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# On the relationship between analyst reports and corporate disclosures: Exploring the roles of information discovery and interpretation

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# On the relationship between analyst reports and corporate disclosures: Exploring the roles of information discovery and interpretation*

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**Abstract**

We examine the relationship between analyst research and corporate earnings announcements to explore the relative importance of information discovery versus interpretation of previously released information. Using equity market reaction to capture information content, we find that information discovery (interpretation) dominates in the week before (after) firms announce their earnings. In addition, we find that the interpretation role increases in importance with the difficulty of financial accounting information. Analysis of all weeks surrounding earnings announcements shows that the information discovery role is overall more important. We are able to reconcile this result with the opposite finding in Francis et al. (2002).

Key words: analyst research; information content; earnings announcements, information discovery.

JEL Classification: G14, G29, M41, M45

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## 1. Introduction

Financial analysts are important information intermediaries in capital markets. They provide information that investors value, as demonstrated in a substantial body of research. The usefulness of analyst research potentially derives from two sources: the discovery of private information and interpretation of public information (e.g., Ivkovic and Jegadeesh 2004; Asquith et al. 2005). If analysts primarily discover and publish material private information, then analyst reports will tend to pre-empt subsequent corporate disclosures. On the other hand, if analyst reports primarily interpret existing public information, such as previously released quarterly earnings reports, then corporate disclosures that are information rich (poor) will tend to be followed by more (less) informative analyst reports because there is more (less) material for analysts to dissect; that is, the two reports tend to reinforce each other.

A number of studies have investigated the impact of analyst coverage on the information content of earnings announcements and find results that are generally consistent with the information discovery role of analyst research: the market impact of earnings announcements tends to be lower for firms with more analysts following (e.g., Dempsey 1989; Shores 1990).[1] On the other hand, more recent studies (Francis et al. 2002; Frankel et al. 2006) present contrary evidence. For example, Francis et al. find a positive association between the market reaction to quarterly earnings announcements and the market reaction to analysts' research reports, aggregated over annual intervals. This evidence is consistent with the two sources of information primarily reinforcing each other. In the terminology of Francis et al., they find evidence in favor of "complementarity" and against "substitution" of analyst reports and

[1] We use "information content," "market impact," and "market reaction" interchangeably, referring to the absolute value of abnormal returns surrounding event dates.

earnings announcements.[2]

In this paper, we argue that both the information discovery and interpretation roles are important for a sequence of two information events. An accurate analyst forecast of earnings can pre-empt the impact of a quarterly earnings announcement, while an informative earnings announcement with precise forward looking information can pre-empt information in subsequent analyst reports. On the other hand, two information sources can reinforce each other if the first information source provides complex data that is made more informative after additional explanation and interpretation by the second source. For examples, analysts can help interpret the implication of a newly announced technology development for future performance; and corporate disclosures can provide facts and explanations to confirm or deny speculations, predictions, and forecasts made by analysts.[3]

Since we expect both information discovery and interpretation roles to be important, we choose contexts under which one of the two roles is likely to dominate. Our review of analyst reports (see Appendix A) suggests that these reports are systematically different depending on the timing of their release relative to quarterly earnings announcement.[4] In the week before earnings announcements, about half of the analyst reports have the purpose of previewing earnings, suggesting that analysts are trying to discover information ahead of upcoming earnings announcement. Right after companies announce earnings, Appendix A suggests that analyst

[2] We do not follow Francis et al.'s use of the terms "complements" and "substitutes" because their usage is inconsistent with the definitions of these terms. In economics, goods X and Y are complements (substitutes) if and only if an increase in the price of X decreases (increases) the demand for Y. All of the studies in this line of inquiry look only at the quantity (and perhaps quality) of information, but not prices.
[3] An example using academic research can illustrate this existence of both pre-emption and reinforcement effects. A research paper published just before another tends to pre-empt the impact of the later work, while the theories and results from one research paper can also stimulate future research.
[4] We focus on quarterly earnings announcements, a type of corporate disclosure that is regular and mandatory. Other types of corporate disclosures are less suitable for this study due to various limitations. For instance, managerial disclosures are voluntary and subject to selection bias; merger announcements and bond rating announcements are less frequent and lead to less powerful tests.

reports for the most part interpret the just-released earnings and therefore they are most likely to help investors understand the implication of the earnings announcements for future performance.[5] This interpretation role of analyst research is arguably more important for corporate disclosures that are more complex, such as information from firms that have high R&D, are large, or have high growth opportunities. However, the earnings announcement can also pre-empt analyst reports issued later: earnings announcements that are more informative about future earnings leave fewer opportunities for analysts to acquire additional information.

We measure information content of an earnings announcement or analyst research as the absolute value of size-adjusted stock returns on the day of the announcement. For analyst research, we aggregate the information content by week. We then estimate the association between the information content of analyst research and that of earnings announcements, separately for the pre- and post-earnings announcement periods, where a negative (positive) association indicates pre-emption (reinforcement). In the analyses, we control for return volatility and proxies for pre-disclosure information environment, such as firm size, analyst coverage, and the information content of prior analyst research. We also control for analysts' reporting decision using the Heckman (1979) two-step procedure. The sample spans a 10 year period from 1994 to 2003.

In these regressions, we find a negative association between the information content of the two information sources for the first week, as well as for the second to the sixth weeks, before the earnings announcement. On the other hand, we find a positive association between the information content of earnings announcements and that of analyst research in the first subsequent week. This relationship then diminishes in the second week, turns negative in the

[5] Quarterly earnings announcements contain much more than the summary earnings number. For brevity, we often use the term "earnings" as short hand for the set of information contained in quarterly earnings announcements.

third and fourth weeks, and becomes significantly negative in the fifth to sixth weeks after earnings announcements. Thus, the quarterly pattern centered on the earnings announcement looks as follows, where "+"and "–" indicate positive and negative relations, and $0^+$ and $0^-$ indicate insignificant positive and negative relations, respectively:

| Week: | -6 | -5 | -4 | -3 | -2 | -1 | 0 | +1 | +2 | +3 | +4 | +5 | +6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Relation: | – | – | – | – | – | – | | + | $0^+$ | $0^-$ | $0^-$ | – | – |

Lastly, we find that the interpretation role of analyst research is stronger and more long-lasting for firms with more complex information, consistent with our prediction.

Our overall finding of a negative relation stands in contrast to the positive relation reported in Francis et al. (2002) (FSV hereafter). We conduct extensive analyses to reconcile the difference. We show that the research design used in FSV introduces two biases toward finding a positive relation. The first bias arises from the sample composition where some firms-years have less than four quarters of data, artificially inducing positive co-variation in the annually-aggregated information content measures. The second bias arises from the simultaneity of analysts' decision to issue research reports and the informativeness of earnings announcements; conditions that result in firm-quarters having more informative earnings announcements also attract more private information acquisition activities.

Our empirical analyses demonstrate the significance of these confounding effects. We first show that removing the sampling bias, by restricting to firm-years with four earnings announcements, turns the positive association found in FSV into an insignificant association. Second, we show that reducing the effect of simultaneity, by either reducing the length of the aggregation period or focusing on firm-years with analyst research in all four quarters, changes the insignificant association to a negative relation.

This paper contributes to our understanding of the role played by financial analysts.

Despite the extensive academic research on financial analysts, it is still unclear what roles financial analysts play in relation to the corporate financial reporting. Focusing on specific settings enables us to document the co-existence of the two distinct roles of financial analysts: discovering / disseminating information and interpreting corporate disclosures. Such evidence reveals the richness of financial analysts' functions.

Understanding the relationship between analyst research and corporate disclosures is critical to furthering our knowledge of firms' information environments. It is also important for evaluating the relative importance of corporate disclosures for investors' decisions (Francis et al. 2002). The evidence supporting the information discovery role suggests that the relative importance of corporate disclosures is indeed reduced by the availability of other information sources. On the other hand, the evidence supporting the interpretation role in the period immediately after an earnings announcement suggests that the importance of an earnings announcement goes beyond its immediate market impact because earnings announcements also induce subsequent analyst research.

The remainder of this paper proceeds as follows. Section 2 develops hypotheses and discusses research designs. Section 3 describes the sample and variable measurement. Section 4 reports the tests of our hypotheses. We reconcile our results with those in Francis et al. (2002) in Section 5. Section 6 reports supplemental analyses and Section 7 concludes.

## 2. Hypothesis development and research design

This section discusses prior research that leads to our hypotheses. We then describe the research design we use to test these hypotheses. We are interested in the two roles that analysts and managers play with respect to the public dissemination of information. They can make these public disclosures based on information that they discover, or based on their interpretation of the information that others have released. Most disclosures are likely to be a combination of these two roles. When information discovery dominates, we expect to see pre-emption; when interpretation dominates, we expect to see reinforcement.

### *2.1 Theory and evidence on information discovery*

Both managers and analysts attempt to resolve uncertainty surrounding firms' future cash flows and earnings. While they have different access to information, both are nonetheless capable of discovering some information. One party discovering and disseminating information publicly pre-empts information from the other party (Holthausen and Verrechia 1988). For example, if more information is disclosed by analysts, the market reaction to the subsequent earnings announcement would be lower.[6]

While the idea of pre-emption is fairly intuitive, the possible endogeneity of the two sources of information can counteract pre-emption. For example, if analysts anticipate significant price-moving information in the earnings announcement, they will intensify information search activities (McNichols and Trueman 1994; Demski and Feltham 1994).

However, analysts' information search efforts are based on their expectations only (i.e., they cannot perfectly predict the information content of earnings reports). In addition, information search is costly, so analysts will only seek to acquire information when it is cost-effective to do so. Some firms have a relatively large amount of private information not accessible by analysts, preventing analyst reports from being informative, yet the firms' public announcements can be very informative if the firm releases that private information in the

[6] As a more concrete example, suppose the firm sells petroleum. Both the analyst and the firm's managers can provide information regarding oil prices, demand forecasts, futures prices, and the amount of hedging, and so on. Thus, there is a high overlap in information sources ex ante. Ex post, in a particular quarter, the analyst is able to accurately predict the company's operating results, so the investors react weakly to the subsequent earning announcement. In a different quarter, the analyst is unable to predict operating performance accurately, so investors are surprised by, and react strongly to, the subsequent earnings report.

earnings announcement. Other firms have relatively low cost of information acquisition and low information asymmetry, such that information that would otherwise be released in the earnings announcement can be pre-empted by analyst reports. For the above reasons, we expect endogeneity to weaken but not eliminate the pre-emption effect of analyst research on subsequent earnings announcements.

Early empirical research provides evidence consistent with the information discovery role of analyst research. Dempsey (1989) and Shores (1990) find that the information content of earnings announcements decreases with analyst coverage.[7] Prior studies have also investigated whether analyst coverage affects the extent to which stock returns reflect future earnings. For example, Ayers and Freeman (2003) find that when annual returns are regressed on contemporaneous and future earnings, the coefficient on contemporaneous earnings decreases with analysts following, while that on future earnings increases with analysts following. These results suggest that stock prices of companies with more analysts following incorporate more timely information from analysts regarding earnings in the future years, consistent with analyst research pre-empting earnings news.

The above empirical studies focus on the sequence of information releases in which analyst reports precede corporate disclosures. However, the pre-emption effect also applies to the reverse sequence: informative disclosures provided by the company can pre-empt analyst reports that are issued later. If an earnings announcement greatly resolves uncertainty about future performance, the remaining uncertainty will be low, leaving less information for analysts to discover.

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[7] In contrast, El-Gazzar (1998) uses a more recent sample and finds that the effect of analysts following on the information content of earnings announcements is insignificant or positive after controlling for firm size and institutional ownership.

### *2.2 Theory and evidence on the interpretation role*

Kim and Verrecchia (1994) argue that market participants have different abilities to interpret public announcements. Financial analysts on average possess superior information processing abilities and are better at interpreting public announcements because they have better training, more experience, and more knowledge about the firm/industry. An analyst with accounting expertise can help investors to understand the meaning of certain accruals while an analyst with training on political economics can better understand the implication of backorders from Brazil (Barron et al. 2002). Analysts' information interpretation expertise is also exemplified in many of the analyst reports we read (Appendix A): after earnings announcements, analysts often discuss the effect of changes in accounting methods, the effect of one-time charges, how to re-compile the financial statements to ensure over-time comparability when there is a merger or acquisition, and the implication of a change in corporate strategy for future performance. Thus, analysts can provide useful reports to investors by helping them to process the information disclosed in earnings announcements.[8] Naturally, if the earnings announcement is uninformative, analysts have no opportunity to exploit their superior information processing ability.

A similar argument can be made for company management discussing prior analyst reports in their earnings release, thereby reinforcing the prior disclosure. Analysts potentially discover new but imprecise information about a company that is later confirmed, adjusted, or refuted by the company's disclosures. For example, an analyst discusses a significant investment project that is rumored to be made, and the company later provides more specific details on this project as part of its earnings announcement or in the accompanying conference calls.

Recent studies find that the information content of analyst research is positively correlated

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[8] Most readers will appreciate an analogous example from a classroom setting: information-rich lectures arguably lead to more in-depth discussion and interpretation by tutorial leaders.

with that of earnings announcements, suggesting that the two information sources reinforce rather than pre-empt each other. Unlike earlier studies, Francis et al. (2002) and Frankel et al. (2006) measure the information content of analyst research by summing the absolute value of abnormal returns associated with each research report disclosed in a year. Francis et al. capture the information content of earnings announcements in a similar fashion by summing the absolute value of abnormal returns associated with the quarterly earnings announcements in a year, while Frankel et al. use the explanatory power of earnings and book value for stock prices. Despite their results, Francis et al. (2002, 340) conclude, "… although our evidence casts doubt on the substitution relation by theory [i.e., pre-emption], the exact nature of the relation between earnings announcements and analyst reports remains unsettled."

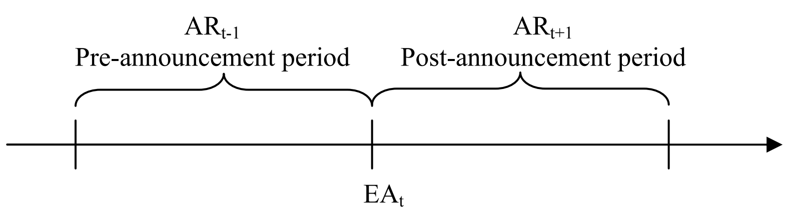
### *2.3 Hypothesis 1*

The above discussion suggests that an information event can pre-empt a second information event, and at the same time, the second information event can reinforce the first event by providing additional interpretations. Analyst research disclosed *before* an earnings announcement can pre-empt the upcoming earnings announcement, while this earnings announcement can confirm or refute analysts' conjectures disclosed in previous research reports. Similarly, analyst research disclosed *after* an earnings announcement can be more informative if it helps investors interpret the earnings announcement, but it might be less informative if the information is pre-empted by the earnings announcement. Thus, the information content of analyst research and corporate disclosures can have a relationship that is either negative (i.e., pre-emption) or positive (i.e., reinforcement), which respectively support the dominance of the information discovery role or the interpretation role. Because either role can dominate the other, we state our hypothesis in non-directional terms. We focus on the relation immediately before and after earnings announcement to maximize the power of our tests to detect each of these two roles.

> **H1**: The information content of an earnings announcement is systematically associated with (1) that of analysts' research reports released before it and (2) that of analysts' research reports released after it.

A key element of our tests of H1 is specifying the relative *timing* of analyst research and earnings announcements, as illustrated in Figure 1. This design distinguishes our study from previous ones (e.g., Francis et al. 2002). It allows the role of analyst research to be contingent upon whether the analyst report precedes or follows the earnings announcement.

**Figure 1 The relative timing of analyst research and earnings announcements**




Note: AR = analyst research; EA= earnings announcements

We test hypothesis H1 by examining the coefficients from regressing the information content of the later information on that of the earlier information. Two equations thus result (firm and quarter subscripts are omitted for brevity):

$$IC\_EA_t = \alpha + \beta \cdot IC\_AR_{t-1} + controls + \varepsilon , \quad (1)$$

$$IC\_AR_{t+1} = \alpha + \beta \cdot IC\_EA_t + controls + \varepsilon , \quad (2)$$

where $IC\_EA_t$ denotes the information content of earnings announcements on date *t* and $IC\_AR_{t-1}$ ($IC\_AR_{t+1}$) denotes the information content of analyst research prior to (following) date *t*. (Details on the measurement of information content and the control variables are provided in Section 3.2.) A negative (positive) $\beta$ coefficient indicates a pre-emptive (reinforcing) relation, consistent with the dominance of the information discovery (interpretation) role of earnings announcements or analyst research.

We denote the quarterly earnings report dates as day 0. Since we cannot distinguish the information content of analysts' research reports disclosed concurrently with earnings reports, we exclude analyst reports released on days -1, 0, and +1.[9] The pre-announcement period thus ends with day -2 and the post-announcement period starts with day +2. Our first test of H1 focuses on the last trading week before the earnings announcement (days [-6, -2]) and the first trading week after the earnings announcement (days [+2, +6]). To examine the time series pattern of the information discovery and interpretation roles, we then analyze five more weeks on each side of the earnings announcements. In total, we cover about three months surrounding each earnings announcement and almost all the analysts' research reports.

### *2.4 Hypothesis 2: Cross-sectional differences in the complexity of financial information*

The importance of analysts' interpretation role depends on the ease with which investors can digest the information disclosed by managers and thus it should vary with the complexity of firms' operations. We expect the interpretation role to be particularly important when the information disclosed by management is difficult for an average investor to understand. For example, when a high-tech firm discusses the development of a new technology, it will be difficult for average investors to quantify the implication of this development for future sales and performance. In such situations, financial analysts, armed with better knowledge of the industry/firm and more experience, can help investors evaluate the implications.[10] Thus, we

[9] About 25% of all the forecasts and recommendations are disclosed on these days and thus excluded, with the majority on days 0 and +1. In a sensitivity analysis reported in Section 6, we conduct frequency tests that do not require excluding the reports that coincide with earnings announcements.

[10] Note that analysts' interpretation role does not imply a pattern of smaller initial reactions to difficult earnings reports followed by a larger reaction to the analysts' report in the same direction. Rather, we expect that more complex corporate announcements result in more uncertainty. Informative analyst reports then help to resolve some of this uncertainty and trigger additional stock price movements that are larger for firms with more complex financial information, but not necessarily in the same direction as the initial reaction.

hypothesize as follows:

> **H2 (Complexity Hypothesis)**: In the post-announcement period, firms with more complex financial information tend to have a more positive (or less negative) association between the information content of analyst reports and earnings announcements.

To test H2, we introduce into equation (2) a variable indicating the degree of complexity of financial information disclosed by a firm, *Complexity*, and its interaction with $IC\_EA_t$:

$$IC\_AR_{t+1} = \alpha + \beta_0 \cdot IC\_EA_t + \beta_1 \cdot Complexity + \beta_2 \cdot IC\_EA_t \times Complexity + controls + \varepsilon \ . \quad (3)$$

The coefficient on the interaction term $(\beta_2)$ captures the impact of complexity on the relation between earnings announcements and subsequent analyst research. H2 predicts $\beta_2$ to be positive.[11]

## 3. Sample and variable measurement

### *3.1 Sample*

Our sample starts with firm-quarters with earnings announcements and analyst coverage available on I/B/E/S in the period 1994-2003. We use the dates of analyst forecasts or recommendations to proxy for the date of analyst research reports.[12] The sample begins in 1994 because individual forecasts and recommendations in I/B/E/S before 1994 are reconstructed from archival tapes and may have imprecise dates. Stock return and financial data are collected from CRSP and Compustat, respectively.

The final sample includes 160,175 firm-quarters for 9,568 unique firms. On average, there are 4,004 firm observations in each calendar quarter, ranging from 3,414 to 4,764. All these firm-

[11] We also considered examining the impact of complexity on the relation between the two information events in the pre-announcement period. While such a hypothesis would be symmetric with H2, it is less conceptually appealing. It is unlikely that high complexity would lead to corporate disclosures that are more revealing about previously released analyst reports. Unreported results indeed suggest that complexity does not affect the relation in the pre-announcement period.

[12] We checked the validity of this assumption in the sample of research reports discussed in Appendix A. The dates on these analyst reports are the same as the dates shown in I/B/E/S for forecasts or recommendations in most cases. In a few cases, the I/B/E/S date is one day earlier.

quarters have analyst reports in the quarter surrounding earnings announcements, but only a subset has analyst reports in the week immediately before or after earnings the announcement date (EAD). As reported in Panel A of Table 1, there are 59,301 firm-quarters with analyst research in the week before EAD. For these firm-quarters, there are on average 1.6 days with analyst research from 2.2 analysts (multiple analysts may issue research reports on the same day). In the week after EAD, analyst research is more prevalent: there are 114,951 firm-quarters with analyst research. For these firm-quarters, there are on average 1.9 days with analyst research from 3.5 analysts.

Analysts' research reports generally contain one or more of the following: short-term forecasts (those that pertain to the next earnings announcement), longer term forecasts (forecasts beyond the next earnings announcement), and buy/sell recommendations. In our sample, the 2.2 (3.5) research reports issued in a typical week before (after) the EAD contain on average 1.3 (3.3) short term forecasts, 6.0 (11.3) longer-term forecasts, and 0.3 (0.3) recommendations.[13]

### *3.2 The measurement of information content*

We measure the information content of earnings announcements by the absolute value of size-adjusted returns on the event day (day 0).[14] Using the absolute value is appropriate as we intend to capture the significance of the news without regard to direction.[15] Using abnormal returns is preferable to non-market measures. For example, using earnings surprises, whether derived from analyst forecasts or time-series models, captures only one element of information that is

[13] While almost all research reports contain a recommendation, most of these recommendations are reiterations. In such cases, analysts generally do not notify I/B/E/S about the recommendations, as they are not new. As a result, the average number of recommendations per report is much lower than one.

[14] We replicate the main analyses by measuring the information content based on abnormal returns in three-day event windows (centered on each information event). The (unreported) results are similar.

[15] While theoretical studies generally use the variance of price changes for analytical tractability, the analyses in Marais (1984) and Rohrback and Chandra (1989) suggest that the absolute value of price changes is more appropriate when price changes have skewed and leptokurtic distributions.

conveyed in an earnings announcement, whereas returns captures all information in the announcement, including conference calls given in conjunction with the earnings announcement (Lo and Lys 2001). The drawback is that there are potentially confounding information events such as dividend changes on the same day as earnings announcements. This disadvantage is mitigated to the extent that such information events are randomly distributed over time.

The information content of analyst research is analogously measured. Specifically, we first measure the abnormal returns on each day that has analyst research. We then sum the signed abnormal returns on all the days with analyst research together for each week, and use the absolute value of the sum to measure the information content of analyst research in that week.[16] If there are no research reports in a week, the information content of analyst research is set to missing.[17]

This market impact measure is preferred to measures based on either the quantity or quality of analyst research. First, the quantity of analyst research, such as the frequency of forecasts and recommendations ignores the variation in the amount of information across research reports. Second, measures of quality such as forecast accuracy are noisy because more accurate forecasts do not necessarily contain more information if market participants have anticipated those forecasts whereas abnormal returns reflect what was unanticipated. Furthermore, market impact captures the information contained in the text of analysts' reports as well as in the summary forecasts and recommendations.

Panel B of Table 1 reports the information content measures. The average information

[16] Francis et al. (2002) take the absolute value first and then sum absolute abnormal returns together over a year. Our results are robust to this research design choice. We have also replicated Francis et al.'s results using our procedure, summing the signed abnormal returns over a week first, taking the absolute value, and then summing over a year.

[17] An alternative is to set information content to zero. Investors do not obtain any information from analysts when no reports are issued, just as when analysts issue uninformative reports. However the information content variable is assigned zero in the former case, but can have non-zero value in the latter case due to other information events or noise trading. This potential bias does not appear to be large, as the results are similar if we adopt this alternative approach and use one-step OLS.

content of an earnings announcement is 3.5%. The information content of analyst research in the week before and after is slightly lower: 2.9% and 3.1%, respectively.

### *3.3 The measurement of control variables*

Since we use the absolute value of abnormal returns to measure the information content of earnings announcements and analyst research, a spurious positive correlation between the two measures can result from cross-sectional variation in return volatility. Following Francis et al. (2002), we use two measures to control for return volatility: the standard deviation and the mean of the absolute value of daily size-adjusted returns in the quarter around earnings announcements (*Std_AAR* and *Mean_AAR*). To ensure the reliability of these estimates, we require at least ten trading days in the estimation of return volatility.

We also control for characteristics of the pre-disclosure information environment since prior research shows that if the pre-disclosure information is of high quality, the market reaction to disclosure is expectedly lower. One typical proxy is firm size. Earlier studies (e.g., Atiase 1985; Shores 1990) generally find results consistent with the market reaction to corporate disclosures decreasing with firm size, but recent studies, including Francis et al. (2002), find opposite results based on more recent data. Because of these conflicting results, we do not have a directional prediction for the impact of firm size. Another commonly used proxy for the pre-disclosure information environment is analyst coverage. In the analyses, we use both proxies. Firm size is measured as the market value six weeks before the EAD and analyst coverage is measured as the number of unique analysts issuing forecasts or recommendations in the year until six weeks before the EAD.

In addition, we also control for the pre-emptive effect of earlier analyst research reports by including the information content of analyst research issued before the week being analyzed

(*IC_PAR*). This variable is the sum of information content of analyst research in the previous weeks since week -6 (set to zero if missing). For the analysis of weeks after earnings announcements, we include both $IC\_PAR_{t+1}$, the information content of analyst research in the six weeks before earnings announcement, and a separate variable for the information content of analyst research in the weeks after earnings announcement but before the week of interest (e.g., the first three weeks for the analysis of week +4).

As reported in Panel C of Table 1, the standard deviation and mean of absolute daily abnormal returns are 2.2% and 2.4%, respectively. The market value is on average $2.5 billion, larger than the size of the average Compustat firm, and the average analyst coverage is 9.5. Both market value and analyst coverage are right-skewed. In the empirical analyses, we log transform these two variables to reduce the impact of the right tail of the distribution.

Table 2 contains the correlation matrix for the variables used in the regression analysis. All variables are significantly correlated with other variables at the 1% level (except between $IC\_AR_{t+1}$ and analyst coverage). As expected, *Std_AAR* and *Mean_AAR* are highly correlated (0.936) as they measure the same concept of return volatility. Firm size and analyst coverage are also highly correlated at 0.761. These high correlations among control variables do not affect the estimation of the coefficient of interest.

## 4. Empirical analyses

In this section, we first report results from tests of H1, including analyses of the pre- and post-announcement periods. Results from tests of H2 then follow.

### *4.1 Analysis of the pre-announcement period*

To estimate the empirical version of equation (1), we need to address the issue that analysts issue reports endogenously. In particular, if the overall information environment affects both the information content of earnings and the likelihood of an analyst issuing a report, then OLS estimates will be biased. To mitigate this problem, we employ the Heckman (1979) two-step procedure. In the first step, we estimate the following equation:

$$\begin{aligned}\text{Step1}: Issue\_AR_{t-1} = a &+ c_1 \cdot Std\_AAR + c_2 \cdot Mean\_AAR \\ &+ c_3 \cdot Firm\ Size + c_4 \cdot Analyst\ Coverage + c_5 \cdot IC\_PAR_{t-1} \\ &+ c_6 \cdot N\_shareholders + c_7 \cdot Inst\_own + c_8 \cdot Turnover + c_9 \cdot B/M \\ &+ c_{10} Lag(Issue\_AR_{t-1}) + \varepsilon_1.\end{aligned} \quad (4)$$

$Issue\_AR_{t-1}$ =1 if one or more analyst reports are issued in week *t*-1. We expect analysts' decision to issue a report to be influenced by return volatility (*Std_AAR* and *Mean_AAR*), firm size, analyst coverage, and the information content of analyst research issued prior to week *t*-1 ($IC\_PAR_{t-1}$). We also include four variables to capture investors' demand for analyst research: (1) the size of the shareholder base (*N_shareholders*), which is the natural log of the number of common shareholders in millions; (2) the fraction of outstanding shares owned by institutional investors (*Inst_own*); (3) the amount of trading (*Turnover*), measured as the fraction of outstanding shares traded daily averaged over the prior quarter, adjusted for the average market turnover; and (4) the book-to-market ratio (*B/M*), a proxy for growth. Finally, to capture persistence in analyst activities, we include the prior quarter's value of $Issue\_AR_{t-1}$. The choice of these variables is largely based on the literature on analyst following (e.g., Bhushan 1989; O'Brien and Bhushan 1990; Barth et al. 2001).

In the second step, we add to equation (1) the Inverse Mills Ratio from Step 1 and the control variables discussed in the last section, to test H1 in the pre-announcement period:[18]

[18] In an untabulated test, we also include |*Forecast Error*| to proxy for the total earnings-related information that could be discovered by pre-announcement analyst research and disclosed in earnings announcements. We obtain the same inferences. However, including this variable reduces our sample size by one-third, so we only include it in a sensitivity test.

$$\text{Step } 2: IC\_EA_t = \alpha + \beta \cdot IC\_AR_{t-1} + \gamma_1 \cdot Std\_AAR + \gamma_2 \cdot Mean\_AAR + \gamma_3 \cdot Firm\ Size + \gamma_4 \cdot Analyst\ Coverage + \gamma_5 \cdot IC\_PAR_{t-1} + \gamma_6 \cdot InverseMillsRatio + \varepsilon_2. \quad (5)$$

To reduce the influence of extreme values, we winsorize all independent variables at the 98$^{th}$ percentile. Equation (4) and (5) are estimated for each calendar quarter and Panel A of Table 3 reports the average coefficients across the 39 quarters in the sample and the corresponding time-series t-statistics (Fama and MacBeth 1973). (We lose the first of the 40 quarters due to the need for *Lag*(*Issue_AR*$_{t\text{-}1}$).)

Model 1 of Table 3 includes the information content of pre-announcement analyst research and two return volatility variables. The coefficient on pre-announcement analyst research is significantly negative (t = -4.42, p<0.001). (Throughout the paper, p-values are one-tailed for variables with directional predictions and two-tailed for non-directional predictions). The coefficient remains stable in magnitude and significance when we add firm size and analyst coverage and prior analyst research (Models 2 and 3). These results suggest that analyst research in the pre-announcement period pre-empts the subsequent earnings announcements.

In all specifications, the impact of return volatility is significantly positive as expected. Firm size and analyst coverage have positive coefficients, consistent with the results reported in Francis et al. (2002). The coefficient on prior analyst research is negative, consistent with the pre-emptive effect of previous analyst research. The coefficient on the Inverse Mills Ratio is significant in Models 2 and 3, but not in Model 1. The difference appears to stem from the inclusion of *Analyst Coverage* in Models 2 and 3, which has a dominant role in the Step 1 self-selection equation. The first stage regression results from Model 3 also suggest that analysts are more likely to issue research reports when return volatility is high, when firm size is large, when they issue reports in the same week of the last quarter, and when research reports in the previous weeks are informative.

Panel B of Table 3 reports the results of repeating the above analysis for each of the six weeks before earnings announcements. (Step 1 regression results and results for control variables in Step 2 are similar to those reported before and are not reported again for the sake of brevity.) The information content of analyst research in each week has a negative association with the information content of the subsequent earnings announcement, indicating that analyst research consistently pre-empts some of the information in subsequent earnings announcements.[19]

### *4.2 Analysis of the post-announcement period*

This section analyzes the role of analyst research released after earnings announcements using the information content of analyst research as the dependent variable. Again, to control for the self-selection effect of analyst research, we also employ the two-step procedure of Heckman (1979), and estimate the following two equations simultaneously:

$$\begin{aligned}\text{Step1: } Issue\_AR_{t+1} &= a + b \cdot IC\_EA_t + c_1 \cdot Std\_AAR + c_2 \cdot Mean\_AAR \\ &+ c_3 \cdot Firm\ Size + c_4 \cdot Analyst\ Coverage + c_5 \cdot IC\_PAR_{t+1} \\ &+ c_6 \cdot N\_shareholders + c_7 \cdot Inst\_own + c_8 \cdot Turnover + c_9 \cdot B/M \\ &+ c_{10} Lag(Issue\_AR_{t+1}) + \varepsilon_1.\end{aligned} \tag{6}$$

$$\begin{aligned}\text{Step 2: } IC\_AR_{t+1} &= \alpha + \beta \cdot IC\_EA_t + \gamma_1 \cdot Std\_AAR + \gamma_2 \cdot Mean\_AAR + \gamma_3 \cdot Firm\ Size \\ &+ \gamma_4 \cdot Analyst\ Coverage + \gamma_5 \cdot IC\_PAR_{t+1} + \gamma_6 \cdot Inverse\ Mills\ Ratio + \varepsilon_2.\end{aligned} \tag{7}$$

Step 1 models analysts' decision to issue research reports in week +1 and Step 2 models the relation between the two information content measures conditional on analysts issuing research reports. $Issue\_AR_{t+1}$ =1 if one or more analyst reports are issued in week *t*+1. As in the pre-earnings announcement period analysis, we include control variables for return volatility (*Std_AAR*, *Mean_AAR*), pre-disclosure environment (*Firms Size*, *Analyst Coverage*, *Prior*

[19] The pre-emption can arise from management issuing preannouncements. Thus, we repeat our analyses to exclude observations with preannouncements (as identified by management forecasts tabulated by First Call) and the results are qualitatively unchanged.

*Analyst Research*), proxies for investors' interest in analyst research (*N_shareholders*, *Inst_own*, *Turnover*, and *B/M*), and the prior quarter's value of $Issue\_AR_{t+1}$. *Inverse Mills Ratio* in Step 2 accounts for the effect of self-selection. As in the analyses above, we estimate this system of equations for each quarter and report the average coefficients and t-statistics from the 39 quarters in Panel A of Table 4.

In all models, the information content of earnings announcements has a positive association with the information content of analyst research in the subsequent week (Step 2: t = 3.08, 2.22, 2.52 in Models 1, 2, and 3, respectively). The return volatility variables have mixed coefficients, negative for *Std_AAR* and positive for *Mean_AAR*. Analyst coverage has a positive coefficient, which is expected because when more analysts follow a company, more information will be discovered and disseminated. The coefficient on *Inverse Mills Ratio* indicates a significant selection effect only in Model 1.

The Step 1 regression results are similar to those in Table 3. In particular, we find that the coefficient on IC_EA is positive in all specifications, suggesting that analysts are more likely to issue research reports when earnings announcements are more informative. This result is consistent with the interpretation role of analyst research.

We also investigate whether the positive relation documented for the first week after earnings announcement persists into the following five weeks. Panel B reports the results, again using the Heckman approach as for the first week. We find that the significantly positive coefficient on $IC\_EA_t$ for the first week after the earnings announcement becomes only marginally significant in the second week (t = 1.72). The coefficient turns insignificantly negative in weeks 3 and 4, then significantly negative in weeks 5 and 6.

Taken together, Table 3 and Table 4 show that the information content of the two information sources are negatively associated with each other in eight of 12 weeks of a quarter. The information discovery role of analyst research dominates in all the six weeks before the earnings announcement. The information interpretation role of analyst research dominates in one or perhaps two weeks after the earnings announcement (weeks +1 and +2) and the pre-emptive effect of earnings announcement on analyst research then dominates in two weeks (weeks +5 and +6). This overall negative relation is at odds with the positive "complementary" relation found in Francis et al. (2002). We explore reasons for this difference in Section 5 after reporting the results for the tests of Hypothesis 2.

### *4.3 Analysis of the impact of complexity level on the post-announcement period*

To examine whether the interpretation role of analyst research is more important for firms with financial information that is difficult to understand (H2), we add the interaction of the information content of earnings announcements and the complexity level to the two equations estimated in Section 4.2:

$$\begin{aligned} Issue\_AR_{t+1} = a &+ b_0 \cdot IC\_EA_t + b_1 \cdot Complexity + b_2 \cdot IC\_EA_t \times Complexity \\ &+ c_1 \cdot Std\_AAR + c_2 \cdot Mean\_AAR + c_3 \cdot Firm\ Size + c_4 \cdot Analyst\ Coverage \\ &+ c_5 \cdot IC\_PAR_{t+1} + c_6 \cdot N\_shareholders + c_7 \cdot Inst\_own + c_8 \cdot Turnover \\ &+ c_9 \cdot B/M + c_{10} \cdot Lag(Issue\_AR_{t+1}) + \varepsilon_1. \end{aligned} \tag{8}$$

$$\begin{aligned} IC\_AR_{t+1} = \alpha &+ \beta_0 \cdot IC\_EA_t + \beta_1 \cdot Complexity + \beta_2 \cdot IC\_EA_t \times Complexity \\ &+ \gamma_1 \cdot Std\_AAR + \gamma_2 \cdot Mean\_AAR + \gamma_3 \cdot Firm\ Size + \gamma_4 \cdot Analyst\ Coverage \\ &+ \gamma_5 \cdot IC\_PAR_{t+1} + \gamma_6 \cdot Inverse\ Mills\ Ratio + \varepsilon_2. \end{aligned} \tag{9}$$

We conjecture that the degree of interpretation difficulty is higher for companies with higher R&D intensity, for companies with larger asset bases, and for companies with higher growth opportunities.[20] Interpreting financial information is difficult for firms with high R&D intensity for several reasons (Aboody and Lev 2000). R&D investments are generally firm-specific and there is no liquid market for R&D investments. Financial statements also provide little information regarding the impact of R&D investments on future performance as these investments are expensed in the period they occur.[21] We also expect that larger firms' operations are on average more complex and difficult to understand owing to their more diversified products and geographic locations. Firms with high growth opportunities are difficult to value because they generally have significant amounts of unrecorded intangible assets.

R&D intensity is calculated as R&D expenditures scaled by net sales and is set as zero for firm-years with missing R&D expenditures in Compustat because firms with minimal R&D expenditures tend to not report R&D expenditures. We measure growth opportunities by the market-to-book ratio. All these variables are measured for the last fiscal year with available financial information prior to the earnings announcement. The descriptive statistics of these variables are reported in Panel D of Table 1. R&D intensity is on average 8.3%, the mean total assets is $2.5 billion, and the mean market-to-book ratio is 3.313.

We construct a complexity index based on these measures to simplify the interactive variables in the regression model. First, we transform the three continuous variables into ordinal variables. Based on the cross-sectional distribution of assets or market-to-book, we assign values of 1, 0.5, and 0 to observations in the top, middle, and bottom third. Because more than half of the observations have zero R&D intensity, we use an indicator variable that takes a value of 1 for

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[20] One can think of other factors that contribute to the difficulty level of interpreting financial information, but we do not intend to explore all such factors. In an untabulated sensitivity test, we include an indicator for high-tech companies in place of R&D intensity in the complexity index variable and find similar results.
[21] Consistent with analysts being better able to interpret financial information of such firms, prior research (e.g., Cheng 2005) finds that the incremental explanatory power of analysts' forecasts for future profitability and market value over earnings and book value is higher for firms with high R&D intensity.

firms with R&D intensity in the top 33% of the distribution, and 0 otherwise. We then set the complexity index as the sum of these three indicator/ordinal variables. Thus, the possible values of the index are 0, 0.5, 1, …, 3. The inferences are similar if we include each of the three variables directly in the model.

Panel A of Table 5 reports the regression results for the first post-earnings announcement week. By construction, the coefficient on the information content of earnings announcement ($\beta_0$) in the Step 2 equation applies to firms with financial reports that are the easiest to understand (*Complexity* = 0). For such firms, the negative coefficient indicates that there is less information from subsequent analyst research when the market reaction to the earnings report is higher. That is, more informative earnings announcement pre-empts future analyst research, and analyst reports do not reinforce earnings reports when these earnings reports are easy to understand.

More importantly, the coefficient on $IC\_EA_t$ × *Complexity* is significantly positive (t = 4.00). Thus, investors find more useful information in analysts' reports that are issued shortly after earnings announcements when those announcements are informative (high $IC\_EA_t$) but difficult to understand (high *Complexity*).

To ease interpretation, Panel B of Table 5 explicitly tabulates the net association of $IC\_EA_t$ and $IC\_AR_{t+1}$ for each of the seven values of *Complexity*. We observe pre-emption for the lowest complexity level (*Complexity* = 0) but reinforcement in the four highest levels (*Complexity* = 1.5, 2, 2.5, 3), with t-statistics of 2.31 or greater.

We also replicate the analyses for other weeks in the post-announcement period. Results in Panel C (Step 2 equation) indicate that the coefficient on the interactive term is significantly positive in all weeks (t-statistic of 2.17 or greater). Tabulating the net effect for each of the seven complexity levels over the six weeks shows a most interesting pattern. Panel C reveals an almost monotonic pattern whereby the persistence of the reinforcement increases with the complexity level.  For firms with the simplest information (*Complexity* = 0), we observe pre-emption in all weeks (weakly so in the second week).  In contrast, firms with the most complex financial information (*Complexity* = 3) show reinforcement in all six weeks (weakly so in the fourth to sixth weeks).  Thus, we conclude that the interpretation role increases in importance with the complexity of financial information, as hypothesized in H2.

## 5. Reconciliation with Francis et al. (2002)

Francis et al. (FSV hereafter) find a "complementary" positive relation between aggregate information content of earnings announcements and analyst reports, where the information content measures are aggregated over annual periods.  This finding starkly contrasts with our results showing an overall negative relation (8 out of 12 weeks) and a relatively short period with a positive relation (2 out of 12 weeks).  In this section, we reconcile these opposing results by demonstrating that the FSV results are subject to two biases.  In the process, we are also able to explain why FSV's results using aggregate information content differ from their results using mean information content (which is defined as aggregate information content of earnings and analyst reports divided by the number of earnings announcements and the number of days with analyst reports, respectively).

Before proceeding with the reconciliation, it is necessary to first replicate the results from FSV using our sample.  Table 6 shows the results of regressing the aggregate (mean) information content of earnings announcements on the aggregate (mean) information content of analyst research, plus control variables, using the following equation:

$$\begin{aligned} IC\_EA_t &= \alpha + \beta \cdot IC\_AR_t + \gamma_1 \cdot Std\_AAR + \gamma_2 \cdot Mean\_AAR \\ &+ \gamma_3 \cdot Firm\,Size + \gamma_4 \cdot Analyst\,Coverage + \nu \end{aligned} . \quad (10)$$

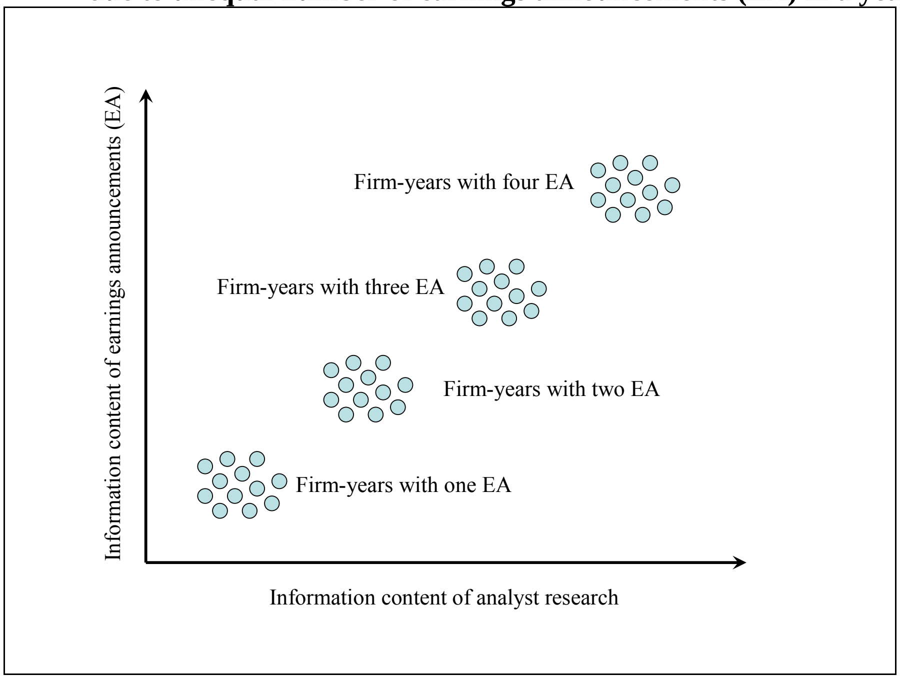
In FSV's annual analysis, all firm-*years* have one or more analyst reports, but not every firm-*quarter* has analyst reports. To be consistent with their sampling design, we generate firm-year observations and the corresponding variables based on our sample of 160,175 firm-quarters with both earnings announcements and analyst research, as used above, plus firm-quarters without earnings announcements or analyst research in the quarter (but with analyst research sometime in the year), resulting in 48,005 firm-years.

Based on our sample, we confirm the positive coefficient on aggregate information content of analyst research found in FSV (t = 22.47 or 16.14 depending on specification). We also find a negative relation in the regression using mean information content (t = -4.50 or -3.72).

### *5.1 Sampling bias*

In common with many other studies, FSV maximized the sample size by employing as few restrictions as necessary. One restriction they did not employ relates to the number of earnings announcements in a year. Their descriptive statistics show that the average number of earnings announcements in each firm-year is 3.7, not four. However, quarterly reporting is mandatory in the U.S., so firm-years with fewer than four earnings reports result from firms entering or exiting the database due to new listings, de-listings, mergers and acquisitions; from an incomplete database; or from other sample construction criteria (e.g., missing return data for calculating information content). Regardless of the source, the mixture of firm-years with one, two, three, and four quarters artificially creates positive co-variation between the aggregated information content measures. This artificial co-variation is analogous to the scale-induced $R^2$ problem analyzed in Brown et al. (1999). All else equal, a firm-year with four earnings announcements will have, in expectation, aggregate information contents of earnings and analyst reports that are four times as large as a firm-year with only one earnings announcement. Thus, the variation in the number of earnings announcements creates four clusters of observations, as illustrated in Figure 2.[22] This positive bias can dominate any within-cluster variation, which contains the relation of interest.

**Figure 2**
**Stylized plot illustrating the co-variation of information content measures due to unequal number of earnings announcements (EA) in a year**




To investigate whether this bias is significant in the data, we divide the data into four groups according to the number of earnings announcements in the year and re-estimate equation (10). Doing so removes the artificial co-variation since all firm-year observations in each sub-sample have the same number of earnings announcements. In our sample, 4.2%, 5.5%, 9.2%, and 81.1% of firm-years have one, two, three, and four earnings announcements, respectively. As shown in Table 7, none of the four sub-samples show a positive relation between aggregate information content of earnings announcements and analyst research. Focusing on the largest

[22] Under the null hypothesis of no relation (or if the within-cluster co-variation is negative), the between cluster variation will induce a positive bias in the association between the two aggregate information content measures. If the within-cluster co-variation is positive, the bias could be positive or negative.

sub-sample with all four earnings announcements, the relation is insignificantly negative (t = -0.49). Alternatively, we focus on the full sample and divide the aggregate information content measures by the number of earnings announcements, similar to the solution suggested in Brown et al. (1999) for the scale-induced $R^2$ issue.[23] Again, the coefficient on $IC\_AR_t$ is insignificantly negative. In conclusion, this sampling bias is indeed significant: once we remove the artificial positive co-variation of information content due to missing firm-quarters, there is no evidence of a positive relationship between aggregate information content measures.

The above results also help to explain why FSV obtain inferences from their aggregate information content analysis that differ from those obtained using mean information content. FSV's aggregate measures show a strong positive relation, while the results using mean information content are mixed (7 years negative, 3 years positive, FSV Table 8, p. 328). As already mentioned, FSV's aggregate analysis does not control for the number of earnings announcements in each firm-year, but their mean information content analysis does so by scaling the information content of earnings and analyst report by the respective number of earnings announcements and days with analyst reports. Given our above findings, FSV's mean information content results are more reliable than their aggregate information content results.

### *5.2 Simultaneity*

We have just shown that removing the sampling bias changes the significant positive relation found in FSV to an insignificant relation between aggregate information content of earnings announcements and analyst research. We next show that aggregation also creates a second positive bias. This bias arises from the simultaneity of (1) the informativeness of earnings

[23] Note that this design has one difference from FSV's mean information content analysis. We scale both earnings and analyst information content measure by the number of earnings announcements, whereas FSV scale by the number of earnings announcements and the number of analyst reports, respectively.

announcements and (2) analysts' decision to issue reports. In contrast to mandatory quarterly earnings announcements, analysts issue reports voluntarily as a result of a rational choice process. That choice is partially a function of whether the analyst believes his/her report will be useful to clients. In other words, the analyst considers whether his/her report, if it were to be issued, has information content that will lead to trading by clients, and therefore commissions for his/her brokerage firm. When there is much information to disseminate, the analyst will likely issue a report. In periods when there is little information to disseminate, the analyst will abstain from issuing a report.

The absence of analyst reports in some quarters is problematic in that it is not sensible to consider the relationship between earnings and analyst reports when one of them is not available. However, FSV's annually aggregated information content measures include firm-years where some firm-quarters do not contain analyst research. The consequence is similar to that depicted in Figure 2 but with a key difference: the source of the positive bias is not mechanical, but rather, it is due to simultaneity. The models of McNichols and Trueman (1994) and Demski and Feltham (1994) suggest that the likelihood of an analyst report in a quarter increases with the expected information content of that quarter's earnings. The positive relationship that results from this type of simultaneity is reduced if the analysis is conducted over shorter aggregation periods because the analysis requires samples with at least one analyst report over a shorter period.[24] For instance, if the analysis uses quarterly periods, then all firm-quarters have at least one analyst report.

If this simultaneity bias is significant, we should see the relation between the information content of earnings and analyst reports become less positive (or more negative) as the analysis

[24] A shorter analysis period reduces but does not eliminate the simultaneity bias because the informativeness of earnings not only affects the *likelihood* of a forecast, but also the *number* of analysts providing forecasts.

period shortens. Thus, as a diagnostic for the significance of this simultaneity bias and as a way to mitigate the bias, we estimate equation (10) for annual, semi-annual, and quarterly aggregation periods. We start with the sub-sample with four earnings announcements in a year as used in the previous sub-section and Table 7, which corrects for sampling bias.

Table 8 reports this analysis, with Panel A describing the construction of the samples while Panel B shows the regression results. The annual aggregation results are repeated from Table 7, which show an insignificant relation between $IC\_EA_t$ and $IC\_AR_t$. When we shorten the aggregation period, the association turns significantly negative for semi-annual periods (coefficient = -0.011, t = -4.14) and even more so in the quarterly analysis (coefficient = -0.028, t = -15.06). Thus, the absence of analyst reports in some quarters within the annual aggregation period changes significantly negative associations to insignificant associations.

Alternatively, we can reduce the effect of the simultaneity bias by fixing the number of quarters with analyst research to be four. Using the sub-sample of firm-years with earnings announcements and analyst research in all four quarters, we find that the relation is also significantly negative (annual period coefficient = -0.011, t = -2.98; not tabulated).

From these two sets of results, we infer that there is a significant upward bias arising from the simultaneity of analyst report issuance and earnings informativeness, and that the use of shorter aggregation periods mitigates this bias.

### *5.3 Effect of sampling bias and simultaneity on weekly analysis*

Given the evidence of significant biases due to sampling and simultaneity, we must consider whether such biases are significant in this paper's approach. Our sample begins with firm-quarters which have both earnings announcements and at least one analyst report (see sub-section 3.1). Within these firm-quarters, we examine information content week-by-week. Thus, our analysis does not have sampling bias arising from missing earnings announcements, and simultaneity is mitigated to the extent that we have excluded firm-quarters without analyst coverage. Furthermore, to the extent that simultaneity exists in the pre-announcement period, the positive bias makes it more difficult to find pre-emption. Post-announcement, the simultaneity biases toward finding reinforcement; while not intended for this purpose, the Heckman (1973) two-step procedure for self-selection helps to mitigate this problem because it controls for analysts' decision to issue a report. Nevertheless, caution is warranted in interpreting the positive relation in the post-earnings announcement period.

## 6. Additional analyses

### *6.1 Analysis based on the frequency of analyst research*

In the main analyses, we exclude analyst research disclosed in the three days around earnings announcements because we cannot distinguish between their market impact from that of earnings announcements. In order to include these analyst reports, we use the frequency of analyst research instead of stock returns. For this analysis, day -1 (0 and +1) is (are) in the pre-announcement (post-announcement) period. After this modification, the number of firm-quarters with analyst research increases to 69,138 in the week before earnings announcements and 141,601 in the week after. The frequency of analyst research is also significantly larger than that presented before. For firm-quarters with analyst research, the average number of forecasts and recommendations increases from 7.7 to 8.4 and the average number of analysts increases from 2.2 to 2.4 in the week before the earnings announcement. In the week after, the increase is much larger: the average number of forecasts and recommendations increases from 14.8 to 27.7 while the average number of analysts increases from 3.5 to 6.3.

To reduce the influence of extreme values, we take log transformation of the frequency measures (i.e., ln[1+frequency]). We assume zero frequency for firm-quarters without analyst research. Table 9 shows that the results based on the two frequency measures are consistent with our main analyses. The market impact of earnings announcements is negatively correlated with the frequency of analyst research in the week prior and positively correlated with the frequency of analyst research in the week after. Note that due to the differences in the measures, the coefficients are not directly comparable to those reported above.[25]

### *6.2 Controlling for post-earnings announcement drift*

In this section, we consider the possibility that the positive association between the information content of earnings announcements and that of analyst research in the subsequent week is related to post-earnings announcement drift. Larger earnings surprises tend to be followed by more pronounced drifts in returns in the same direction. Therefore, it is possible that abnormal returns associated with analyst reports releases after earnings announcements capture the drift in returns.

We use two approaches to control for the influence of post-earnings announcement drift. First, we add to regression equations (6) and (7) the absolute value of the standardized unexpected earnings (SUE), calculated using the procedure described in Bernard and Thomas (1990). The coefficient on the absolute value of SUE is significantly positive, consistent with drift. More importantly, the coefficient on $IC\_EA_t$ remains significantly positive and its magnitude is almost identical to that reported in Table 4. Second, we calculate drift-adjusted abnormal returns associated with analyst research. Specifically, for each calendar quarter we rank observations based on SUE into ten groups and estimate the average of daily size-adjusted returns for each SUE decile-quarter combination. For those days with analyst research, we then

[25] When the research reports disclosed in the three days around earnings announcements are excluded, the results based on analyst research frequency are similar for the week before, but weaker for the week after due to the omission of almost half of the analyst reports in the post announcement period.

deduct from the size-adjusted returns the average daily size-adjusted returns of the corresponding SUE decile-quarter group. We use the absolute value of this SUE- and size-adjusted return measure summed across days with analyst research to capture the information content of analyst research. The results (unreported) are similar to those reported in Table 4.

## 7. Conclusions

This study provides evidence consistent with analyst research and corporate disclosures playing both information discovery and interpretation roles, where the importance of each role depends on timing of one disclosure relative to the other. The amount of information in analyst research issued prior to earnings announcements is negatively associated with that contained in earnings announcements, consistent with analyst research pre-empting the earnings report. In contrast, the amount of information in analyst research released soon afterwards is positively associated with the amount of information in the earnings reports, consistent with analysts interpreting corporate reports. The evidence also shows that this interpretation role is particularly important when firms' operations are more complex because of their research focus, size, and growth opportunities.

Our results generally support existing disclosure theory, which predicts that higher quality prior information will lead to smaller market reactions to subsequent earnings announcements. The findings for the pre-emption effect are also consistent with several past empirical studies (Dempsey 1989; Shores 1990; Ayers and Freeman 2003). At the same time we reconcile with studies that come to contrary conclusions (e.g., Francis et al. 2002).

This paper furthers our understanding of the role of financial analysts in the capital markets, extending the literature on the nature of the information provided by financial analysts (Ivkovic and Jegadeesh 2004; Asquith et al. 2005). Our evidence of the co-existence of the information discovery and interpretation roles of financial analysts extends prior studies on the interaction between analyst research and corporate disclosures.

**Appendix A**
**Summary of readings from analyst research reports**

We randomly select 30 firms and obtain from *Investext* the analyst research reports that were released on these firms in the week prior and subsequent to each of the first two earnings announcements in 1999. When there are multiple reports for the same firm for the same week, we examine only one of them. In total, there are potentially 120 reports (30 firms × 2 quarters/firm × 2 reports/quarter), but the actual number is only 80 because not all firms selected have analyst reports in the two weeks surrounding earnings announcements. The split is 30 reports in the week prior to the earnings announcement, and 50 in the week following.

In general, in a research report, an analyst states his/her estimates of near term earnings, longer-term earnings, stock recommendations, and target prices. Analysts also provide detailed discussions of the company's performance (for example, justifications for the earnings estimates and stock recommendations). Asquith et al. (2005) include a detailed description of a typical analyst report.

Most importantly, we notice that the focus differs between research reports issued right before and right after earnings announcements. Reports issued right beforehand tend to focus on predicting the upcoming earnings announcement. In contrast, analyst reports issued right afterwards usually analyze and interpret the information contained in earnings announcements.

The following tabulates the frequencies of the stated purposes of the research reports. (Columns may total more than 100% as some reports have multiple stated purposes).

| | Week before | | Week after | |
|---|---|---|---|---|
| | Count | % (of 30) | Count | % (of 50) |
| Earnings preview | 14 | 47% | -- | |
| Analyst's own research (e.g. survey) | 5 | 17% | -- | |
| Interpreting earnings announcement | -- | | 46 | 92% |
| Firm news | 4 | 13% | 4 | 8% |
| Firm update | 4 | 13% | 4 | 8% |
| Industry news | 3 | 10% | 2 | 4% |
| Coverage initiation | 3 | 10% | 2 | 4% |

Using one specific firm as an example, two days before IBM announced its 1999 Q4 results (on January 19, 2000), PaineWebber issued a report entitled "IBM fourth quarter *preview*" [emphasis added]. In this report, the analysts discussed their expectations of IBM's business. They predicted that hardware sales will decrease by 10%, global services revenues will increase by 8.5%, software revenues will increase by 7%, global financing revenues will be flat, and enterprise investment sales will be flat.

Many of these predictions are confirmed by IBM's 1999 Q4 earnings announcement a couple of days later. IBM announced that hardware revenues declined by 10%, global services revenues increased by 7%, software revenues increased by 6%, global financing revenues increased by 22%, and enterprise investment revenues declined by 10%. Thus, some of the information in this earnings announcement had been accurately anticipated by the PaineWebber report.

IBM's 1999 Q4 earnings report also provided revenue and gross margin breakdown by business segments and by major product lines in each segment. Analysts then relied on this information to discuss in great detail IBM's performance and the implications. Across the research reports right after the announcement (for example, SG Cowen, Robertson Stephens, Morgan Stanley on Jan. 20th, Wasserstein Perella on Jan. 21st, CSFB on Jan. 24th), analysts noted that IBM overall had better expense control, the hardware segment demonstrated a shift to better performing units, service remained the dominant growth engine with strong backlog but slower growth than before, e-business faced increasing competition, etc.

In sum, our readings of analyst reports suggest that analyst research prior to and after earnings announcements likely serves distinct roles: discovering new information and interpreting earnings announcements.

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**Table 1 Descriptive statistics**

The sample includes 160,175 firm-quarters in the period 1994-2003. This table reports the descriptive statistics of key variables used in the analyses.

*Panel A: Frequency of analyst research in the two weeks around earnings announcement date (EAD), given the existence of analyst research*

| | The week before EAD (n = 59,301) | | | The week after EAD (n = 114,951) | | |
|---|---|---|---|---|---|---|
| | Mean | Std. | Median | Mean | Std. | Median |
| Days with analyst research | 1.566 | 0.868 | 1 | 1.930 | 1.037 | 2 |
| Analysts issuing research reports | 2.216 | 2.513 | 1 | 3.516 | 3.722 | 2 |
| Forecasts or recommendations * | 7.723 | 14.523 | 4 | 14.841 | 24.963 | 7 |
| Short term forecasts | 1.344 | 2.679 | 1 | 3.273 | 6.217 | 2 |
| Longer term forecasts | 6.044 | 12.248 | 3 | 11.303 | 19.943 | 5 |
| Recommendations | 0.335 | 0.611 | 0 | 0.265 | 0.564 | 0 |

* Short term forecasts refer to forecasts that apply to the next earnings announcement, and all other forecasts are referred to as longer term forecasts.

| | n | Mean | Std. | Q1 | Med. | Q3 |
|---|---|---|---|---|---|---|
| *Panel B: Information content of earnings announcements and analyst research* | | | | | | |
| Earnings announcements ($IC\_EA_t$) | 160,175 | 0.035 | 0.045 | 0.009 | 0.021 | 0.045 |
| Analyst research in the week … | | | | | | |
| Before earnings announcements ($IC\_AR_{t-1}$) | 59,301 | 0.029 | 0.042 | 0.007 | 0.017 | 0.036 |
| After earnings announcements ($IC\_AR_{t+1}$) | 114,951 | 0.031 | 0.038 | 0.009 | 0.020 | 0.041 |
| *Panel C: Key control variables* | | | | | | |
| Return volatility | | | | | | |
| Std. dev. of \|daily abnormal returns\| (*Std_AAR*) | 160,175 | 0.022 | 0.014 | 0.012 | 0.019 | 0.029 |
| Mean of \|daily abnormal returns\| (*Mean_AAR*) | 160,175 | 0.024 | 0.013 | 0.014 | 0.020 | 0.030 |
| Firm size ($ billions) | 160,175 | 2.529 | 12.554 | 0.114 | 0.344 | 1.154 |
| Analyst coverage | 160,175 | 9.509 | 8.773 | 3.000 | 6.000 | 13.000 |
| Information content of analyst research in the weeks before week -1 ($IC\_PAR_{t-1}$) | 160,175 | 0.053 | 0.080 | 0.001 | 0.027 | 0.069 |
| Information content of analyst research in the weeks before week +1 ($IC\_PAR_{t+1}$) | 160,175 | 0.064 | 0.090 | 0.006 | 0.035 | 0.085 |
| *Panel D: Complexity level variables* | | | | | | |
| R&D intensity | 159,526 | 0.083 | 0.244 | 0 | 0 | 0.044 |
| Total assets ($ billions) | 159,526 | 2.555 | 6.319 | 0.112 | 0.419 | 1.601 |
| Growth (market-to-book ratio) | 159,526 | 3.313 | 3.595 | 1.348 | 2.112 | 3.654 |

Variable measurement (all variables are measured for a firm-quarter):

| | |
|---|---|
| *IC_EA*$_t$ = | The information content of earnings announcements, measured as the absolute value of the size-adjusted returns on the day of earnings announcements; |
| *IC_AR*$_{t-1}$ = | The information content of analyst research in the week prior to earnings announcements, measured as the absolute value of the sum of the size-adjusted returns on each day with analyst research, missing for weeks with no analyst reports; |
| *IC_AR*$_{t+1}$ = | The information content of analyst research in the week after earnings announcements, measured similarly to IC_AR$_{t-1}$; |
| *Std_AAR* = | The standard deviation of the absolute value of daily size-adjusted returns in the quarter around earnings announcements; |
| *Mean_AAR* = | The mean of the absolute value of daily size-adjusted returns in the quarter around earnings announcements; |
| Firm size = | The market value, stock price multiplied by outstanding shares, measured six weeks before earnings announcements; this variable is log-transformed in regression analyses; |
| Analyst coverage = | The number of unique analysts issuing forecasts or recommendations in the year until six weeks before earnings announcements; this variable is log-transformed in regression analyses; |
| *IC_PAR*$_{t-1}$ = | The information content of analyst research in the weeks prior to week -1, measured as the sum of the information content of analyst research for each of the five weeks before week -1, where week -1 is the week prior to earnings announcements; |
| *IC_PAR*$_{t+1}$ = | The information content of analyst research in the weeks prior to week +1, measured as the sum of the information content of analyst research for each of the six weeks prior to earnings announcements; |
| R&D intensity = | R&D expenditures over net sales for the previous fiscal year; |
| Total assets = | Total assets for the previous fiscal year; |
| Growth = | The market-to-book ratio, with book value from the previous fiscal year and market value as described above. |

**Table 2 Correlation matrix**

This table displays Pearson correlations for the sample of 160,175 firm-quarters (59,301 firm-quarters for correlations with $IC\_AR_{t-1}$, 114,951 firm-quarters for correlations with $IC\_AR_{t+1}$, 159,526 firm-quarters for correlations with *Complexity*). $IC\_EA_t$ ($IC\_AR_{t-1}$, $IC\_AR_{t+1}$) refers to the information content of earnings announcement (analyst research in the week before, analyst research in the week after earnings announcement). $IC\_PAR_{t-1}$ ($IC\_PAR_{t+1}$) refers to the information content of analyst research in the weeks before week -1 (week +1). See Table 1 for detailed variable definitions. *Complexity* is the sum of the R&D indicator, the ordinal value of total assets (0, 0.5, 1), and the ordinal value of the market-to-book ratio (0, 0.5, 1). R&D indicator is 1 for firms with R&D intensity in the top 33% of the sample, and 0 otherwise; The ordinal value of total assets (the market-to-book ratio) is 1 for firms with total assets (the market-to-book ratio) in the top 33%, 0.5 for firms with total assets (the market-to-book ratio) in the middle 34%, and 0 otherwise. *Firm Size* and *Analyst Coverage* are log-transformed variables as used in the regression analyses below. All correlations are significant at the 0.01 level, except that between $IC\_AR_{t+1}$ and analyst coverage (p=0.610). For brevity, variables used solely in first stage self-selection model equations have been excluded from this table.

| | $IC\_EA_t$ | $IC\_AR_{t-1}$ | $IC\_AR_{t+1}$ | *Std_AAR* | *Mean_AAR* | *Firm Size* | *Analyst Coverage* | $IC\_PAR_{t-1}$ | $IC\_PAR_{t+1}$ |
|---|---|---|---|---|---|---|---|---|---|
| $IC\_AR_{t-1}$ | 0.174 | | | | | | | | |
| $IC\_AR_{t+1}$ | 0.191 | 0.205 | | | | | | | |
| Return volatility (*Std_AAR*) | 0.422 | 0.429 | 0.410 | | | | | | |
| Return volatility (*Mean_AAR*) | 0.405 | 0.428 | 0.429 | 0.936 | | | | | |
| *Firm Size* | -0.149 | -0.099 | -0.092 | -0.386 | -0.392 | | | | |
| *Analyst Coverage* | -0.068 | -0.041 | -0.002 | -0.230 | -0.232 | 0.761 | | | |
| $IC\_PAR_{t-1}$ | 0.088 | 0.165 | 0.168 | 0.289 | 0.277 | 0.213 | 0.344 | | |
| $IC\_PAR_{t+1}$ | 0.096 | 0.534 | 0.183 | 0.303 | 0.293 | 0.231 | 0.369 | 0.947 | |
| *Complexity* | 0.008 | 0.102 | 0.108 | -0.018 | -0.009 | 0.563 | 0.404 | 0.180 | 0.193 |

## Table 3 The relation between the information content of earnings announcements and that of analyst research disclosed before earnings announcements

This table reports results from the following regressions:

$$\begin{aligned} Step1: Issue\_AR_{t-1} = {} & a + c_1 \cdot Std\_AAR + c_2 \cdot Mean\_AAR \\ & + c_3 \cdot Firm\ Size + c_4 \cdot Analyst\ Coverage + c_5 \cdot IC\_PAR_{t-1} \\ & + c_6 \cdot N\_shareholders + c_7 \cdot Inst\_own + c_8 \cdot Turnover + c_9 \cdot B/M \\ & + c_{10} Lag(Issue\_AR_{t-1}) + \varepsilon_1. \end{aligned} \quad (4)$$

$$\begin{aligned} \text{Step 2}: IC\_EA_t = {} & \alpha + \beta \cdot IC\_AR_{t-1} + \gamma_1 \cdot Std\_AAR + \gamma_2 \cdot Mean\_AAR \\ & + \gamma_3 \cdot Firm\ Size + \gamma_4 \cdot Analyst\ Coverage + \gamma_5 \cdot IC\_PAR_{t-1} + \gamma_6 Inverse\ Mills\ Ratio + \varepsilon_2. \end{aligned} \quad (5)$$

Step 1 estimates the probability in week *t*-1 that an analyst report is issued ($Issue\_AR_{t-1} = \{1, 0\}$), using all firm-quarters. $Lag(Issue\_AR_{t-1})$ is the value of the report issuance indicator from the same week one quarter ago. Step 2 uses only firm-quarters with analyst reports in week -1, and includes the *Inverse Mills Ratio* computed using information from Step 1 to correct for the self-selection effect.

*N_shareholders* is the Size of shareholder base, measured as the natural log of the number of common shareholders (in millions) at the beginning of the quarter; *Inst_own* is institutional ownership, measured as the ratio of shares owned by institutional investors to the number of outstanding shares at the beginning of the quarter; *Turnover* is daily trading volume divided by the number of outstanding shares in the prior quarter; adjusted for average market turnover of the prior quarter; and *B/M* is the ratio of book value to market value of equity at the beginning of the quarter. See Table 1 for the measurement of other variables.

Panel A focuses on the first week before earnings announcements, while Panel B reports results for each of the six weeks in the pre-announcement period, estimated using Model 3 (with corresponding adjustments to timing of the variables in equations (4) and (5)): for week $\tau$, the dependent variable in Equation (4) is $Issue\_AR_{t-\tau}$, the independent variables become $IC\_AR_{t-\tau}$, $IC\_PAR_{t-\tau}$, and $Lag(Issue\_AR_{t-\tau})$. See Table 1 for variable measurement.

These equations are estimated for each calendar quarter and the table reports the average coefficients over the 39 calendar quarters in the sample period (1994 – 2003) and the corresponding t-statistics of the average coefficients. One-sided (two-sided) critical t-values for significance levels of 0.10, 0.05, and 0.01 are 1.28, 1.65, 2.33 (1.65, 1.96, 2.58), respectively. $R^2$s are not available as the two equations are estimated as a system.

*Panel A: Regression results for analyst research disclosed in the last week before earnings announcements*

| | Pred. | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|---|
| | Signs | Step 1 | Step 2 | Step 1 | Step 2 | Step 1 | Step 2 |
| Intercept | | -0.821 | 0.004 | -2.576 | -0.043 | -2.477 | -0.042 |
| | | (-28.79) | (2.71) | (-54.54) | (-4.14) | (-55.09) | (-4.35) |
| Information content of analyst research | +/- | | -0.039 | | -0.035 | | -0.037 |
| (*IC_AR*$_{t-1}$) | | | (-4.42) | | (-4.49) | | (-4.78) |
| Return volatility | | | | | | | |
| *Std_AAR* | + | -3.263 | 1.036 | 3.345 | 0.917 | 1.765 | 0.966 |
| | | (-2.63) | (10.11) | (2.86) | (8.88) | (1.54) | (8.95) |
| *Mean_AAR* | + | -3.241 | 0.426 | 3.892 | 0.423 | 2.962 | 0.454 |
| | | (-1.76) | (4.87) | (3.49) | (5.21) | (2.58) | (5.60) |
| Pre-disclosure information environment | | | | | | | |
| *Firm Size* | ? | | | 0.083 | 0.001 | 0.080 | 0.001 |
| | | | | (9.78) | (5.02) | (9.93) | (5.06) |
| *Analyst Coverage* | ? | | | 0.692 | 0.011 | 0.654 | 0.011 |
| | | | | (44.05) | (3.96) | (39.82) | (4.46) |
| *Prior analyst research* | ? | | | | | 1.171 | -0.019 |
| (*IC_PAR*$_{t-1}$) | | | | | | (11.39) | (-2.57) |
| Proxies for investors' interest in analyst research | | | | | | | |
| *N_shareholders* | + | 0.181 | | 0.002 | | 0.004 | |
| | | (23.52) | | (0.49) | | (0.82) | |
| *Inst_own* | + | 0.522 | | 0.021 | | 0.017 | |
| | | (18.21) | | (1.16) | | (0.96) | |
| *Turnover* | + | 0.212 | | 0.055 | | 0.041 | |
| | | (16.17) | | (5.73) | | (5.00) | |
| *B/M* | - | -0.182 | | -0.015 | | -0.014 | |
| | | (-14.71) | | (-1.94) | | (-1.77) | |
| Prior quarter *Issue_AR*$_{t-1}$ | + | 0.520 | | 0.105 | | 0.105 | |
| | | (22.77) | | (6.45) | | (6.72) | |
| Inverse Mills Ratio | ? | | -0.001 | | 0.016 | | 0.015 |
| | | | (-0.55) | | (3.60) | | (3.36) |
| Number of quarters | | 39 | 39 | 39 | 39 | 39 | 39 |
| Avg # of firms per quarter | | 3,846 | 1,432 | 3,846 | 1,432 | 3,846 | 1,432 |

*Panel B: Regression results in each of the six weeks in the pre-announcement period*

Estimation uses Model 3 from Panel A. For brevity, results from step 1 regression and the coefficients on the control variables for step 2 regression have been omitted. The results for the first week before earnings announcement are repeated here for comparison purposes.

| | Pred. signs | Week $\tau$ before earnings announcement | | | | | |
|---|---|---|---|---|---|---|---|
| | | 6th | 5th | 4th | 3rd | 2nd | (Panel A) Last |
| Intercept | | -0.075 | -0.062 | -0.053 | -0.043 | -0.054 | -0.042 |
| | | (-4.84) | (-5.50) | (-5.10) | (-4.58) | (-5.22) | (-4.35) |
| Information content of analyst research ($IC\_AR_{t-\tau}$) | +/− | -0.043 | -0.033 | -0.037 | -0.053 | -0.024 | -0.037 |
| | | (-3.89) | (-4.64) | (-5.09) | (-6.40) | (-3.09) | (-4.78) |
| Control variables | | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of quarters | | 39 | 39 | 39 | 39 | 39 | 39 |
| Average # of firms per quarter | | 917 | 1,431 | 1,498 | 1,497 | 1,498 | 1,432 |

## Table 4 The information content of earnings announcements and that of analyst research in the post-announcement period

This table reports results from the following regressions, following the two-step procedure of Heckman (1979):

$$\begin{aligned}\text{Step1: } Issue\_AR_{t+1} &= a + b\cdot IC\_EA_t + c_1\cdot Std\_AAR + c_2\cdot Mean\_AAR \\ &+ c_3\cdot Firm\ Size + c_4\cdot Analyst\ Coverage + c_5\cdot IC\_PAR_{t+1} \\ &+ c_6\cdot N\_shareholders + c_7\cdot Inst\_own + c_8\cdot Turnover + c_9\cdot B/M + c_{10}Lag(Issue\_AR_{t+1}) + \varepsilon_1.\end{aligned} \quad (6)$$

$$\begin{aligned}\text{Step 2: } IC\_AR_{t+1} &= \alpha + \beta\cdot IC\_EA_t + \gamma_1\cdot Std\_AAR + \gamma_2\cdot Mean\_AAR \\ &+ \gamma_3\cdot Firm\ Size + \gamma_4\cdot Analyst\ Coverage + \gamma_5\cdot IC\_PAR_{t+1} + \gamma_6\cdot Inverse\ Mills\ Ratio + \varepsilon_2.\end{aligned} \quad (7)$$

Step 1 estimates the probability in week *t*+1 that an analyst report is issued ($Issue\_AR_{t+1} = \{1, 0\}$), using all firm-quarters. $Lag(Issue\_AR_{t+1})$ is the value of the report issuance indicator from the same week one quarter ago. Step 2 uses only firm-quarters with analyst reports in week +1, and includes the *Inverse Mills Ratio* computed using information from Step 1 to correct for the self-selection effect.

*N_shareholders* is the Size of shareholder base, measured as the natural log of the number of common shareholders (in millions) at the beginning of the quarter; *Inst_own* is institutional ownership, measured as the ratio of shares owned by institutional investors to the number of outstanding shares at the beginning of the quarter; *Turnover* is daily trading volume divided by the number of outstanding shares in the prior quarter; adjusted for average market turnover of the prior quarter; and *B/M* is the ratio of book value to market value of equity at the beginning of the quarter. See Table 1 for the measurement of other variables.

Panel A focuses on the first week after earnings announcements, while Panel B reports results for each of the six weeks in the post-announcement period (with corresponding adjustments to timing of the variables in equations (6) and (7)): for week $\tau$, the dependent variables become $Issue\_AR_{t+\tau}$ and $IC\_AR_{t+\tau}$, and the independent variables become $Lag(Issue\_AR_{t+\tau})$. In addition to $IC\_PAR_{t+1}$, we also include in both equations the sum of the information content of analyst research from the first week after earnings announcement to the week prior to the week of interest.

These equations are estimated for each calendar quarter and the table reports the average coefficients over the 39 calendar quarters in the sample period (1994 – 2003) and the corresponding t-statistics of the average coefficients. One-sided (two-sided) critical t-values for significance levels of 0.10, 0.05, and 0.01 are 1.28, 1.65, 2.33 (1.65, 1.96, 2.58), respectively. $R^2$s are not available as the two equations are estimated as a system.

*Panel A: Regression results for analyst research disclosed in the first week after earnings announcements*

| | Pred. signs | Model 1 Step 1 | Model 1 Step 2 | Model 2 Step 1 | Model 2 Step 2 | Model 3 Step 1 | Model 3 Step 2 |
|---|---|---|---|---|---|---|---|
| Intercept | | -0.095 | 0.008 | -1.591 | -0.005 | -1.570 | -0.007 |
| | | (-2.01) | (21.62) | (-17.78) | (-2.84) | (-17.57) | (-3.07) |
| Information content of earnings announcements ($IC\_EA_t$) | +/- | 0.319 | 0.009 | 0.302 | 0.007 | 0.232 | 0.007 |
| | | (2.51) | (3.08) | (2.01) | (2.22) | (1.51) | (2.52) |
| Return volatility | | | | | | | |
| *Std_AAR* | + | -6.185 | -0.122 | -4.770 | -0.110 | -4.522 | -0.099 |
| | | (-4.96) | (-4.82) | (-4.97) | (-4.39) | (-4.78) | (-4.03) |
| *Mean_AAR* | + | -3.329 | 1.162 | 6.190 | 1.155 | 5.536 | 1.153 |
| | | (-1.71) | (46.20) | (3.93) | (42.79) | (3.85) | (39.66) |
| Pre-disclosure information environment | | | | | | | |
| *Firm Size* | ? | | | 0.091 | 0.000 | 0.088 | 0.000 |
| | | | | (8.79) | (-0.07) | (8.40) | (0.44) |
| *Analyst Coverage* | ? | | | 0.687 | 0.005 | 0.687 | 0.005 |
| | | | | (36.96) | (6.98) | (40.39) | (6.44) |
| *Prior analyst research* ($IC\_PAR_{t+1}$) | ? | | | | | 0.063 | -0.004 |
| | | | | | | (0.73) | (-1.91) |
| Proxies for investors' interest in analyst research | | | | | | | |
| *N_shareholders* | + | 0.145 | | -0.021 | | -0.020 | |
| | | (19.82) | | (-4.30) | | (-4.14) | |
| *Inst_own* | + | 0.899 | | 0.373 | | 0.364 | |
| | | (30.42) | | (12.05) | | (11.21) | |
| *Turnover* | + | 0.178 | | 0.044 | | 0.039 | |
| | | (10.35) | | (2.97) | | (2.61) | |
| *B/M* | - | -0.193 | | -0.016 | | -0.015 | |
| | | (-14.27) | | (-1.07) | | (-1.04) | |
| Prior quarter $Issue\_AR_{t+1}$ | + | 0.720 | | 0.329 | | 0.334 | |
| | | (50.21) | | (15.43) | | (15.26) | |
| Inverse Mills Ratio | ? | | -0.004 | | 0.001 | | 0.001 |
| | | | (-16.82) | | (0.66) | | (0.73) |
| Number of quarters | | 39 | 39 | 39 | 39 | 39 | 39 |
| Avg # of firms per quarter | | 3,846 | 2,798 | 3,846 | 2,798 | 3,846 | 2,798 |

*Panel B: Regression results for each of the six weeks in the post-announcement period*

Estimation uses the full model (Model 3 from Panel A). Intercepts and the coefficients on control variables for both equations (6) and (7) are omitted. The results for the first week after earnings announcement from Panel A are repeated here for comparison purposes.

| | | Week $\tau$ after earnings announcement | | | | | |
|---|---|---|---|---|---|---|---|
| | Pred. signs | (Panel A) 1st | 2nd | 3rd | 4th | 5th | 6th |
| $IC\_EA_t$ in step 1 regression | +/– | 0.232 | 0.578 | 0.329 | 0.151 | -0.019 | -3.010 |
| | | (1.51) | (5.18) | (2.44) | (1.10) | (-1.51) | (-2.67) |
| $IC\_EA_t$ in step 2 regression | +/– | 0.007 | 0.006 | -0.002 | -0.007 | -0.019 | -0.034 |
| | | (2.52) | (1.72) | (-0.50) | (-1.50) | (-3.84) | (-4.58) |
| Control variables | | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of quarters | | 39 | 39 | 39 | 39 | 39 | 39 |
| Number of firms per quarter in step 1 regression | | 3,846 | 3,846 | 3,846 | 3,846 | 3,846 | 3,846 |
| Average # of firms with analyst research per quarter in step 2 regression | | 2,798 | 1,783 | 1,589 | 1,482 | 1,367 | 869 |

**Table 5 The level of complexity and the interpretation role of analyst research**

This table reports results from the following system of equations for the weeks after earnings announcements:

$$\text{Step1}: Issue\_AR_{t+1} = a + b_0 \cdot IC\_EA_t + b_1 \cdot Complexity + b_2 \cdot IC\_EA_t \times Complexity$$
$$+ c_1 \cdot Std\_AAR + c_2 \cdot Mean\_AAR + c_3 \cdot Firm\ Size + c_4 \cdot Analyst\ Coverage + c_5 \cdot IC\_PAR_{t+1} \quad (8)$$
$$+ c_6 \cdot N\_shareholders + c_7 \cdot Inst\_own + c_8 \cdot Turnover + c_9 \cdot B/M + c_{10} Lag(Issue\_AR_{t+1}) + \varepsilon_1$$

$$\text{Step 2}: IC\_AR_{t+1} = \alpha + \beta_0 \cdot IC\_EA_t + \beta_1 \cdot Complexity + \beta_2 \cdot IC\_EA_t \times Complexity$$
$$+ \gamma_1 \cdot Std\_AAR + \gamma_2 \cdot Mean\_AAR + \gamma_3 \cdot Firm\ Size + \gamma_4 \cdot Analyst\ Coverage + \gamma_5 \cdot IC\_PAR_{t+1} \quad (9)$$
$$+ \gamma_6 \cdot Inverse\ Mills\ Ratio + \varepsilon_2$$

*N_shareholders* is the Size of shareholder base, measured as the natural log of the number of common shareholders (in millions) at the beginning of the quarter; *Inst_own* is institutional ownership, measured as the ratio of shares owned by institutional investors to the number of outstanding shares at the beginning of the quarter; *Turnover* is daily trading volume divided by the number of outstanding shares in the prior quarter; adjusted for average market turnover of the prior quarter; and *B/M* is the ratio of book value to market value of equity at the beginning of the quarter. See Table 1 for the measurement of other variables.

Panel A focuses on the first week after earnings announcements and Panel B reports the net effect at each Complexity level for the first week. Panel C reports regression results and net effect at each Complexity level for each of the six weeks in the post-announcement period (with corresponding adjustments to timing of the variables in equations (8) and (9)): for week $\tau$, the dependent variables become $Issue\_AR_{t+\tau}$ and $IC\_AR_{t+\tau}$, and the independent variables become $Lag(Issue\_AR_{t+\tau})$. In addition to $IC\_PAR_{t+1}$, we also include in both equations the sum of the information content of analyst research from the first week after earnings announcement to the week prior to the week of interest. *Complexity* is the sum of the R&D indicator, the ordinal value of total assets (0, 0.5, 1), and the ordinal value of the market-to-book ratio (0, 0.5, 1). R&D indicator is 1 for firms with R&D intensity in the top 33% of the sample, and 0 otherwise; the ordinal value of total assets (the market-to-book ratio) is 1 for firms with total assets (the market-to-book ratio) in the top 33%, 0.5 for firms with total assets (the market-to-book ratio) in the middle 34%, and 0 otherwise. $Lag(Issue\_AR_{t+1})$ is the value of the report issuance indicator from the same week one quarter ago. See Table 1 for measurement of other variables.

These equations are estimated for each calendar quarter and the table reports the average coefficients over the 39 calendar quarters in the sample period (1994 – 2003) and the corresponding t-statistics of the average coefficients. One-sided (two-sided) critical t-values for significance levels of 0.10, 0.05, and 0.01 are 1.28, 1.65, 2.33 (1.65, 1.96, 2.58), respectively. $R^2$s are not available as the two equations are estimated as a system.

*Panel A: Regression results for the first week after earnings announcement*

| Variable | Predicted signs | Step 1 | Step 2 |
|---|---|---|---|
| Intercept | | -1.594 | -0.008 |
| | | (-17.85) | (-3.90) |
| Information content of earnings announcements ($IC\_EA_t$) | ? | 0.506 | -0.014 |
| | | (1.80) | (-2.53) |
| *Complexity* | ? | -0.018 | -0.000 |
| | | (-1.65) | (-1.70) |
| $IC\_EA_t \times Complexity$ | + | -0.225 | 0.015 |
| | | (-1.36) | (4.00) |
| Return volatility | | | |
| *Std_AAR* | + | -3.915 | -0.048 |
| | | (-3.68) | (-1.60) |
| *Mean_AAR* | + | 6.756 | 1.186 |
| | | (4.38) | (33.13) |
| Pre-disclosure information environment | | | |
| *Firm Size* | ? | 0.095 | 0.000 |
| | | (8.69) | (-0.10) |
| *Analyst Coverage* | ? | 0.681 | 0.006 |
| | | (37.25) | (6.93) |
| *Prior analyst research* ($IC\_PAR_{t+1}$) | ? | 0.020 | -0.005 |
| | | (0.24) | (-2.47) |
| Proxies for investors' interest in analyst research | | | |
| *N_shareholders* | + | -0.021 | |
| | | (-4.23) | |
| *Inst_own* | + | 0.360 | |
| | | (11.24) | |
| *Turnover* | + | 0.041 | |
| | | (2.81) | |
| *B/M* | - | -0.034 | |
| | | (-2.43) | |
| Prior quarter $Issue\_AR_{t+1}$ | + | 0.322 | |
| | | (14.07) | |
| Inverse Mills Ratio | ? | | 0.003 |
| | | | (1.25) |
| Number of quarters | | 39 | 39 |
| Average # of firms per quarter | | 3,799 | 2,776 |

*Panel B: Net association of $IC\_EA_t$ with $IC\_AR_{t+1}$ conditional on Complexity*

| Complexity level | Proportion of the sample (%) | Net effect[†] (t-statistic) |
|---|---|---|
| 0 | 3.67 | -0.014 |
| | | (-2.53) |
| 0.5 | 12.89 | -0.007 |
| | | (-1.58) |
| 1 | 26.80 | 0.001 |
| | | (0.24) |
| 1.5 | 25.24 | 0.008 |
| | | (2.31) |
| 2 | 19.67 | 0.016 |
| | | (3.48) |
| 2.5 | 7.36 | 0.023 |
| | | (3.93) |
| 3 | 4.36 | 0.031 |
| | | (4.09) |

*Panel C: Regression results and net association of $IC\_EA_t$ with $IC\_AR_{t+\tau}$ conditional on Complexity for each of the six weeks after earnings announcements ($\tau = 1,\ldots,6$)*

For brevity, intercepts and the coefficients on the control variables have been omitted. The results for the first week after earnings announcement are repeated here for comparison purposes. Shading of cells separates negative from positive net effects.

| | Week $\tau$ after earnings announcement | | | | | |
|---|---|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th | 5th | 6th |
| *Coefficient estimates in step 1 regression* | | | | | | |
| $IC\_EA_t$ | 0.506 | 0.225 | -0.192 | -0.240 | -0.248 | -0.652 |
| | (1.80) | (0.91) | (-0.80) | (-0.77) | (-0.85) | (-2.09) |
| $IC\_EA_t$ × *Complexity* | -0.225 | 0.214 | 0.379 | 0.376 | 0.118 | 0.431 |
| | (-1.36) | (1.46) | (2.78) | (2.08) | (0.73) | (2.22) |
| *Coefficient estimates in step 2 regression* | | | | | | |
| $IC\_EA_t$ | -0.014 | -0.011 | -0.022 | -0.022 | -0.044 | -0.068 |
| | (-2.53) | (-1.38) | (-2.90) | (-2.96) | (-4.64) | (-3.80) |
| | 0.015 | 0.011 | 0.013 | 0.011 | 0.019 | 0.024 |
| $IC\_EA_t$ × *Complexity* | (4.00) | (2.18) | (3.11) | (2.19) | (3.21) | (2.17) |
| *Net effect at each complexity level*[†] | | | | | | |
| 0 | -0.014** | -0.011 | -0.022*** | -0.022*** | -0.044*** | -0.068*** |
| 0.5 | -0.007 | -0.006 | -0.015*** | -0.016*** | -0.035*** | -0.056*** |
| 1 | 0.001 | 0.000 | -0.009** | -0.011*** | -0.025*** | -0.044*** |
| 1.5 | 0.008** | 0.006* | -0.003 | -0.005 | -0.016*** | -0.032*** |
| 2 | 0.016*** | 0.011** | 0.004 | 0.001 | -0.007 | -0.020** |
| 2.5 | 0.023*** | 0.017*** | 0.010** | 0.006 | 0.003 | -0.009 |
| 3 | 0.031*** | 0.022*** | 0.016*** | 0.012 | 0.012 | 0.003 |

[†] The net effect equals $\beta_0 + \beta_2 \times$ *Complexity*.

*, **, and *** indicate that the net effect is significant at the 10%, 5%, and 1% levels based on two-sided tests.

**Table 6 Replication of Francis et al. (2002)**

This table reports the results of the regression with measures aggregated over annual periods:

$$IC\_EA_t = \alpha + \beta \cdot IC\_AR_t + \gamma_1 \cdot Std\_AAR + \gamma_2 \cdot Mean\_AAR + \gamma_3 \cdot Firm\,Size + \gamma_4 \cdot Analyst\,Coverage + \nu. \quad (10)$$

See Table 1 for variable definitions. The sample period is divided into non-overlapping annual periods. Mean information content of earnings announcements (EA) and analyst reports (AR) are calculated by dividing the aggregate information content by the number of dates with EA and AR in the year, respectively. To be consistent with the sampling process in Francis et al. (2002), we generate firm-year observations and the corresponding variables based on the 160,175 firm-quarters with both earnings announcement and analyst research, as used before, and add the firm-quarters without earnings announcements or analyst research in the quarter, resulting in 192,020 firm-quarters (48,005 firm-years). These additional firm-quarters all belong to firm-years with at least one analyst research report in the year (as required by Francis et al.).

| Dependent variable | Aggregate information content of EA | | Mean information content of EA | |
|---|---|---|---|---|
| | Model 1 | Model 2 | Model 1 | Model 2 |
| Intercept | 0.018 | 0.043 | 0.004 | -0.000 |
| | (5.49) | (6.01) | (5.58) | (-0.17) |
| *$IC\_AR_t$* (Aggregate information content of analyst research) | 0.036 | 0.046 | | |
| | (22.47) | (16.14) | | |
| *$IC\_AR_t$* (Mean information content of analyst research) | | | -0.054 | -0.046 |
| | | | (-4.50) | (-3.72) |
| *Std_AAR* (Std. dev. \|abnormal returns\|) | 2.002 | 1.933 | 0.822 | 0.833 |
| | (6.56) | (6.13) | (7.75) | (7.88) |
| *Mean_AAR* (Mean \|abnormal returns\|) | 2.145 | 1.947 | 0.582 | 0.601 |
| | (7.79) | (7.74) | (6.27) | (6.55) |
| *Firm size* | | -0.004 | | 0.000 |
| | | (-2.67) | | (0.58) |
| *Analyst coverage* | | -0.000 | | 0.001 |
| | | (-0.03) | | (2.47) |
| Number of firm-years | 48,005 | 48,005 | 48,005 | 48,005 |
| Average adjusted $R^2$ | 0.267 | 0.270 | 0.307 | 0.309 |

**Table 7 Replication of Francis et al. (2002) with correction for sampling bias**

This table shows the results of the following regression with measures aggregated over annual periods:

$$IC\_EA_t = \alpha + \beta \cdot IC\_AR_t + \gamma_1 \cdot Std\_AAR + \gamma_2 \cdot Mean\_AAR$$
$$+\gamma_3 \cdot Firm\,Size + \gamma_4 \cdot Analyst\,Coverage + \nu. \quad (10)$$

See Table 1 for variable definitions. The sample period is divided into non-overlapping annual periods. To be consistent with the sampling process in Francis et al. (2002), we generate firm-year observations and the corresponding variables based on the 160,175 firm-quarters with both earnings announcement and analyst research, as used before, and add the firm-quarters without earnings announcements or analyst research in the quarter, resulting in 192,020 firm-quarters (48,005 firm-years). These additional firm-quarters all belong to firm-years with at least one analyst research report in the year (as required by Francis et al.).
The sample is divided into four sub-samples with one, two, three, or four earnings announcements (EA) available in the year. The far right column is based on the full sample, but using the mean information content measures, calculated as the aggregated information content measures divided by the number of earnings announcements (EAs).

| | Firm-years with one EA | Firm-years with two EAs | Firm-years with three EAs | Firm-years with four EAs | All firm-years, information content measures scaled by number of EAs |
|---|---|---|---|---|---|
| Intercept | -0.025 | -0.010 | 0.005 | 0.003 | -0.001 |
| | (-2.08) | (-1.12) | (0.51) | (0.48) | (-0.80) |
| $IC\_AR_t$ (Information content | -0.026 | -0.010 | 0.011 | -0.002 | -0.004 |
| of analyst research) | (-1.31) | (-0.79) | (1.06) | (-0.49) | (-0.96) |
| *Std_AAR* | 0.740 | 0.822 | 3.008 | 4.297 | 0.812 |
| (Std. dev. \|abn. returns\|) | (2.23) | (2.47) | (2.73) | (12.20) | (7.59) |
| *Mean_AAR* | 1.063 | 2.104 | 1.177 | 1.163 | 0.590 |
| (Mean \|abnormal returns\|) | (3.46) | (6.16) | (1.17) | (3.16) | (5.72) |
| *Firm size* | 0.003 | 0.002 | -0.002 | 0.000 | 0.000 |
| | (1.34) | (1.05) | (-0.86) | (0.65) | (0.71) |
| *Analyst coverage* | 0.001 | 0.002 | 0.004 | 0.007 | 0.002 |
| | (0.28) | (0.48) | (1.11) | (2.65) | (2.43) |
| Number of firm-years | 2,034 | 2,660 | 4,401 | 38,910 | 48,005 |
| (% of full sample) | (4.2%) | (5.5%) | (9.2%) | (81.1%) | (100%) |
| Average adjusted $R^2$ | 0.206 | 0.247 | 0.320 | 0.344 | 0.309 |

**Table 8 Diagnostic and mitigation of the simultaneity bias in the analysis of aggregate information content as used in Francis et al. (2002)**

Beginning with the sample with four earnings announcements (EAs) in the year (see Table 7), 38,910 firm-years, this table shows the results of the following regression with measures aggregated within non-overlapping annual, semi-annual, or quarterly periods (see Table 1 for variable definitions):

$$IC\_EA_t = \alpha + \beta \cdot IC\_AR_t + \gamma_1 \cdot Std\_AAR + \gamma_2 \cdot Mean\_AAR + \gamma_3 \cdot Firm\,Size + \gamma_4 \cdot Analyst\,Coverage + \nu \quad (10)$$

*Panel A: Construction of the three samples*

For each aggregation period (annual, semi-annual, quarterly), each observation must have an analyst report. That is, the annual (semi-annual) [quarterly] sample has at least one report in each firm-year (firm-half-year) [firm-quarter].

| Aggregation period (non-overlapping) | Annual | | Semi-annual | | Quarterly |
|---|---|---|---|---|---|
| Number of observations before restrictions on existence of analyst reports in the aggregation period | 38,910 (Table 7) | ×2= | 77,820 | ×2= | 155,640 |
| Number of observations without analyst reports in the semi-annual period | | | −2,720 | ×2= | − 5,440 |
| Number of observations with at least one analyst report in the semi-annual period | | | 75,100 | ×2= | 150,200 |
| Number of observations without analyst reports in the quarter | | | | | − 8,379 |
| Number of observations with analyst reports in each quarter | | | | | 141,821 |

*Panel B: Regression results*

| Aggregation period: | (Table 7) Annual | Semi-annual | Quarterly |
|---|---|---|---|
| Intercept | 0.003 | -0.005 | -0.009 |
| | (0.48) | (-2.11) | (-8.84) |
| $IC\_AR_t$ (Information content of analyst research) | -0.002 | -0.011 | -0.028 |
| | (-0.49) | (-4.14) | (-15.06) |
| *Std_AAR* (Std. dev. \|abnormal returns\|) | 4.297 | 2.317 | 1.311 |
| | (12.20) | (12.17) | (18.94) |
| *Mean_AAR* (Mean \|abnormal returns\|) | 1.163 | 0.565 | 0.294 |
| | (3.16) | (3.00) | (4.38) |
| *Firm size* | 0.000 | 0.001 | 0.001 |
| | (0.65) | (2.12) | (5.21) |
| *Analyst coverage* | 0.007 | 0.004 | 0.003 |
| | (2.65) | (4.61) | (8.85) |
| Number of observations | 38,910 firm-years in 10 years | 75,100 firm-periods in 20 half-years | 141,821 firm-quarters in 40 quarters |
| Average adjusted $R^2$ | 0.344 | 0.245 | 0.176 |

**Table 9 Analysis of analyst research frequency**

This table reports the results from four regressions. Column (1) reports the results of regressing the information content of earnings announcements on the frequency of analyst research in the week before earnings announcement date (EAD). Column (2) reports the results of regressing the frequency of analyst research in the week after EAD on the information content of earnings announcements. For each regression, we use two alternative measures of analyst research frequency: one based on the number of *forecasts and recommendations* issued in the week, and the other based on the number of *analysts* issuing research reports in that week. To reduce the influence of extreme values, we use log transformation of the frequency measures (ln[1+frequency]). In all regressions, we control for return volatility, firm size, and analyst coverage. For simplicity, the coefficients on these control variables are not reported.

The sample includes 160,175 firm-quarters in the period 1994-2003. Each equation is estimated for each calendar quarter and the table reports the average coefficients over the 40 calendar quarters in the sample period (1994 – 2003) and the corresponding t-statistics of the average coefficients. One-sided (two-sided) critical t-values for significance levels of 0.10, 0.05, and 0.01 are 1.28, 1.65, 2.33 (1.65, 1.96, 2.58), respectively. There are on average 4,004 firms per quarter.

| | (1) The week before earnings announcement date | | (2) The week after earnings announcement date | |
|---|---|---|---|---|
| | Predicted signs | The coefficient on $IC\_AR_{t-1}$ | Predicted signs | The coefficient on $IC\_EA_t$ |
| *Frequency based on the number of forecasts and recommendations* | | | | |
| Coefficient | +/– | -0.001 | +/– | 1.812 |
| (t-statistics) | | (-7.35) | | (15.90) |
| *Frequency based on the number of analysts* | | | | |
| Coefficient | +/– | -0.001 | +/– | 1.044 |
| (t-statistics) | | (-6.57) | | (17.41) |