to the comprehensive measure of mandatory disclosure investment.

In Table 4, Panel B, we report results for voluntary disclosure efficiency. The tenor of these results is similar to those we reported in Panel A with one key exception. In particular, the first three models indicate that voluntary disclosure investment is persistent, with a coefficient on prior-year $DISCINV\_VOL_{t-1}$ between 0.440 and 0.460 (p-values < 0.01), although persistence is generally lower than that observed for *DISCINV_MAN*, as evidenced by lower auto-correlation coefficients and lower adjusted R^2 values in Panel B relative to Panel A. More interestingly, in contrast to our results in Panel A, results in model (3) where we add a control for the prior-year mandatory disclosure investment score show a coefficient on $DISCINV\_MAN_{t-1}$ that is positive and significant (coeff. = 0.179, p-value < 0.01). This result suggests significant spill-overs from low-value, high marginal benefit investments in mandatory disclosure for subsequent investments in the voluntary disclosure portfolio. In economic terms, a standard deviation movement in $DISCINV\_MAN_{t-1}$ ($DISCINV\_VOL_{t-1}$) of 0.067 (0.239) leads to a predicted increase of 0.029 (0.043) in $DISCINV\_VOL_t$, pointing to relatively larger effects for voluntary disclosure efficiency in predicting subsequent year voluntary disclosure investment scores. The results in the final column, where outputs and inputs are included individually, yield significant coefficients in the predicted direction consistent with our results in Panel A.

5.2 Capital market determinants of disclosure efficiency

Table 4 provides some baseline results on the determinants of our disclosure investment scores. In our next phase of analysis, we introduce proxies for variation in the costs and benefits of disclosure. In particular, we argue that firm conditions and events should affect the economics of disclosure investment, providing incentives to adopt either a high-volume, low average benefit

per disclosure strategy (evidenced by DEA scores closer to zero) or a low-volume, high average benefit per disclosure strategy (evidenced by DEA scores closer to one). Consistent with this, we examine sources of within-firm variation in the expected marginal costs or benefits of disclosure that we expect to alter the optimal disclosure investment strategy.

We start by examining how proprietary costs affect the disclosure investment strategy of the firm. We expect that firms facing a shock that increases proprietary costs will have an incentive to restrict the amount of disclosure that potentially reveals proprietary information, resulting in a lower volume disclosure strategy (holding other things equal). In light of evidence suggesting that firms limit mandatory disclosures in response to proprietary costs (e.g., Boone et al., 2016; Barth et al., 2017), we expect firms to predominantly shift toward low volume, high average benefit disclosure strategies in their mandatory disclosures. In contrast, we expect that to the extent that voluntary disclosures (that do not reveal proprietary information) serve as a substitute for reduced mandatory disclosures in response to proprietary costs (e.g., Barth et al., 2017; Glaeser, 2018), we should also observe firms shifting toward relatively high volume, low average benefit voluntary disclosure strategies in response to elevated proprietary costs of disclosure.

Following Glaeser (2018), we measure the presence of time-varying proprietary costs using the presence of confidential treatment order filed with the SEC.[11] A confidential treatment order encompasses material that is redacted from a regulatory disclosure during the year, including redactions in the 10-K annual report and in 8-Ks filed for items such as material contracts. We interpret the redaction as evidence of proprietary information that the firm does not want to reveal.

[11] Glaeser (2018) also examines the extent of reliance on trade secrecy by firms as a relatively time-invariant measure of proprietary costs. Consistent with Glaeser (2018), we find that 84.5% (86.0%) of firms that mentioned (did not mention) "trade secret" or "trade secrecy" in their prior-year 10-K report also mention (do not mention) this in the current-year 10-K. In contrast, we find that firms filing a confidential treatment order in the prior year are only slightly more likely (53.8%) to file a confidential treatment order in the current year, suggesting considerably more within-firm variation in confidential treatment orders.

This interpretation is consistent with the SEC's rules governing confidential treatment orders: firms are required to substantiate that their request for confidential treatment by illustrating the disclosure would have an "…adverse effect on the business' competitive position" (17 CFR 200.83[d][2]). We use an indicator variable, *CTO*, which we set to a value of one if the firm has at least one confidential treatment order during the 12-month period ending three months after the fiscal year-end and zero otherwise.

We next consider incentives related to issuing equity. In periods of capital raising, we expect that firms possess two (non-mutually exclusive) channels for reducing the cost of capital via disclosure: enhancing awareness with prospective investors that expands the investor base (and corresponding demand for the firm's shares) and/or reducing information asymmetry between insiders and investors. The first channel suggests that firms will have incentives to engage in a greater volume of disclosure designed to enhance awareness. To the extent that firms adopt this strategy, we expect to observe a drop in our measures of disclosure investment during the year of an equity offering, consistent with relatively higher-volume and/or relatively lower marginal benefit disclosures being issued, reflected in lower disclosure investment scores (closer to zero). This strategy will also be observed to the extent that firms "hype" their stock by issuing a larger number of relatively uninformative disclosures ahead of the offering (Lang and Lundholm, 2000). In contrast, to the extent that firms adopt a strategy of reducing information asymmetry by issuing relatively more informative disclosures, we expect to observe relatively lower-volume and/or relatively higher marginal benefit disclosures being issued, reflected in higher disclosure investment scores (closer to one).

We consider the issuance of public equity via a seasoned equity offering (*SEO*). When issuing equity via an SEO, firms have incentives to limit information asymmetry between insiders

and investors, as equity pricing is sensitive to publicly-available information. We therefore predict a positive association between shifts in our disclosure investment scores and firms issuing equity via an SEO in the year of the offering. We measure *SEO* with an indicator set equal to one if the firm undergoes a SEO transaction during the year and to zero otherwise.

The second economic driver that we consider is disclosure-related securities class action lawsuits. Existing literature displays mixed evidence on whether disclosure (particularly of bad news) shields firms from securities litigation (e.g., Francis, Philbrick, and Schipper, 1994; Skinner, 1997; Field, Lowry, and Shu, 2005; Donelson et al., 2012). Further, more recent studies find that firms decrease their level of voluntary disclosure following a lawsuit (e.g., Rogers and Van Buskirk, 2009). Existing studies infer that firms shift their disclosures in response to the potential cost of releasing information, such that firms disclose less because they are concerned that they will be held responsible (via an increased risk of litigation) for the contents of the information at a later date. Following this logic, we examine whether firms respond to a lawsuit by adopting a lower volume, higher marginal benefit disclosure investment strategy (rather than merely limiting the quantity) of their disclosures following the lawsuit. To the extent firms are sued for issuing relatively uninformative disclosures, adopting this revised strategy should shield firms from further litigation. We thus predict a negative association between our disclosure investment scores and the filing of a lawsuit in the current year. Further, we expect to observe an increase in disclosure investment scores following the filing of a lawsuit targeting the firm. Our proxy for litigation, *Lawsuit*, is an indicator set equal to one (zero) in years in which a firm was (not) subject to a disclosure-related securities class action suit.

We estimate the following regression to examine the role of these incentive variables:

$$[DISCINV]_t = \alpha + \beta * Incentive + \Gamma * Controls + \tau + \iota + \varepsilon \quad (5)$$

Where *[DISCINV]* is either *DISCINV_MAN* or *DISCINV_VOL*. *Incentive* is one of the three variables (*CTO, SEO,* or *Lawsuit*) described above. We run separate specifications for each incentive and include incentive values measured in the year before (*t-1*), year of (*t*), and year following (*t+1*) the measurement period for our disclosure inputs into the DEA program. We also examine models that include a vector of time-varying firm-level controls (*Controls*) and alternatively firm-fixed effects. Firm-level controls include the beginning-of-year market value of equity (*SIZE*), book-to-market ratio (*BM*), accounting performance (*ROA*), an indicator for negative earnings (*LOSS*), expenditures on research and development and advertising as a proportion of operating expenses (*RDAD_EXP*), net debt and equity financing (*NEW_FIN*), availability of a credit rating (*CR_DUM*), and the firm's short interest as a proportion of outstanding equity (*SHORTINT*). Finally, we include a measure of relatively time-invariant proprietary costs as a control. *TradeSecrecy* is an indicator set to one for firms mentioning "trade secret" or "trade secrecy" in their 10-K report, following Glaeser (2018). We expect these firms rely on trade secrets as part of their operations, so that one of the costs of revealing information would be to compromise these trade secrets to competitors. We provide descriptive statistics for incentive and control variables in Table 5, Panel A and a correlation matrix in Table 5, Panel B.

We examine the three incentives using multiple regression models. We start in Table 6 by examining the disclosure investment strategy in the period before, during, and after a *CTO*. We report regression results for models (1) – (3), examining mandatory disclosure (*DISCINV_MAN*). The coefficient *CTO* is positive and significant in each specification, but varies little, ranging from 0.006 to 0.008. This is consistent with firm adopting a lower volume mandatory disclosure strategy when faced with a shift in proprietary costs. In contrast, the results for models (4) – (6) show a significant but negative coefficient on *CTO* in the tests of voluntary disclosure (*DISCINV_VOL*).

The coefficients here also show little variation across models, ranging from -0.017 to -0.014. Consistent with prior evidence suggesting that firms substitute more limited mandatory disclosure in response to proprietary costs with more extensive voluntary disclosure, *CTO* is associated with a higher volume voluntary disclosure strategy.

The results in Panel A reveal little variation in the periods surrounding *CTO*s. The results in Panel A are based on models including year- and industry-fixed effects. As an alternative test, we also consider a model with year- and *firm*-fixed effects. This allows us to isolate more clearly the effects of within-firm changes in disclosure strategy around periods with requests for confidential treatment. The results for *DISCINV_MAN* reveal a significant difference in the period before the *CTO* (-0.003) and during the *CTO* (0.002), suggesting a decrease in informative mandatory disclosure that is associated with a movement in our *DISCINV_MAN* scores toward one. Conversely, the coefficient on *CTO* drops from -0.004 to -0.007 for *DISCINV_VOL*. This result confirms a within-firm increase in voluntary disclosure volume around a *CTO*, but not an increase in the information provided by these disclosures.

Next, we examine variation in the expected marginal benefits of disclosure in a given period. Tests in Table 7 examine equity issuances in the form of an SEO. Beginning with Panel A of Table 7 that includes time-varying firm controls, we report regression results for $DISCINV\_MAN_t$ ($DISCINV\_VOL_t$) as the dependent variable in models (1) – (3) ([4] – [6]). Results for models (1) – (3) show that firms that are larger and with more investments in intangibles via R&D and advertising have higher $DISCINV\_MAN_t$ scores. Interestingly, we find a significant negative (positive) association between an indicator for firms with a credit rating (short interest ratios) and $DISCINV\_MAN_t$, suggesting that firms accessing debt markets tend to display lower mandatory disclosure investment scores while firms with more short interest display relatively

higher scores (all else equal). This evidence for the relation with short interest is contrary to findings in extant literature on bad news disclosure quantity.[12]

We next turn to our results for the relation between $DISCINV\_MAN_t$ and selling equity via an SEO. Models (1) – (3) in Panel A show that $DISCINV\_MAN_t$ is significantly higher in the years surrounding an SEO based on our X_{t+n} coefficients (p-values < 0.01) and is especially higher in the year of an SEO (X_{t+n} coefficient of 0.015). Adding firm-fixed effects in Panel B shows that the coefficient on X_{t+n} is significantly positive only in the year of the offering (X_t coeff. = 0.007, p-value < 0.01). We infer that mandatory disclosure investment is tilted toward a low volume, high marginal benefit strategy in the equity issuance period.

Models (4) – (6) in Table 7 Panel A presents results for voluntary disclosure efficiency models ($DISCINV\_VOL_t$). In contrast to results for *DISCINV_MAN*, we find that performance is more significantly associated with voluntary disclosure efficiency, with significant positive coefficients on *ROA* (p-values < 0.01). In line with results for *DISCINV_MAN*, we also find that firms with greater short interest report higher voluntary efficiency. Turning to results for SEO issuances shows dynamic relations for *DISCINV_VOL* comparable to that of *DISCINV_MAN*. Specifically, results in Panels A and B in model (5) show significant positive coefficients on X_t for the year of an SEO of 0.026 (p-value < 0.01) and 0.009 (p-value < 0.05), respectively. This suggests that firms also shift their voluntary disclosure portfolio toward a low volume, high marginal benefit strategy in the equity issuance period. Model (6) shows that a higher *DISCINV_VOL* is isolated to the year of the SEO, with insignificant coefficients of 0.006 and -0.007 on X_{t+1} in Panels A and B, respectively.

[12] Bao et al. (2018) document a *negative* association between short interest and disclosure. Their results, however, focus on bad news disclosures and residual short interest purged of hedging and availability of loanable share effects. As a result, these results are less comparable to the result we report in the table for broader measures of disclosure and unadjusted short interest.

Table 8 presents results of tests examining disclosure efficiency around disclosure-related securities class action lawsuits ($Lawsuit_{t+n}$). We find limited variation in models (1) – (3) for *DISCINV_MAN* in both Panels A and B. Moving to results for *DISCINV_VOL* in models (4) – (6) shows that while coefficients on the X_{t-1} indicator for the year prior to a lawsuit are insignificant and near zero in Panels A and B, coefficients on the X_t indicator for the *Lawsuit* year are negative and significant (coefficients of -0.035 and -0.045, p-value < 0.01). This evidence is consistent with firms adopting high volume, low marginal benefit investments in voluntary disclosure in the year of a lawsuit. However, our evidence suggests that in the year following a disclosure-related lawsuit, firms display *DISCINV_VOL* scores that are relatively *higher* compared to control firms. This evidence supports a dramatic shift toward a low volume, high marginal benefit voluntary disclosure strategy following the suit. In particular, the X_{t+1} coefficients in Panel A (0.025) and B (0.022) are positive and significant. This evidence lends support to the conjecture by Rogers and Van Buskirk (2009, p. 137) that litigation causes managers at sued firms to adopt "…the belief that plaintiff attorneys will use voluntary disclosures to accuse managers of misconduct…" Our evidence shows that voluntary disclosures that are relatively uninformative are elevated for sued firms in the year of the lawsuit filing.

6 Summary and Conclusion

In this study, we apply a production efficiency view to investments that firms make in generating mandatory and voluntary disclosures. To do so, we use data envelopment analysis (DEA) to develop novel measures of disclosure investment strategy for both mandatory and voluntary disclosures. By allowing for flexible, observation-level weights on disclosure inputs and capital market outputs that reflect benefits of disclosure, our approach differs fundamentally from regression-based approaches, which identify the central tendency of the data. Consistent with this,

our evidence suggests that firms adopt differing disclosure strategies around changes in proprietary costs, seasoned equity offerings, and securities class action lawsuit filings.

While we believe that we develop measures of disclosure investment strategy that will be useful to researchers, an important caveat applies when interpreting our findings. Specifically, there are a number of possible inputs and outputs that we could have included in our DEA program measuring the disclosure production function. We focused our attention on a) developing a comprehensive but parsimonious set of inputs and outputs and b) using inputs and outputs that can be readily measured. In this regard, we hope this study stimulates future research that expands and enhances our formulation of the disclosure production function, potentially using alternative inputs and outputs in the DEA program.

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Appendix A
Variable Definitions and Data Sources

Variable	Definition	Data Source
Measures of Disclosure Investment (Conditional on the Information Environment):		
DISCINV_MAN$_t$	Mandatory disclosure investment measured using Data Envelopment Analysis (DEA) based on three disclosure inputs measured using the 10-K report for fiscal year *t* (*FileLag*, *BogIndex*, *FileSize*) and three capital market outputs measured in year *t* (*LIQ*, *NumAnalyst*, *NumInstOwn*). All inputs and outputs are scaled to be non-negative and are rescaled to be increasing in disclosure timeliness/readability/quantity and in the quality of the information environment, respectively. The resulting efficiency score is scaled between 0 (furthest possible from the efficient frontier) and 1 (on the efficient frontier).	Various (See variables below)
DISCINV_VOL$_t$	Voluntary disclosure investment measured using Data Envelopment Analysis (DEA) based on four disclosure inputs for fiscal year *t* (*NumPRs*, *NumVol8Ks*, *NumMEFs*, *MEF_Precision*) and three capital market outputs measured in year *t* (*LIQ*, *NumAnalyst*, *NumInstOwn*). All inputs and outputs are scaled to be non-negative and are rescaled to be increasing in disclosure quantity/precision and in the quality of the information environment, respectively. The resulting efficiency score is scaled between 0 (furthest possible from the efficient frontier) and 1 (on the efficient frontier).	Various (See variables below)
DEA Disclosure Investment Inputs/Outputs:		
FILELAG	The inverse of the number of days between the end date of the fiscal year and the filing date of the 10-K report multiplied by 100.	SEC Analytics
BOGINDEX	The Bog Index measure of plain English readability computed using StyleWriter's software program for 10-K annual reports, where a higher Bog Index indicates a less readable document. See Bonsall et al. (2017) for details. Bog Index measures are retrieved from Brian Miller's website (https://kelley.iu.edu/bpm/index.html).	Brian Miller's website
FILESIZE	The natural logarithm of 1 + the size of the 10-K annual report file in megabytes uploaded to the SEC's EDGAR website.	SEC Analytics
LOG_PRS	The number of firm-initiated press releases issued during the 12-month period ending three months after the end of the fiscal year. Press releases are required to have an event similarity day count greater than zero and a relevance score of 100 (consistent with first-time releases of information about the firm of interest) available via *Ravenpack*'s PR Edition.	Ravenpack
LOG_VOL8Ks	The number of 8-Ks issued during the 12-month period ending 3 months after the fiscal year-end with an 8-K item classified as "Other Events" (Item 8.01) following the classification of voluntary 8-K items by Lerman and Livnat (2010). These 8-K items do not have a required filing deadline.	SEC Analytics
LOG_MEFS	The number of management earnings per share forecasts (both quarterly and annual) issued during the 12-month period ending 3 months after the fiscal year-end.	I/B/E/S Guidance
FCAST_PREC	Precision of management earnings per share forecasts measured following Li and Zhang (2015) as the width of the earnings per share forecast range provided in quantitative earnings forecasts (with point forecasts having a width of zero) scaled by the beginning of quarter price per share.	I/B/E/S Guidance
LIQ	Equity price liquidity measured based on Amihud's (2002) illiquidity measure as –1 * natural logarithm$(1 + \frac{1{,}000{,}000}{n}\sum\frac{\lvert RET\rvert}{VOL})$ where *n* is the number of trading days over the fiscal year, $\lvert RET\rvert$ is the absolute daily equity return, and *VOL* is daily dollar trading volume.	CRSP
NUM_ANALYST	The number of unique sell-side analysts issuing earnings per share forecasts for fiscal quarters ending in fiscal year t.	I/B/E/S
NUM_INSTOWN	The average number of institutional owners listed as of the required quarterly reporting periods occurring during the fiscal year.	Thomson Reuters Institutional Holdings

Determinants of Disclosure Investment:

CTO	An indicator variable set to one for firms filing at least one confidential treatment order that requests permission to redact a portion of any SEC filing (e.g., 10-K, 8-K) during the 12-month period ending three months after the fiscal year-end and to zero otherwise. Confidential treatment orders are available on the SEC's EDGAR website beginning in May 2008. As a result, we measure *CTO* for fiscal years ending on December 31, 2008 and later.	SEC Analytics
SEO	An indicator variable set to one for firms issuing equity via a seasoned equity offering during the current fiscal year and to zero otherwise.	SDC Platinum
Lawsuit	An indicator variable set to one for firms with a disclosure-related securities class action lawsuit filed under Rule 10b-5 during the fiscal year and to zero otherwise.	Stanford Securities Class Action Clearinghouse
CR_DUM	An indicator variable set to one for firms with an available issuer-level credit rating from Standard & Poor's and to zero otherwise.	Compustat
NEW_FIN	Net debt and equity financing measured following Hoberg and Phillips (2010) as [(Common and preferred stock sold - Equity repurchased) + (Long-term debt issuance – Debt retired)] / Book value of total assets.	Compustat
RDAD_EXP	The proportion of operating expenses accounted for by research and development (R&D) and advertising measured as (R&D + Advertising) / (Cost of goods sold + Selling, general, and administrative expenses).	Compustat
ShortInt	The average short interest ratio computed over the fiscal year using adjusted short interest available via *Compustat* scaled by shares outstanding as of the fiscal period-end.	Compustat
Size	The natural logarithm of the firm's equity market capitalization computed as of the end of the fiscal year using shares outstanding and price per share available via *Compustat*.	Compustat
BM	The book-to-market ratio computed using common equity (CEQ) scaled by total equity market capitalization as of the end of the fiscal year.	Compustat
LEV	Financial leverage calculated as the sum of current and non-current debt outstanding scaled by the book value of total assets as of the end of the fiscal year.	Compustat
LOSS	An indicator variable set equal to one for fiscal years with negative income before extraordinary items and to zero otherwise.	Compustat
ROA	Return on assets calculated as income before extraordinary items scaled by ending book value of total assets.	Compustat
RET	Buy-and-hold equity returns measured for the 12-month period ending 3 months after the fiscal period-end using monthly returns available from CRSP.	CRSP
TradeSecrecy	An indicator variable set to one for firms mentioning "trade secret" or "trade secrecy" in their annual 10-K report (and amendments) identified via a keyword search of the SEC Analytics database and to zero otherwise.	SEC Analytics
STD_ARET	Standard deviation of daily abnormal equity returns measured by subtracting the daily return to the firm's size and book-to-market reference portfolio using the 5x5 portfolio returns available from Kenneth French's website (https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).	CRSP; Ken French's Data Library

Table 1
Sample selection criteria for firms with data available to compute disclosure investment scores using Data Envelopment Analysis (DEA)

This table presents sample selection criteria in Panel A used to arrive at the sample of firm-year observations with data available to compute our three mandatory disclosure inputs reflecting disclosure quantity, readability, and timeliness in firm's 10-K reports filed with the SEC (*FILESIZE*, *BOGINDEX*, *FILELAG*, respectively), our four voluntary disclosure inputs reflecting quantity and precision of disclosure (*LOG_PRS*, *LOG_VOL8KS*, *LOG_MEFS*, *FCAST_PREC*), and our three outputs reflecting the quality of the firm's information environment (*NUM_ANALYST*, *NUM_INSTOWN*, *LIQ*). Further, we require data on key determinants for disclosure efficiency using data available in Compustat in fiscal year t (*BM*, *ROA*, *RDAD_EXP*, *LEV*, *ShortInt*). Variable definitions and data sources appear in Appendix A. Panel B presents the distribution of observations by year for our final sample.

Panel A: Sample selection criteria

Sample Selection Criteria	N
Firm-year observations in *Compustat* with fiscal years between 2000 and 2017	202,749
Observations missing data to measure disclosure outputs reflecting the quality of firms' information environments in fiscal year *t* (*NUM_ANALYST*, *NUM_INSTOWN*, *LIQ*) and beginning of year market capitalization	(101,151)
Observations missing data to measure mandatory disclosure inputs reflecting the quantity, readability, and timeliness of disclosure in the 10-K report filed with the SEC for fiscal year *t* (*FILESIZE*, *BOGINDEX*, *FILELAG*, respectively)	(27,377)
Observations missing data to measure voluntary disclosure inputs reflecting the quantity and precision of voluntary disclosures in fiscal year *t* (*LOG_PRS*, *LOG_VOL8KS*, *LOG_MEFS*, *FCAST_PREC*)	(523)
Observations with zero values for voluntary and/or mandatory disclosure inputs	(4,003)
Observations missing data for determinant/control variables in fiscal year *t* (*BM*, *ROA*, *RDAD_EXP*, *LEV*, *ShortInt*)	(407)
Final sample of firm-year observations	**69,288**

Table 1, continued

Panel B: Sample composition of firm-year observations by fiscal year

Fiscal Year	N	% of Total
2000	3,281	4.74%
2001	4,212	6.08%
2002	4,124	5.95%
2003	4,088	5.90%
2004	4,127	5.96%
2005	4,168	6.02%
2006	4,193	6.05%
2007	4,147	5.99%
2008	4,170	6.02%
2009	3,974	5.74%
2010	3,795	5.48%
2011	3,690	5.33%
2012	3,558	5.14%
2013	3,612	5.21%
2014	3,704	5.35%
2015	3,779	5.45%
2016	3,402	4.91%
2017	3,264	4.71%
Total	**69,288**	

Table 2
Summary statistics for inputs/outputs into the Data Envelopment Analysis (DEA) program to measure disclosure investment scores conditional on the information environment

This table presents summary statistics for the disclosure inputs/outputs for the final sample of 69,695 firm-year observations detailed in Table 1 with data available to compute all measures of mandatory and voluntary disclosure and measures of the capital market benefits of disclosure (outputs). To measure mandatory disclosure inputs, we require data available for three measures extracted from firm's annual 10-K report filed with the SEC reflecting disclosure quantity (*FILESIZE*), readability (*BOGINDEX*), and timeliness (*FILELAG*). To measure voluntary disclosure inputs, we require data available for four measures reflecting the amount of voluntary disclosure (*LOG_PRS*, *LOG_VOL8KS*, *LOG_MEFS*) and the precision of information released conditional on a disclosure being made (*FCAST_PREC*). Measures used as outputs for the DEA program reflect the capital market benefits of disclosure in terms of the quality of the firm's external information environment as proxied by coverage by sell-side equity analysts (*NUM_ANALYST*), investments by institutional investors (*NUM_INSTOWN*), and equity price liquidity using a transformed version of Amihud's (2002) illiquidity measure (*LIQ*). Variable definitions and data sources appear in Appendix A. We present summary statistics in Panel A and a correlation matrix in Panel B.

Panel A: Summary statistics of output and input variables from DEA program (N = 69,288 firm-year observations)

Variable	Mean	Std Dev	Min	Median	Max
LIQ_t	-0.323	0.817	-8.671	-0.009	0.000
$NUM\_ANALYST_t$	4.492	5.045	0.000	3.000	43.750
$NUM\_INSTOWN_t$	138.298	190.922	0	84	2483
$FILELAG_t$	1.485	0.352	0.112	1.408	7.143
$FILESIZE_t$	1.583	1.056	0.035	1.227	6.077
$BOGINDEX_t$	85.016	7.058	49	85	211
LOG_MEFS_t	0.600	0.857	0.000	0.000	3.807
$FCAST\_PREC_t$	0.191	0.392	0.000	0.000	1.000
LOG_PRS_t	2.911	0.951	0.000	3.091	6.397
LOG_VOL8KS_t	0.780	0.830	0.000	0.693	5.380

Table 2, continued

Panel B: Pearson (Spearman) correlations above (below) the diagonal among disclosure inputs and information environment outputs into DEA program

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
[1] LIQ_t		0.80	0.90	0.64	0.35	-0.19	0.39	0.26	0.55	0.18	0.93
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[2] $ln(NUM\_ANALYST)_t$	0.47		0.75	0.53	0.27	-0.17	0.42	0.32	0.50	0.13	0.77
	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[3] $ln(NUM\_INSTOWN)_t$	0.54	0.69		0.59	0.30	-0.15	0.40	0.27	0.51	0.14	0.88
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[4] $FILELAG_t$	0.32	0.48	0.49		0.50	-0.21	0.19	0.10	0.53	0.28	0.60
	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[5] $FILESIZE_t$	0.12	0.27	0.24	0.44		-0.30	-0.04	-0.08	0.51	0.42	0.32
	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[6] $(100/BOGINDEX)_t$	-0.14	-0.16	-0.13	-0.18	-0.30		-0.01	0.02	-0.27	-0.20	-0.15
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[7] LOG_MEFS_t	0.23	0.41	0.38	0.19	-0.02	-0.01		0.68	0.21	-0.09	0.37
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)		(0.00)	(0.00)	(0.00)	(0.00)
[8] $FCAST\_PREC_t$	0.15	0.30	0.25	0.10	-0.08	0.02	0.70		0.12	-0.10	0.25
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
[9] LOG_PRS_t	0.28	0.43	0.42	0.41	0.42	-0.26	0.18	0.09		0.34	0.49
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)
[10] LOG_VOL8KS_t	0.08	0.13	0.11	0.22	0.37	-0.21	-0.08	-0.10	0.29		0.14
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)
[11] $SIZE_t$	0.54	0.77	0.82	0.54	0.32	-0.14	0.37	0.23	0.43	0.15	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

Table 3
Summary statistics for measures of disclosure investment scores and determinants

This table presents summary statistics for our final sample of 69,288 firm-years over the 2000 – 2017 period with data available to compute both voluntary and mandatory disclosure efficiency using the Data Envelopment Analysis (DEA) program. Panel A (B) presents summary statistics for the full sample (separately by Fama-French 17 industry classification). Refer to Appendix A for detailed variable definitions and data sources.

Panel A: Descriptive statistics (N = 69,288 firm-year observations)

Variable	Mean	Std Dev	Min	Q1	Median	Q3	Max
$DISCINV\_MAN_t$	0.889	0.067	0.540	0.841	0.887	0.938	1.000
$DISCINV\_VOL_t$	0.442	0.239	0.079	0.257	0.379	0.570	1.000

Panel B: Disclosure investment scores by Fama-French 17 industry

Fama-French	DISCINV_MAN			DISCINV_VOL			
Industry	Mean	Median	St. Dev.	Mean	Median	St. Dev	N
Cars	0.886	0.882	0.061	0.547	0.500	0.292	3,281
Chems	0.895	0.890	0.060	0.433	0.365	0.237	4,212
Clths	0.881	0.877	0.069	0.436	0.379	0.217	4,124
Cnstr	0.876	0.872	0.067	0.416	0.352	0.220	4,088
Cnsum	0.924	0.932	0.061	0.465	0.398	0.246	4,127
Durbl	0.870	0.866	0.065	0.435	0.369	0.238	4,168
FabPr	0.874	0.870	0.060	0.421	0.349	0.238	4,193
Finan	0.859	0.855	0.065	0.432	0.374	0.230	4,147
Food	0.863	0.855	0.071	0.482	0.431	0.236	4,170
Machn	0.906	0.905	0.060	0.443	0.385	0.237	3,974
Mines	0.869	0.863	0.059	0.461	0.420	0.226	3,795
Oil	0.901	0.896	0.069	0.457	0.397	0.246	3,690
Other	0.901	0.900	0.064	0.418	0.344	0.235	3,558
Rtail	0.888	0.884	0.072	0.439	0.376	0.237	3,612
Steel	0.887	0.883	0.060	0.396	0.324	0.236	3,704
Trans	0.881	0.879	0.067	0.421	0.356	0.229	3,779
Utils	0.897	0.896	0.061	0.418	0.363	0.223	3,402

Table 4
Basic determinants models for disclosure investment

This table presents results of basic determinants models for mandatory (Panel A) and voluntary (Panel B) disclosure investment measures computed using Data Envelopment Analysis (DEA). Models are designed to measure the auto-correlation in disclosure investment scores and to examine the extent of variation explained by the separate inputs/outputs into the DEA models for the disclosure investment scores. Our measures of mandatory disclosure investment are computed using disclosure inputs from the 10-K annual report filed for fiscal year *t* that reflect the amount, readability, and timeliness of disclosure (*FILESIZE*, *BOGINDEX*, and *FILELAG*). Our measures of voluntary disclosure investment are computed using disclosure inputs that reflect the amount and precision of voluntary disclosure during year *t* (*LOG_PRS*, *LOG_VOL8KS*, *LOG_MEFS*, and *FCAST_PREC*). Both mandatory and voluntary disclosure investment scores use outputs reflecting the capital market benefits of disclosure in terms of the quality of the firm's external information environment (in period *t*) (*NUM_ANALYST*, *NUM_INSTOWN*, and *LIQ*). Models include fixed effects for fiscal year, Fama-French 17 industry, and firm where indicated. t-statistics clustered by fiscal year appear in parentheses below the coefficients. *, **, and *** denote two-tailed p-values significant at a 10%, 5%, and 1% level, respectively. Refer to Appendix A for detailed variable definitions and data sources.

Panel A: Mandatory disclosure investment (*DISCINV_MAN*) basic determinants models

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
$DISCINV\_MAN_{t-1}$	0.668***	0.638***	0.638***		
	(31.442)	(34.226)	(33.938)		
$DISCINV\_VOL_{t-1}$			0.000		
			(0.135)		
LIQ_t					0.003**
					(2.383)
$ln(NUM\_INSTOWN)_t$					0.007***
					(7.340)
$ln(NUM\_ANALYST)_t$					0.023***
					(19.435)
$(100/BOGINDEX)_t$					-0.424***
					(-22.388)
$FILESIZE_t$					-0.041***
					(-10.165)
$(100/FILELAG)_t$					-0.056***
					(-20.118)
$SIZE_t$					-0.001
					(-0.746)
Constant	0.295***				
	(15.178)				
Fixed Effects	None	Year, Industry	Year, Industry	Year, Firm	Year, Industry
Observations	58,929	58,929	58,929	58,929	69,288
Adjusted R^2	0.453	0.472	0.472	0.532	0.559

Table 4, continued

Panel B: Voluntary disclosure investment (*DISCINV_VOL*$_t$) basic determinants models

Model	(1)	(2)	(3)	(4)	(5)
$DISCINV\_VOL_{t-1}$	0.460***	0.452***	0.440***		
	(15.742)	(19.233)	(19.031)		
$DISCINV\_MAN_{t-1}$			0.179***		
			(7.312)		
LIQ_t					0.024***
					(4.048)
$\ln(NUM\_INSTOWN)_t$					0.055***
					(6.753)
$\ln(NUM\_ANALYST)_t$					0.159***
					(19.265)
LOG_PRS_t					-0.123***
					(-22.452)
LOG_VOL8KS_t					-0.102***
					(-28.503)
LOG_MEFS_t					-0.040***
					(-5.913)
$FCAST\_PREC_t$					-0.060***
					(-8.564)
$SIZE_t$					-0.045***
					(-15.363)
Constant	0.233***				
	(20.801)				
Fixed Effects	None	Year, Industry	Year, Industry	Year, Firm	Year, Industry
Observations	58,929	58,929	58,929	58,929	69,288
Adjusted R^2	0.219	0.245	0.248	0.363	0.407

Table 5
Summary statistics for measures of disclosure investment scores and determinants

This table presents summary statistics for determinants and control variables used in our tests examining disclosure investment scores from our Data Envelopment Analysis (DEA) program around equity issuances and securities litigation. Panel A presents summary statistics for the full sample of observations with data available for tests, and Panel B reports the correlation matrix among these variables. Our primary variables of interest are the disclosure investment scores for mandatory (*DISCINV_MAN*) and voluntary (*DISCINV_VOL*) disclosure investment. Refer to Appendix A for detailed variable definitions and data sources.

Panel A: Descriptive statistics

Variable	Mean	Std Dev	Min	Q1	Median	Q3	Max	N
Determinants models:								
$SIZE_t$	6.184	1.992	-3.730	4.757	6.131	7.499	13.348	69,288
BM_t	0.633	0.707	-4.125	0.277	0.505	0.822	7.917	69,288
ROA_t	-0.030	0.217	-1.556	-0.023	0.018	0.064	0.365	69,288
$LOSS_t$	0.315	0.464	0	0	0	1	1	69,288
NEW_FIN_t	0.041	0.170	-0.346	-0.025	0.000	0.044	1.189	69,288
$RDAD\_Exp_t$	0.086	0.162	0.000	0.000	0.015	0.088	0.846	69,288
LEV_t	0.225	0.225	0.000	0.028	0.168	0.352	1.133	69,288
CR_DUM_t	0.284	0.451	0	0	0	1	1	69,288
$ShortInt_t$	0.036	0.050	0.000	0.002	0.017	0.047	0.346	69,288
$TradeSecrecy_t$	0.495	0.500	0	0	0	1	1	69,288
Equity issuance and litigation tests:								
CTO_t	0.123	0.328	0	0	0	0	1	30,019
SEO_t	0.069	0.254	0	0	0	0	1	65,174
$Lawsuit_t$	0.025	0.157	0	0	0	0	1	65,174

Table 5, continued

Panel B: Univariate correlations (Pearson below and Spearman above the diagonal)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
[1] DISCINV_MAN		0.22	0.24	0.10	0.11	-0.16	0.13	-0.03	0.20	-0.03	0.14	0.01	-0.19
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)
[2] DISCINV_VOL	0.24		0.03	-0.02	0.08	-0.04	0.00	0.09	0.02	-0.01	0.18	0.04	-0.18
	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.45)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)
[3] TradeSecrecy	0.24	0.02		0.08	0.00	-0.23	0.21	-0.12	0.48	-0.18	0.06	-0.11	-0.03
	(0.00)	(0.00)		(0.00)	(0.46)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[4] New_FIN	0.15	-0.01	0.15		-0.10	-0.10	0.15	-0.26	0.08	0.07	-0.04	-0.08	0.08
	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[3] SIZE	0.12	0.07	0.01	-0.14		-0.26	-0.58	0.36	-0.05	0.20	0.46	0.55	-0.90
	(0.00)	(0.00)	(0.02)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[4] BM	-0.11	-0.02	-0.15	-0.12	-0.23		0.09	-0.19	-0.27	-0.05	-0.20	-0.06	0.33
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[5] STD_ARET	0.09	-0.01	0.16	0.20	-0.47	0.17		-0.44	0.23	-0.14	-0.27	-0.32	0.59
	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[8] ROA	-0.13	0.06	-0.23	-0.55	0.29	0.04	-0.47		-0.18	-0.05	0.19	0.15	-0.40
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
[9] RDAD_EXP	0.27	0.01	0.41	0.39	-0.06	-0.17	0.23	-0.50		-0.30	0.03	-0.19	0.03
	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)
[10] LEV	0.01	0.00	-0.14	0.06	0.13	-0.12	0.00	-0.02	-0.17		0.09	0.39	-0.20
	(0.06)	(0.85)	(0.00)	(0.00)	(0.00)	(0.00)	(0.68)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
[11] ShortInt	0.15	0.18	0.08	-0.03	0.24	-0.11	-0.10	0.08	0.05	0.05		0.20	-0.52
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)
[12] CR_DUM	0.01	0.03	-0.11	-0.11	0.55	-0.07	-0.23	0.17	-0.19	0.33	0.08		-0.53
	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)
[13] ILLIQ	-0.17	-0.12	-0.06	-0.02	-0.50	0.29	0.37	-0.14	-0.05	-0.07	-0.24	-0.22	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

Table 6

Disclosure investment and confidential treatment orders (CTO)

This table presents results of OLS regressions where mandatory (*DISCINV_MAN*) and voluntary (*DISCINV_VOL*) disclosure investment scores computed using Data Envelopment Analysis (DEA) appear as dependent variables, and the independent variable of interest is an indicator for periods where the firm files at least one request for confidential treatment of an SEC filing (e.g., 10-K, 8-K) during the 12-month period ending 3 months after fiscal year-end (*CTO*). Our measures of mandatory disclosure efficiency are computed using disclosure inputs from the 10-K annual report filed for fiscal year *t* that reflect the amount, readability, and timelines of disclosure (*FILESIZE*, *BOGINDEX*, and *FILELAG*, respectively). Our measures of voluntary disclosure efficiency are computed using disclosure inputs that reflect the amount and precision of voluntary disclosure during year *t* (*LOG_PRS*, *LOG_VOL8KS*, *LOG_MEFS*, and *FCAST_PREC*). Both mandatory and voluntary efficiency scores use outputs reflecting the capital market benefits of disclosure in terms of the quality of the firm's external information environment (in period *t*) (*NUM_ANALYST*, *NUM_INSTOWN*, and *LIQ*). Indicators are included for the year prior to (Models 1 and 4), year of (Models 2 and 5), and year following (Models 3 and 6) a seasoned equity offering. Models in Panels A include firm-level controls shown in prior research to be associated with the extent and/or quality of disclosure and Fama-French 17 industry-fixed effects as controls. Panel B includes firm-fixed effects. All models include fixed effects for fiscal year. t-statistics clustered by fiscal year appear in parentheses below the coefficients. *, **, and *** denote two-tailed p-values significant at a 10%, 5%, and 1% level, respectively. Refer to Appendix A for detailed variable definitions and data sources.

Table 6, continued

Disclosure investment scores (*DISCINV_MAN*, *DISCINV_VOL*) around confidential treatment orders (*CTO*)

Dependent variable	DISCINV_MAN			DISCINV_VOL		
X(t+n) indicator for:	Year before CTO (t-1)	CTO year (t)	Year after CTO (t+1)	Year before CTO (t-1)	CTO year (t)	Year after CTO (t+1)
Model	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Omitting firm-fixed effects						
X(t+n)	0.006***	0.008***	0.008***	-0.017**	-0.015***	-0.014***
	(6.823)	(8.628)	(11.547)	(-3.037)	(-4.195)	(-3.429)
New_FIN	0.046***	0.045***	0.045***	0.021**	0.021**	0.020**
	(10.107)	(10.130)	(10.062)	(2.920)	(2.882)	(2.777)
Size	0.008***	0.008***	0.008***	0.004	0.004	0.004
	(9.200)	(9.180)	(9.154)	(1.431)	(1.430)	(1.431)
BM	0.001	0.001	0.001	0.002	0.002	0.002
	(0.854)	(0.862)	(0.873)	(0.730)	(0.743)	(0.733)
STD_ARET	0.318***	0.316***	0.317***	-0.526**	-0.526**	-0.528**
	(6.654)	(6.709)	(6.670)	(-3.060)	(-3.069)	(-3.082)
ROA	0.022***	0.022***	0.022***	0.075***	0.075***	0.074***
	(8.260)	(8.232)	(8.452)	(6.379)	(6.363)	(6.291)
Loss	0.011***	0.010***	0.010***	0.018***	0.018***	0.018***
	(10.420)	(10.328)	(9.948)	(4.454)	(4.463)	(4.349)
Lev	0.012***	0.012***	0.012***	0.002	0.002	0.002
	(5.853)	(5.803)	(5.862)	(0.311)	(0.318)	(0.309)
RDAD_Exp	0.072***	0.070***	0.070***	0.043*	0.042*	0.041*
	(18.163)	(17.620)	(18.696)	(1.912)	(1.963)	(2.087)
CR_DUM	-0.003**	-0.003*	-0.003*	-0.000	-0.000	-0.000
	(-2.328)	(-2.237)	(-2.217)	(-0.012)	(-0.024)	(-0.037)
ShortInt	0.145***	0.144***	0.144***	0.989***	0.988***	0.988***
	(15.097)	(15.221)	(15.168)	(30.649)	(28.633)	(29.317)
Fixed effects	Year, Industry	Year, Industry	Year, Industry	Year, Industry	Year, Industry	Year, Industry
Observations	30,019	30,019	30,019	30,019	30,019	30,019
Adjusted R^2	0.208	0.209	0.209	0.099	0.099	0.099
Panel B: Firm-fixed effects models						
X(t+n)	-0.003**	0.002	0.000	-0.004	-0.007***	-0.004
	(-2.755)	(1.826)	(0.173)	(-0.510)	(-4.170)	(-0.686)
Fixed effects	Year, Firm	Year, Firm	Year, Firm	Year, Firm	Year, Firm	Year, Firm
Observations	30,019	30,019	30,019	30,019	30,019	30,019
Adjusted R^2	0.625	0.625	0.625	0.459	0.459	0.459

Table 7

Disclosure investment and seasoned equity offerings (SEO)

This table presents results of OLS regressions where mandatory (*DISCINV_MAN*) and voluntary (*DISCINV_VOL*) disclosure investment scores computed using Data Envelopment Analysis (DEA) appear as dependent variables, and independent variables of interest are indicators for years surrounding equity issuances in the form of seasoned equity offerings (*SEO*). Our measures of mandatory disclosure efficiency are computed using disclosure inputs from the 10-K annual report filed for fiscal year *t* that reflect the amount, readability, and timelines of disclosure (*FILESIZE*, *BOGINDEX*, and *FILELAG*, respectively). Our measures of voluntary disclosure efficiency are computed using disclosure inputs that reflect the amount and precision of voluntary disclosure during year *t* (*LOG_PRS*, *LOG_VOL8KS*, *LOG_MEFS*, and *FCAST_PREC*). Both mandatory and voluntary efficiency scores use outputs reflecting the capital market benefits of disclosure in terms of the quality of the firm's external information environment (in period *t*) (*NUM_ANALYST*, *NUM_INSTOWN*, and *LIQ*). Indicators are included for the year prior to (Models 1 and 4), year of (Models 2 and 5), and year following (Models 3 and 6) a seasoned equity offering. Models in Panels A include firm-level controls shown in prior research to be associated with the extent and/or quality of disclosure and Fama-French 17 industry-fixed effects as controls. Panel B includes firm-fixed effects. All models include fixed effects for fiscal year. t-statistics clustered by fiscal year appear in parentheses below the coefficients. *, **, and *** denote two-tailed p-values significant at a 10%, 5%, and 1% level, respectively. Refer to Appendix A for detailed variable definitions and data sources.

Table 7, continued

Disclosure investment scores (*DISCINV_MAN*, *DISCINV_VOL*) around seasoned equity offerings (*SEO*)

Dependent variable	DISCINV_MAN			DISCINV_VOL		
X(t+n) indicator for:	Year before SEO (t-1)	SEO year (t)	Year after SEO (t+1)	Year before SEO (t-1)	SEO year (t)	Year after SEO (t+1)
Model	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Omitting firm-fixed effects						
X(t+n)	0.005**	0.015***	0.006***	0.004	0.026***	0.006
	(2.401)	(6.897)	(3.861)	(0.585)	(5.579)	(0.995)
TradeSecrecy	0.011***	0.011***	0.011***	0.007**	0.007**	0.007**
	(13.074)	(13.050)	(13.058)	(2.668)	(2.636)	(2.669)
Size	0.005***	0.005***	0.005***	-0.000	-0.000	-0.000
	(5.747)	(5.685)	(5.687)	(-0.030)	(-0.026)	(-0.049)
BM	-0.002	-0.002	-0.002*	0.001	0.001	0.000
	(-1.617)	(-1.530)	(-1.741)	(0.217)	(0.300)	(0.182)
STD_ARET	0.220***	0.218***	0.217***	-0.227	-0.230	-0.230
	(3.727)	(3.680)	(3.704)	(-1.147)	(-1.152)	(-1.159)
ROA	0.012**	0.013**	0.012**	0.076***	0.078***	0.076***
	(2.607)	(2.828)	(2.504)	(4.931)	(5.102)	(5.031)
Loss	0.009***	0.009***	0.009***	0.003	0.003	0.003
	(8.917)	(8.976)	(8.768)	(0.434)	(0.434)	(0.426)
Lev	0.009***	0.010***	0.009***	-0.004	-0.003	-0.004
	(3.816)	(3.868)	(3.824)	(-0.409)	(-0.389)	(-0.406)
RDAD_Exp	0.073***	0.071***	0.073***	0.064***	0.060***	0.064***
	(21.860)	(21.129)	(21.214)	(3.877)	(3.536)	(3.771)
CR_DUM	-0.004***	-0.004***	-0.004***	0.003	0.003	0.004
	(-3.394)	(-3.416)	(-3.231)	(1.056)	(0.938)	(1.080)
ShortInt	0.138***	0.136***	0.136***	0.863***	0.859***	0.861***
	(23.831)	(23.046)	(23.715)	(16.489)	(16.284)	(16.438)
Fixed effects	Year, Industry	Year, Industry	Year, Industry	Year, Industry	Year, Industry	Year, Industry
Observations	65,174	65,174	65,174	65,174	65,174	65,174
Adjusted R^2	0.174	0.176	0.174	0.081	0.081	0.081
Panel B: Firm-fixed effects models						
X(t+n)	-0.004***	0.007***	0.001	-0.021***	0.009**	-0.007
	(-3.021)	(5.465)	(0.860)	(-4.570)	(2.149)	(-0.941)
Fixed effects	Year, Firm	Year, Firm	Year, Firm	Year, Firm	Year, Firm	Year, Firm
Observations	65,174	65,174	65,174	65,174	65,174	65,174
Adjusted R^2	0.515	0.515	0.515	0.336	0.335	0.335

Table 8
Disclosure investment and disclosure-related securities class action litigation

This table presents results of OLS regressions where mandatory (*DISCINV_MAN*) and voluntary (*DISCINV_VOL*) disclosure investment scores computed using Data Envelopment Analysis (DEA) appear as dependent variables, and independent variables of interest are indicators for years surrounding disclosure-related securities class action lawsuits filed under Rule 10b-5 (*Lawsuit*). Our measures of mandatory disclosure efficiency are computed using disclosure inputs from the 10-K annual report filed for fiscal year *t* that reflect the amount, readability, and timelines of disclosure (*FILESIZE*, *BOGINDEX*, and *FILELAG*, respectively). Our measures of voluntary disclosure efficiency are computed using disclosure inputs that reflect the amount and precision of voluntary disclosure during year *t* (*LOG_PRS*, *LOG_VOL8KS*, *LOG_MEFS*, and *FCAST_PREC*). Both mandatory and voluntary efficiency scores use outputs reflecting the capital market benefits of disclosure in terms of the quality of the firm's external information environment (in period *t*) (*NUM_ANALYST*, *NUM_INSTOWN*, and *LIQ*). Indicators are included for the year prior to (Models 1 and 4), year of (Models 2 and 5), and year following (Models 3 and 6) each type of equity issuance. Models in Panel A include firm-level controls shown in prior research to be associated with the extent and/or quality of disclosure and Fama-French 17 industry-fixed effects as controls. Panel B includes firm-fixed effects. All models include fixed effects for fiscal year. t-statistics clustered by fiscal year appear in parentheses below the coefficients. *, **, and *** denote two-tailed p-values significant at a 10%, 5%, and 1% level, respectively. Refer to Appendix A for detailed variable definitions and data sources.

Table 8, continued

Disclosure investment scores (*DISCINV_MAN, DISCINV_VOL*) around securities class action lawsuits filed under Rule 10b-5 (*Lawsuit*)

Dep.variable	DISCINV_MAN$_t$			DISCINV_VOL$_t$		
X(t+n) indicator for:	Year before Lawsuit (t-1)	Lawsuit year (t)	Year after Lawsuit (t+1)	Year before Lawsuit (t-1)	Lawsuit year (t)	Year after Lawsuit (t+1)
Model	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Lawsuit models omitting firm-fixed effects						
X(t+n)	0.015***	0.012***	0.011***	-0.001	-0.035***	0.025**
	(5.253)	(5.615)	(4.768)	(-0.083)	(-3.847)	(2.527)
Sizet	0.004***	0.004***	0.005***	0.001	0.001	0.001
	(4.517)	(4.596)	(4.687)	(0.280)	(0.398)	(0.226)
BMt	-0.001	-0.001	-0.001	0.000	0.001	-0.000
	(-1.310)	(-1.400)	(-1.332)	(0.054)	(0.212)	(-0.008)
ROAt	0.019***	0.020***	0.020***	0.091***	0.088***	0.092***
	(4.791)	(5.041)	(4.874)	(5.605)	(5.156)	(5.649)
Losst	0.013***	0.013***	0.013***	0.003	0.004	0.002
	(11.300)	(11.205)	(11.324)	(0.393)	(0.509)	(0.307)
Levt	0.007**	0.007**	0.007**	-0.007	-0.007	-0.007
	(2.868)	(2.812)	(2.818)	(-0.782)	(-0.779)	(-0.779)
RDAD_Expt	0.075***	0.076***	0.075***	0.064***	0.063***	0.063***
	(20.767)	(20.933)	(20.441)	(3.835)	(3.811)	(3.807)
New_FINt	0.033***	0.034***	0.034***	0.027***	0.025**	0.028***
	(8.696)	(9.043)	(8.963)	(2.919)	(2.564)	(2.909)
CR_DUMt	-0.004***	-0.004***	-0.004***	0.003	0.003	0.003
	(-3.090)	(-3.107)	(-3.243)	(0.991)	(0.846)	(0.993)
ShortIntt	0.141***	0.140***	0.140***	0.865***	0.872***	0.860***
	(23.425)	(23.287)	(23.445)	(16.077)	(16.073)	(16.165)
Fixed effects	Year, Industry	Year, Industry	Year, Industry	Year, Industry	Year, Industry	Year, Industry
Observations	65,174	65,174	65,174	65,174	65,174	65,174
Adjusted R^2	0.172	0.171	0.171	0.081	0.081	0.081
Panel B: Lawsuit models including firm-fixed effects						
X(t+n)	0.010***	0.007***	0.003	-0.005	-0.045***	0.022**
	(7.042)	(4.989)	(1.542)	(-0.379)	(-7.552)	(2.415)
Fixed effects	Year, Firm	Year, Firm	Year, Firm	Year, Firm	Year, Firm	Year, Firm
Observations	65,174	65,174	65,174	65,174	65,174	65,174
Adjusted R^2	0.515	0.515	0.515	0.335	0.336	0.335