Stock Return Volatility Before and After Regulation FD

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Abstract

We examine the effect of Regulation FD on stock return volatility. Critics suggest FD has increased volatility by causing firms to (a) disclose less information, resulting in increased noise trading and pricing errors; or (b) substitute essentially continuous communication to the market through professional analysts with infrequent public announcements, precipitating large price swings. While we find generally higher volatility in the fourth quarter of 2000 (after FD's implementation) than in the fourth quarter of 1999 (before FD's implementation), additional analyses suggest Regulation FD is unlikely the cause. Specifically, we find an increase in neither the proportion of extreme return days nor in negative serial correlation in returns post-FD. We find increased volatility around earnings pre-announcements, but we find an approximately offsetting *decrease* in volatility around announcements of actual earnings, such that we find no significant increase in volatility attributable to all earnings information release days.

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STOCK RETURN VOLATILTY BEFORE AND AFTER REGULATION FD

1. Introduction

On October 23, 2000, the U.S. Securities and Exchange Commission issued Regulation FD (Fair Disclosure). Regulation FD prohibits corporations from disclosing material information to select investors or securities market professionals without simultaneously disclosing the same information to the investing public.[1] While the intent of Regulation FD is to eliminate superior trading opportunities for beneficiaries of firms' selective disclosures, a number of brokers, analysts, and even corporate executives contend that an unintended consequence of this regulation is increased stock return volatility. Increased return volatility allegedly arises because Regulation FD will cause firms to either (a) disclose less information, resulting in increased noise trading and pricing errors; or (b) substitute gradual and more or less continuous communication to the market through professional analysts with infrequent public announcements, precipitating large price swings.[2] In this paper, we empirically investigate whether Regulation FD has resulted in increased stock return volatility. We do find generally higher return volatility in the fourth quarter of 2000 (after FD's implementation) than in the fourth quarter of 1999 (before FD's implementation), but additional analyses suggest it is unlikely this higher volatility is attributable to Regulation FD.

It is widely acknowledged that before Regulation FD, firms regularly disclosed value relevant information to select professional analysts and investors, prior to its public disclosure.[3] Regulation FD was promulgated because the SEC likens such selective disclosure to insider trading and fears this practice can undermine investor confidence in the integrity of the capital markets. Analysts and other

[1] Regulation FD requires that material information intentionally disclosed to select market participants, specifically securities market professionals and/or investors who may trade on the information, be simultaneously disclosed to the public-at-large. It requires unintentional disclosures be made public as soon as practical, but no later than 24 hours after the initial disclosure.

[2] The financial press is replete with such arguments. An incomplete list includes Hasset (2000), Clifford (2000), Cramer (2001), Opdyke (2000), Opdyke and Lucchetti (2000), Weber (2000), and Williams and McGough (2000).

[3] The SEC, in the text of the regulation, refers to a number of anecdotes. See http://www.sec.gov/rules/final/33-7881.htm#P41_12912. Pulliam (1999) is an example of such a report in the financial press.

constituents of the securities industry, however, have expressed concern that Regulation FD has increased security price volatility for several reasons. First, it is argued that dissemination of value relevant information will be less frequent because all communication between firms and investors must be through public channels. Thus, instead of more or less continuous private communication with professional analysts, firms will only periodically disseminate information through public announcements such as press releases, SEC 8-K reports, and public conference calls.[4] Even if the information revealed through public announcements is the same as that revealed through private communication with analysts, it is suggested that information flow to the market will occur in less frequent 'lumps'. These relatively infrequent public announcements will communicate large amounts of information to investors all at once and precipitate large short-term price movements, as opposed to the gradual price movements associated with essentially continuous disclosure through professional analysts.

Second, it is argued that the amount and quality of information suffers when disclosure is via public announcement than through private disclosure to professional analysts, and that less information will lead to greater return volatility. There are several facets to this argument. First, it is maintained that sterile public disclosure can never capture the ‘richness’ of private conversation. Second, it is likely that firms will be willing to reveal less information to the public than to professional analysts. This may arise because firms may be less willing to disclose competitively sensitive information to the public-at-large than to ‘trusted’ analysts. Also, firms may be reluctant to disclose sensitive information through the press, which lacks the experience and expertise to interpret and communicate that information as effectively as professional analysts. Finally, even if the information flow from firms is unchanged, interpretation by investors may suffer without the filtering and judgment provided by professional analysts. Due to

[4] Examples of this argument can be found in Clifford (2000) and Cramer (2001). An assumption implicit in these arguments appears to be that public disclosure mediums (press releases and 8-K's) are more costly than simple phone calls to analysts, leading to less frequent use.

speculative trading in the absence of information and/or additional mispricing from poor interpretation, it is argued that prices will move and then correct, leading to additional volatility.[5]

We examine these arguments empirically by comparing stock return volatility in the fourth quarter of 2000 (the first full quarter governed by Regulation FD) to the fourth quarter of 1999 (pre-FD).[6] We compute return volatility as squared market model prediction errors (i.e. volatility of abnormal returns computed using the market model).[7] We find return volatility, measured over various intervals, is generally higher in fourth quarter of 2000 than the in fourth quarter of 1999. Our finding of increased return volatility is robust to controls for various firm-specific and time-varying factors that may have contributed to this increase.

Having documented higher return volatility in our post-FD quarter, we investigate whether this increased volatility is likely attributable to Regulation FD. We employ three sets of analyses to provide evidence about whether Regulation FD affected return volatility. First, since critics suggest FD will cause information to arrive to markets in infrequent 'lumps', leading to large price swings over short periods of time, we examine whether our post-FD quarter is characterized by more days with extreme returns. We first examine kurtosis in the firm specific distributions of abnormal returns, since higher kurtosis indicates greater incidence of extreme values. We find firm specific abnormal return distributions exhibit marginally *lower* kurtosis post-FD, regardless of whether we cumulate abnormal returns over one day or over rolling two, three, or five day windows. We also compute the percentage of the total abnormal return volatility attributable to the extreme one and five percent of the daily abnormal returns for each

[5] Examples of these arguments can be found in Cramer (2001), Opdyke and Lucchetti (2000), Weber (2000), and Hasset (2000) among others. The sentiment that firms disclose less under Regulation FD is also reflected in surveys of professional analysts. Surveys of professional analysts conducted by the Securities Industry Association (SIA) (2001) and the Association for Investment Management and Research (AIMR) (2001) indicate that 72 percent (SIA survey) and 56 percent (AIMR survey) of analysts responding believe the 'overall quality' of information disseminated by companies has declined as a result of Regulation FD. Forty-seven and 57 percent, respectively of the SIA and AIMR survey respondents, believe the companies they follow now disseminate less total information.

[6] We define our quarters with respect to successive earnings announcements, i.e., from three days after the current earnings announcement to two days after the current announcement.

[7] Despite problems, the market model has been used extensively in the past and is still the advocated methodology for computing abnormal returns in event studies (see Campbell, Lo and MacKinlay, 1997). We also replicate all our analyses using several alternative measures of abnormal returns, with no significant changes in our inferences.

firm/quarter and find that such extreme days explain a *smaller* proportion of the total return volatility during the post-FD quarter than the pre-FD quarter. These results are robust to controls for various factors potentially influencing the distribution of returns. Overall, we find a *decrease* in the incidence of extreme returns. This evidence is inconsistent with the notion that Regulation FD motivated firms to communicate large amounts of information to investors through relatively infrequent public announcements that precipitate large price swings.

Second, since it is alleged that Regulation FD will reduce information availability to the markets, leading to more speculative trading and mispricing, we examine whether our post-FD quarter is characterized by greater negative serial correlation in returns. Our rationale for examining serial correlation is that returns induced by misinterpretation and/or speculation/noise trading should mean revert.[8] However, we find little evidence of increased negative serial correlation in abnormal returns in our post-FD quarter, regardless of whether the return window is one, two, three or five days. These results are also robust to various controls. This evidence is inconsistent with increased speculative or noise trading resulting from less total information available to investors post-FD

Finally, since a primary focus of Regulation FD is earnings related information, we examine return volatility around earnings announcements and earnings pre-announcements and around such announcements by other firms in the same industries.[9] If the increased volatility we observe in the fourth quarter of 2000 is induced by Regulation FD, we should be able to attribute much of the increase to these information release periods. We find that abnormal return volatility around earnings announcements in the fourth quarter of 2000 is *lower* than in the fourth quarter of 1999.[10] We do find higher abnormal return

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[8] The impact of speculative trading on prices is discussed in DeLong, Shleifer, Summers, and Waldman (1990), and Blanchard and Watson (1982) and Harris and Raviv (1993).

[9] The text of the regulation specifically cites earnings forecast guidance provided to analysts as an example of a communication that generates "high risk" of violating the regulation. Also much of the discussion in the financial press relates to the effect of Regulation FD on earnings related information.

[10] This result is also reported by Heflin, Subramanyam, and Zhang (2001). To our knowledge, theirs is the only other study, to date, that examines the economic consequences of Regulation FD. The focus of their study is the impact of FD on the availability of earnings-related information in the markets, prior to earnings announcements. In addition to lower return volatility around earnings announcements, they document an increase in earnings pre-

volatility around voluntary public forecasts of future earnings (i.e. 'pre-announcements') post-FD. However, the magnitude of this increase is not sufficient to explain the increased return volatility in general. We also investigate abnormal volatility around earnings announcements and pre-announcements by other firms in the same industry (information transfers) and reach similar conclusions. Finally, we find that the increased return volatility post-FD largely occurs during days not associated with earnings-related information flows. The preponderance of our evidence suggests Regulation FD is unlikely the cause of the observed increase in abnormal return volatility in the fourth quarter of 2000. [11]

Like any empirical study of regulatory effects, ours inferences should be interpreted with certain caveats in mind. First, our empirical design involves examining stock return volatility before and after the implementation of a new regulation. While we have attempted to control for changes in economic factors that could affect our inferences, we can never completely rule out the possibility that our results are driven by some other contemporaneous economic event unrelated to Regulation FD. Also, since our study has been conducted within a few months of the promulgation of Regulation FD, it is possible that the long-term effects of Regulation FD may differ from those that we document. Regardless, considerable resources are devoted to regulating securities markets and our study, despite its limitations, is potentially useful to those wishing to better understand the consequences of this important market regulation in a timely manner.

The rest of this paper is organized as follows. In section two, we examine the change in return volatility before and after Regulation FD. In section three, we investigate whether the increased return volatility post-FD is attributable to Regulation FD. Section four concludes.

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announcements and no change in analysts' earnings forecast accuracy. However, they do not study the impact of Regulation FD on return volatility in general.

[11] Sensitivity analysis indicates that the magnitude of the increased volatility in the fourth quarter of 2000 is influenced by industry-related commonalities in returns (Campbell, Lettau, Malkiel and Xu, 2001).

2. Return Volatility Before and After Regulation FD

2.1. Univariate Tests

Assessing the impact of any regulation necessarily involves a comparison of the values of economic variables both before and after implementation of the regulation. Since Regulation FD became effective on October 23, 2000, we define the fourth quarter of 2000 as our 'post FD' quarter. To provide a basis for comparison, we choose the most recent fourth quarter prior to Regulation FD, which is the fourth quarter of 1999, as our 'pre-FD' quarter. We define quarters with respect to corporate earnings announcements, i.e., our quarters begin three days after the previous quarters' earnings announcements and end two days after the current quarters' announcement. Defining quarters relative to earnings announcements is important for our design. First, since earnings information is a prominent target of Regulation FD[12], defining our period of analysis with respect to earnings information allows us to compare complete earnings 'cycles', before and after the advent of Regulation FD. Second, in tests reported in section 3, we decompose total return volatility into various earnings-related information windows. Defining quarters relative to earnings announcements ensures one earnings announcement (and related pre-announcements) for each sample firm during each quarter under consideration.[13] Thus, for our pre- and post-FD quarters, the majority of the data is obtained from the first calendar quarters of 2000 and 2001 respectively, when most earnings pertaining to the fiscal fourth quarters of 1999 and 2000 were announced.

Our sample of 2,340 firms, consists of all December 31 year-end firms with sufficient stock return data from the Center for Research in Security Prices (CRSP) as well as earnings announcement dates from the First Call database for our pre- and post-FD quarters.[14] However, the total number of firms

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[12] In describing the types of information that management should "review carefully" in deciding whether its disclosure would be governed by Regulation FD, the SEC prominently lists earnings and merger/acquisition related information (Securities and Exchange Commission, 2000). Unlike mergers, earnings information releases occur at regular intervals and are thus more amenable to analysis.

[13] Additionally, research suggests earnings announcements are associated with increased return volatility. Examples include Beaver (1968) and Rendleman, Jones, and Latane (1982).

[14] We eliminate all firms with a "DDC" code indicated in the First Call database. The "DDC" code denotes a discontinuity in the EPS series arising from events such as accounting change and mergers and acquisitions. The

employed in individual tests is lower since we delete observations whose absolute values exceed the 99th percentile of the distribution of that variable's absolute values. If an extreme observation is identified in either the pre- or the post-FD periods for a firm, we delete that firm's observations from both periods, so that each sample firm has one observation in our pre and one observation in our post-FD quarters.

Since Regulation FD focuses on firm specific information, we examine volatility in abnormal returns, which abstracts from market wide movements. We use the standard market model, rather than more recent techniques, to estimate abnormal returns for the following reasons. First, our purpose for determining 'abnormal' return is to merely remove the effects of market wide events and obtain the effects of idiosyncratic information flows, rather than identify pricing inefficiencies. Thus, we use the market model in a purely statistical, rather than economic, sense and do not restrict our parameters estimates to be consistent with theory such as the CAPM. Second, we model abnormal return over one to five day intervals. The choice of the model for determining expected returns is unlikely to have a significant effect over such short horizons. Finally, our approach is similar in spirit to Campbell, Lettau, Malkiel and Xu (2001), who also study firm specific volatility. In sum, we employ the standard market model because of its parsimony and its accepted usage in event study contexts where the objective is to isolate idiosyncratic price movements (e.g. see Cambell, Lo, and MacKinlay, 1997). Nonetheless, in section three, we assess the sensitivity of our results to alternative specifications to the standard market model.[15]

First Call database also has multiple entries for restated earnings. In such cases, we retained the earliest reported earnings information which is the number reported with the earnings announcement.

[15] Our approach is not identical to that used by Cambell, Lettau, Malkiel, and Xu (2001). They employ a market model including an industry return index, with the intercept constrained to zero and the market and industry betas constrained to one. They show that by aggregating within sample, constraining the betas to one is equivalent to estimating betas using weighted in-sample indices, provided the weights sum to one. Our analysis does not lend itself directly to their methodology because our aggregation occurs across different periods in time for different firms, i.e. we aggregate across firms over days *relative* to earnings announcements rather than across *calendar* days. Also, we omit an industry index because the impact of Regulation FD on return volatility may be industry wide—removing industry-wide commonalities in returns may thus hinder our ability to detect the regulation's impact. Nonetheless, in section 3, we address industry effects in two ways. First, when examining the impact of Regulation FD on return volatility around releases of earnings information, we also examine the effects of releases by other firms in the same industry (intra-industry information transfers). Second, we repeat all of our tests with an expanded model that includes industry indices in addition to the value-weighted market index. As we report later, our inferences are qualitatively similar when using this expended model.

We measure total abnormal return volatility for firm i in quarter q as the sum of the squared market model prediction errors over the period starting three days after the earnings announcement for the third quarter of 2000 (1999) and ending two days after the earnings announcement for the fourth quarter of 2000 (1999):

$$Total\ ARV_{i,q} = \sum_{s=1}^{M_{i,q}} \left(\hat{e}_{i,s,q} \right)^2 \qquad (1)$$

where $ARV_{i,q}$ is the abnormal return volatility for firm i in quarter q, $\hat{e}_{i,s,q}$ is the market model prediction error for firm i on day s in quarter q, q is either the fourth quarter of 2000 or the fourth quarter of 1999, and $M_{i,q}$ is the number of days from the third day (inclusive) after firm i's third quarter earnings announcement through two days after firm i's fourth quarter earnings announcement.[16] The market model (using an equal weighted index) is estimated over the one-year period ending on the day before the start of each firm’s fiscal fourth quarter. The cross sectional mean and median of our sample's total abnormal return volatility (i.e. total $ARV_{i,t}$), for both our pre- and post-FD quarters, are shown in panel A of table 1 (columns 2 and 3, labeled ‘Total Volatility – One-Day’). Both the mean and median volatilities are higher in our post-FD quarter than in our pre-FD quarter. Specifically, the cross sectional mean (median) total volatility is 0.1698 (0.0889) for the post-FD quarter and is 0.1519 (0.0799) for the pre-FD quarter and the differences are statistically significant.[17] To control for differences in the number of trading days across the pre- and post-FD quarters, we also report, in columns 4 and 5, cross-sectional means and medians for average daily volatilities (i.e. mean and median $\sum_{i=1}^{M_{i,q}} \frac{ARV_{i,q}}{M_{i,q}}$). The results are qualitatively similar to that using total volatility.

[16] We use the phrase ‘abnormal return volatility’ throughout the paper to imply volatility in abnormal returns, not abnormality in return volatility.

[17] Significance levels are two sided and determined via a t-test for means and a sign test for medians.

Prior research suggests autocorrelation in firm specific daily returns.[18] Therefore, price movements over multiple days could be proportionally larger (or smaller) than over individual days. Accordingly, we compute average two- (three-, five-) day volatility by summing the daily market model prediction errors across consecutive two (three, five) trading day periods, producing a series of rolling two (three, five) day cumulative abnormal returns for each firm. These two (three, five) day cumulative abnormal returns are then squared and averaged across each firm and quarter, producing an average two- (three-, five-) day volatility for each firm-quarter:

$$\text{Average } x \text{ day } ARV_{i,q} = \frac{\sum_{k=1}^{M_{i,q}-(x-1)} \left[\left(\sum_{s=k}^{k+(x-1)} \hat{e}_{i,s,q} \right)^2 \right]}{M_{i,q} - (x-1)} \qquad (2)$$

where x is either two, three, or five and all other variables are as previously defined.

The columns labeled 'Average Two (Three, Five)-Day Volatility' (i.e. columns 6 through 11) in table 1 display the cross sectional mean and median of the average two (three, five) day volatilities. The mean and median volatilities from our post-FD quarter exceed the respective means and medians from our pre-FD quarter for all three return intervals (i.e. two, three, and five days), and the differences between the pre- and post-FD quarter are statistically significant in all cases. Overall, our initial analyses suggest return volatility is higher following Regulation FD.

There is considerable cross-sectional variation in return volatility. Hence, if Regulation FD impacted different firms differently, it is possible that cross-sectional differences in 'normal' volatility could contaminate our inferences regarding changes in return volatility from before to after Regulation FD. Therefore, we replicate the analysis in panel A after scaling the various volatility metrics, for each firm, by that firms' average daily abnormal return volatility during the pre-FD quarter's market model estimation period. The results, presented in panel B of table 1, represent normalized versions of the results presented in panel A and differ in virtually no material aspect from those presented in panel A. That is,

[18] Evidence can be found in Fama (1966), French and Roll (1986), Lo and MacKinlay (1988), Chan (1993), Sias and Starks (1997), and Cooper (1999).

return volatility in the fourth quarter of 2000 (post-FD) is significantly higher than in the fourth quarter of 1999 (pre-FD), regardless of the return window.

Return volatility will tend to be higher the further a firm's price moves over the course of a quarter. Therefore, it is possible that our observed increase in return volatility in the fourth quarter of 2000 may simply reflect larger price movements over the entire quarter. To control for this possibility, in panel C, we scale the mean (median) measures of volatility presented in panel A by the sample mean (median) absolute cumulative abnormal return over the respective quarter, producing a measure of volatility per unit of absolute price movement over the quarter. These results are also qualitatively the same as those presented in panel A and continue to suggest that return volatility is higher in the post-FD quarter than in the pre-FD quarter.

2.2. Multivariate tests

Our univariate results employ abnormal returns, which control for market wide movements in stock prices and, therefore, changes in macro-economic variables. However, the univariate tests conducted thus far do not control for potential changes in firm specific determinants of return volatility. Therefore, in this section, we present the results of tests that condition on various additional controls for differences in firm-specific economic variables between the fourth quarters of 1999 and 2000. Specifically, we estimate the following pooled cross sectional OLS regression[19]:

$$\begin{aligned} ARV_{i,q} &= a_0 + a_1 POSTFD_q + a_2 LOSS_{i,q} + a_3 SIGNUE_{i,q} + a_4 ABSUE_{i,q} \\ &+ a_5 SIGNCAR_{i,q} + a_6 ABSCAR_{i,q} + a_7 VAR_i + e_{i,q} \end{aligned} \tag{3}$$

where $ARV_{i,q}$ constitutes alternative measures of unscaled return volatility for firm *i* and quarter *q* as reported in panel A of table 1.

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[19] To ensure that our significance levels are not affected by heteroscedasticity, we replicate our results using White's (1980) covariance matrix and find qualitatively identical results for all our models (in this and following sections). Since we have only two data points per firm, separated by a year, autocorrelation is unlikely an issue in our sample. In the absence of autocorrelation and with the instruments equal to the independent variables, White (1980) and GMM standard errors are equivalent (Greene, 1997, page 531).

Since our sample construction procedure ensures that each firm is present in both our pre- and post-FD quarters, and since we construct both periods to be approximately of equal length in time, we need only control for firm specific variables whose values may have changed from the fourth quarter of 1999 (pre-FD) to the fourth quarter of 2000 (post-FD). As Campbell, Lettau, Malkiel, and Xu (2001) note, research on firm specific volatility is sparse and provides little guidance regarding potential controls. We include $SIGNCAR_{i,q}$ which is the signed cumulative abnormal return for firm *i* over fiscal quarter *q*, as results in Black (1976) and Christie (1982) suggest volatility is higher in down than in up markets, thus volatility for firms with declining stock prices may be higher than those with rising prices. We also include our two alternative scalars in the univariate tests: $ABSCAR_{i,q}$ is the absolute value of the cumulative abnormal return for firm *i* over fiscal quarter *q*, and VAR_i, is the average daily variance of the market model prediction errors over the market model estimation period during the pre-FD quarter.

Heflin, Subramanyam, and Zhang (2001) examine firm-specific abnormal return volatility in three-day windows around earnings announcements, employing various controls motivated by extant research on the relation between earnings and stock prices, and find those controls generally statistically significant. In the absence of prior research motivating controls for longer periods, we adopt their variables as additional controls. Specifically, we include in equation (3): $LOSS_{i,q}$ which is an indicator variable equaling one if firm *i*'s earnings in quarter *q* are negative and zero otherwise; $SIGNUE_{i,a}$ which is an indicator variable equaling one if firm *i*'s earnings in quarter *q* are lower than in the same quarter of the previous year and zero otherwise; $ABSUE_{i,q}$ which is the absolute value of the seasonal change in earnings. Although not necessarily identified in previous research as being associated with abnormal return volatility, as Heflin, Subramanyam and Zhang indicate, these variables have been identified as important explanators of the widely researched relation between stock returns and accounting earnings.[20]

[20] Initial evidence of the association between yearly and quarterly stock prices and annual and quarterly earnings numbers, can be found in Ball and Brown (1968). Beaver (1968) documents a relation between earnings announcements and price volatility. The control variables Heflin, Subramanyam, and Zhang (2001) employ are motivated by Hayn (1995), Freemen and Tse (1992), and Barth, Elliot, and Finn (1999).

Our main variable of interest is $POSTFD_q$, which equals one if return volatility is measured in the fourth quarter of 2000 and zero otherwise. The coefficient on $POSTFD_q$ is expected to be positive (negative) if abnormal return volatility is higher (lower) for the fourth quarter of 2000 than for the fourth quarter of 1999.

Results from estimating equation (3) are presented in table 2. Most of the control variables are significant at conventional levels and the R-squares are relatively high, suggesting the regressions capture economically meaningful determinants of return volatility across the two quarters. Specifically, the coefficient on $LOSS_{i,q}$ is positive and statistically significant, suggesting that firms reporting accounting losses experience greater return volatility. The coefficient on $SIGNUE_{i,q}$ is positive and statistically significant in two of the five regressions, suggesting that firms reporting lower earnings than the previous quarter experience greater return volatility. The coefficient on $ABSUE_{i,q}$ is positive and significant in all five regressions in table 2, suggesting that firms reporting unexpectedly large earnings changes experience greater return volatility. The coefficient on $ABSCAR_{i,q}$ is positive and significant in all five regressions, suggesting firms with higher absolute cumulative abnormal returns exhibit greater return volatility. The coefficient on $SIGNCAR_{i,q}$ is negative and significant in three of the five regressions, which is opposite to the predicted sign. One explanation for this is that we have controlled for several closely related variables such as the sign of the level of earnings, the change in earnings, and the absolute magnitude of cumulative abnormal return. Finally, as expected, firms with greater volatility in the market model estimation period display greater return volatility, as evidenced by the positive and significant coefficient on VAR_i.

As mentioned earlier, the primary variable of interest in our analysis is $POSTFD_q$. The sign of its coefficient indicates whether firm specific return volatility is higher post or pre-FD. Table 2 reveals the estimate of the $POSTFD_q$ coefficient is positive and statistically significant for all five measures of volatility. Thus, our results suggest that, return volatility during our post-FD quarter is higher than during our pre-FD quarter, even after controlling for both macro-economic and firm-specific factors that may have influenced differences in return volatility across the pre and post-FD quarters.

In summary, this section investigates equity return volatility before and after the implementation of Regulation FD. The results of our tests suggest that return volatility is higher post-FD than pre-FD. In subsequent sections, we provide evidence about whether this observed increase in return volatility is likely attributable to the implementation of Regulation FD or is due to unrelated economic factors.

3. Can the Increased Return Volatility be attributed to Regulation FD?

Results presented in the previous section suggest higher return volatility after implementation of Regulation FD. In this section, we attempt to shed further light on whether the increase in return volatility we observe is likely attributable to the implementation of Regulation FD or is due to unrelated economic factors. Since Regulation FD concerns information dissemination, our analyses focus on information events and on the potential effects of a change in how information is disseminated on the distribution of abnormal returns.

Critics charge that Regulation FD will cause the flow of information to change from relatively continuous flow (through analysts) to a more discrete flow, where lengthy non-information periods are punctuated by significant company announcements precipitating large price swings.[21] Accordingly, we first compare the distribution of returns in the fourth quarter of 1999 (pre-FD) to that in the fourth quarter of 2000 (post-FD), with particular emphasis on identifying extreme price changes. Additionally, since some maintain that firms will simply not disclose as much information and that the absence of information will result in noise trading and random price movements (e.g. Brenowitz, 2000), which presumably must reverse over time, we compare the serial correlation in returns from pre- to post-FD.

Finally, since Regulation FD largely concerns information flows to the market, particularly those related to earnings, we examine return volatility around various earnings' related information events. In particular, since Heflin, Subramanyam, and Zhang (2001) document a significant increase in pre-announcements following Regulation FD, we examine the extent to which these additional voluntary

[21] For example, the chief investment strategist at Bear Stearns is quoted as indicating it is unclear "whether there will be less disclosure overall, but certainly it will be less continuous" (Clifford, 2000).

public disclosures account for the increase in volatility we observe in the post-FD quarter. We also examine return volatility precipitated by information transfers from earnings announcements and pre-announcements from firms in the same industry.

3.1 Distribution of Abnormal Returns

Our objective in this analysis is to determine if fourth quarter 2000 (post-FD) returns are characterized by more large price movements over short periods (ranging from one through five days) than fourth quarter 1999 (pre-FD) returns. Thus, we compare the shapes of the distributions of daily abnormal returns in the fourth quarter of 2000 to the fourth quarter of 1999. Specifically, our interest is in the fourth moments of the respective distributions, or kurtosis, since higher kurtosis suggests more of the distribution's mass lies in the tails (more extreme observations). We compare the kurtosis of the distributions of one-, two-, three-, and five-day returns for each firm during the pre-FD and post-FD quarters.

We report the results of this analysis in panel A of table 3. The results clearly do *not* suggest a shift in mass from the center to the tails of the distributions from the fourth quarter of 1999 to the fourth quarter of 2000. For all four return windows, cross-sectional mean and median kurtosis are *lower* in the post-FD quarter than in the pre-FD quarter and all differences, except the five-day return, are statistically significant (at the 0.10 level or better). Thus, our univariate analyses of kurtosis suggest there are fewer extreme returns in the post-FD quarter than in our pre-FD quarter. This is *not* consistent with the notion that Regulation FD has resulted in less continuous information flows and more instances of large short period price movements precipitated by surprise information releases.

In Panel B we report results of an alternative test of whether Regulation FD precipitated large single-day price movements. Specifically, we compute the proportion of each firm's total daily volatility in a quarter that is contributed by the most extreme one percent (five percent) of the daily returns in that quarter. In other words, for each firm, we first identify the most extreme one percent (five percent) of a quarter's squared daily abnormal returns and divide that by the cumulative squared abnormal returns for the entire quarter for that firm. Since the number of trading days in a quarter is around 64, the most extreme 1% of the distribution contains the single most extreme return day, while the top 5% contains the most extreme three days.

The results reveal little difference between our pre-FD and post-FD quarters in the proportion of total volatility explained by extreme trading days. On average, 19 (43.6) percent of each firm's total volatility in the fourth quarter of 1999 (pre-FD) is contributed by the most extreme one (five) percent of daily returns. By comparison, only 18.6 (43.0) percent of each firm's total volatility in the fourth quarter of 2000 (post-FD) is contributed by the most extreme one (five) percent of daily returns. Results employing the medians are qualitatively similar. With the exception of the mean proportion for the 5% extreme days, none of the differences between the pre- and post-FD quarters are statistically significant at conventional levels. Thus, our evidence is not consistent with an increase in the proportion of total return volatility attributable to extreme days following implementation of Regulation FD.

In table 4, we present results from estimating equation (3) with either firm specific kurtosis or firm specific volatility proportion (i.e. the percent of a firm-quarter's total volatility contributed by the most extreme one or three days) as the dependent variables and the control variables described in the previous section as the independent variables. Of the control variables, the sign of unexpected earnings ($SIGNUE_{i,q}$), the absolute value of unexpected earnings ($ABSUE_{i,q}$), the sign of the quarter's cumulative abnormal return ($SIGNCAR_{i,q}$), the absolute value of the quarter's cumulative abnormal return ($ABSCAR_{i,q}$), and the firm's normal volatility ($VAR_{i,q}$) are generally statistically significant in two sided tests. The coefficients on $SIGNUE_{i,q}$ and $ABSUE_{i,q}$ are positive, indicating firms reporting negative unexpected earnings firms reporting large unexpected earnings exhibit more extreme short period return realizations. Similarly, the coefficients on $ABSCAR_{i,q}$ and VAR_i are positive, indicating firms with large changes in price over the quarter and firms with higher normal volatility are more likely to experience extreme short period returns. The coefficient on $SIGNCAR_{i,q}$ is negative, suggesting that firms with negative returns, in total, over the quarter, are less likely to experience extreme short period returns.

Of interest to our study is the coefficient on $POSTFD_q$, which is negative and statistically significant for every regression estimated and presented in table 4. Recall that $POSTFD_q$ equals one if the observation is from the post-FD quarter and zero if from the pre-FD quarter. In other words, regardless of whether we assess extreme return realizations via firm specific kurtosis or via the proportion of the quarter's total volatility contributed by the most extreme daily returns, we find that large, short period returns are, in fact, less prevalent following Regulation FD's implementation. Further, with respect to kurtosis, the coefficient on $POSTFD_q$ is negative and significant for return intervals of one, two, three and five days.

In summary, this section presents tests aimed at assessing the notion that Regulation FD has broken up the previously continuous flow of information from firms to the market through analysts into a more discrete flow consisting of public announcements precipitating large short period (one or a few days) price swings. Our analyses of firm specific kurtosis and of the proportion of a firm-quarter's total volatility contributed by the one to three days with the most extreme returns provides no evidence to support this contention.

3.2 Serial Correlation in Returns

Some of the criticism of Regulation FD implies serial correlation in returns. This implication stems from concerns that firms will disclose less information post-FD, resulting in increased rumor based and speculative trading, which can lead to negative serial correlation in returns. A number of reasons have been offered for why FD could result in reduced disclosure. First, firms will be unwilling to disclose sensitive information to the public, which they may have previously been willing to disclose to trusted analysts (Brenowitz, 2000). Second, it is alleged information disclosed directly to the financial press and/or the public is more likely misinterpreted than if filtered through professional analysts. With less information, and less skill at interpreting information, rumors, speculation, and pricing errors are more likely.[22] If these arguments are descriptive, increased negative serial correlation, and increased return volatility, could result as prices correct from prior errors.[23]

Table 5 presents the results of analyses designed to assess this conjecture.[24] Panel A shows the cross sectional mean and median first-order serial correlation in one, two, three, and five day returns for both the fourth quarters of 2000 and 1999.[25] Consistent with prior evidence (e.g. Lo and MacKinlay, 1988, Chan, 1993; Sias and Starks, 1997), mean and median abnormal returns exhibit negative serial correlation for return horizons from one through five days. For all except the one-day returns, mean and median serial correlations are significantly *less* negative in the fourth quarter of 2000 (post-FD) than in the fourth quarter of 1999 (pre-FD), which is *not* consistent with the notion that FD has led to greater pricing errors. For one-day returns however, the mean and median serial correlations are more negative in the fourth quarter of 2000 than in the fourth quarter of 1999 but the difference is statistically significant at conventional levels only for the mean. Thus, the evidence from the univariate tests may be considered somewhat mixed, but generally indicates no exacerbation in the negative serial correlation after Regulation FD became operational.

We also present results from an alternative test of negative serial correlation that does not rely on only the first order correlation coefficient. Consider an arbitrary interval of *n* days. Since the expected

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[22] Both Blanchard and Watson (1982) and De Long, Shleifer, Summers, and Waldmann (1990) present models in which prices deviate from fundamental values and are subsequently reversed. The notion that pricing errors lead to negative serial correlation can be found in a number of empirical studies, including, among others, French and Roll (1986), and in longer horizons, by Debondt and Thaler (1985) and, as Lo and Mackinlay (1990) point out is the basis of much of the empirical 'overreaction' literature.

[23] These arguments are reported in various financial press articles, including Opdyke and Schroeder (2001), Cramer (2001), Weber (2000), Shiller (2000), Hasset (2000), Williams and McGough (2000), and Opdyke (2000).

[24] Detecting negative serial correlation in returns induced by pricing errors depends on the time interval required for prices to revert and whether the holding periods we employ in our tests are consistent with that interval. We employ holding periods of up to five days. If the time interval required for prices to revert is longer than five days, our serial correlation tests will lack power. However, Blanchard and Watson (1982) point out that price 'bubbles' can increase the kurtosis of the distribution of returns, as the bursting of the bubble generates large returns. The longer price bubbles build before reversion back to fundamental values, the more likely the reversions will be large enough to be detected in our tests for kurtosis and extreme returns.

[25] To compute the serial correlation in two-day returns, we compute abnormal return over days t and t+1 and correlate that with the return over days t+2 and t+3, for all available days in that quarter for each firm. Thus, we compute the correlation between all consecutive, non-overlapping two day periods. Serial correlations for three and five day returns are computed analogously.

abnormal return over any return interval is zero, the variance of the sum of the abnormal returns over n days can be written as:

$$Var[AR_{i,n}] = n\left(Var\left[\hat{e}_i\right]\right) + 2\left(\sum_{t=1}^{n-1}\sum_{s=t+1}^{n} Cov\left[\hat{e}_{i,t}, \hat{e}_{i,s}\right]\right) \quad (4)$$

where $AR_{i,n}$ is the abnormal return for firm i over the n day period. If the daily returns across the n days are serially uncorrelated, the covariance terms in equation (4) will all equal zero and $Var[AR_{i,n}]$ = $n(Var[e_{i,t}])$. We compare empirical estimates of $Var[AR_{i,n}]$ without and with the assumption of serial independence for each firm-quarter in our sample, through the following ratio:

$$ARVR_{i,q,n} = \frac{\sum_{s=1}^{M_{i,q}-(n-1)}\left(\sum_{t=1}^{n} e_{i,q,t}\right)^2 \Big/ \left(M_{i,q} - (n-1)\right)}{n\left(\sum_{s=1}^{M_{i,q}} e_{i,q,s}^2 \Big/ M_{i,q}\right)} \quad (5)$$

where $ARVR_{i,q,n}$ is the abnormal return variance ratio for firm i and quarter q, and all other variables are as previously defined.

The numerator of equation (5) is an estimate of $Var[AR_{i,n}]$ for quarter q without assuming the daily abnormal returns are serially independent, i.e. it is the average n day abnormal return variance for firm i in quarter q. The denominator in equation (5) is an estimate of $Var[AR_{i,n}]$ assuming the daily abnormal returns *are* serially independent. Therefore, $ARVR_{i,q,n}$ will equal one if daily abnormal returns over the n day interval are serially uncorrelated. If the daily abnormal returns in the n day interval are negatively (positively) serially correlated, then $ARVR_{i,q,n}$ will be less (greater) than one, since the covariance terms in equation (4) will be negative (positive). This test differs from our earlier first-order serial correlation tests in that it incorporates serial correlations of different orders within the n day period into one measure, since it includes covariance terms between all combinations of days within the n day interval, and not just the covariance between subsequent intervals.[26]

[26] Fama and French (1988) and Lo and MacKinlay (1988) also employ variance ratios. Our objective differs from theirs, however, in that we only wish to assess whether the time series covariance structure, at the individual security level, has changed. We make no assumption about the time series process that generates returns, nor about the

Panel B of table 5 reports cross-sectional mean and median abnormal return variance ratios *($ARVR_{i,q}$)* for two, three and five day periods (i.e. n = 2, 3, and 5) during the fourth quarters of 1999 and 2000. All the ratios are below one for both quarters, suggesting the presence of negative serial correlation in abnormal returns. The mean and median ratios for the two-day window (columns 4 and 5 of panel B in table 5) are somewhat smaller post-FD than pre-FD, consistent with the greater negative autocorrelation in daily returns reported earlier, but the differences are statistically insignificant. The ratios for the three and five-day windows (columns 6 through 9 in panel B of table 5) are higher post-FD, and the differences are statistically significant for the five-day window. Overall these results are consistent with the results in Panel A. We find little or no evidence of greater negative serial correlation post-FD.

In table 6, we present results from estimating equation (3) with the first-order autocorrelations from the one, two, three, and five day returns and the abnormal return variance ratios for two, three, and five day intervals separately as dependent variables. The results suggest that firms reporting negative unexpected earnings ($SIGNUE_{i,q}$) and large unexpected earnings ($ABSUE_{i,q}$), and firms with greater 'normal' volatility are characterized by more negative serial correlation in returns. Firms with larger price movements over the quarter ($ABSCAR_{i,q}$) and those reporting losses ($LOSS_{i,q}$) are characterized by less negative serial correlation in returns, although the coefficient on $LOSS_{i,q}$ is not always statistically significant at conventional levels. The coefficient on $SIGNCAR_{i,q}$ is generally negative, though not always significant, suggesting firms with negative returns are characterized by greater negative serial correlation.

Again, the variable of interest is $POSTFD_q$, and its coefficient is positive and significant for first-order autocorrelations computed from two, three, and five day returns, and for abnormal return variance ratios involving five day periods. This suggests serial correlation is somewhat *less* negative in our post-FD quarter, even after controlling for various factors that might have influenced the distributions of

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distribution of prices or returns. Significance levels based on t-tests may be invalid, since the variance ratios may not be distributed normally and, as Lo and MacKinally (1988) indicate, may be cross sectionally dependent. However, distributional problems are mitigated in the median based tests we report, which are distribution free. Cross sectional correlation is likely less of a problem in our tests since (a) the days over which we compute variances are not aligned in calendar time across our firms, and (b) our tests focus on changes in the variance ratios across time, rather than on their levels at a point in time.

returns across the two quarters. However, when the abnormal return volatility ratios are the dependent variables, the $POSTFD_q$ coefficient is negative when the two day interval abnormal return variance ratio is the dependent variable and positive when the three day interval abnormal return variance ratio is the dependent variable, but both are insignificant.

Overall, our univariate and multivariate tests suggest little evidence of increased negative serial correlation in returns when the period of analysis is larger than contiguous single days. Our univariate tests produce weak evidence of increased negative serial correlation for one-day return intervals and our multivariate tests produce weak evidence of increased negative serial correlation two-day interval abnormal return variance ratios. However, our evidence suggests no increase in the negative serial correlation in returns beyond consecutive days.[27]

3.3 Volatility Attributable to Information Releases

To this point, we have examined the characteristics of the returns distributions to *indirectly* infer the nature of information flows to the market and their resultant impact on return volatility. In this section, we more *directly* investigate the impact of Regulation FD on return volatility by examining return volatility around specific information events likely affected by the regulation. As we observe earlier, one of the primary issues Regulation FD addresses is information dissemination regarding forthcoming earnings' announcements.[28] Accordingly, we examine return volatility around earnings announcements

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[27] As Roll (1984), and other authors note, bid-ask bounce can induce negative serial correlation. Within our sample period, the minimum tick size on the NYSE was reduced from 1/16 of a dollar to one cent. Chakravarty, Harris, and Wood (2001) find that decimalization decreased effective spreads by about 11 percent. Although our sample is not entirely from the NYSE, as spreads decline, so does the impact of bid-ask bounce. Also, as Cooper (1999) indicates, this problem is more severe if returns are computed conditionally on past returns. Our measures are computed unconditionally, further mitigating the impact of bid-ask bounce. Additionally, bid-ask bounce is less likely a factor over longer holding periods, such as our five day interval. Finally, based on results in Conrad, Gultekin, and Kaul (1997) indicating that bid-ask bounce is less of a factor in price reversals for large than small capitalization firms, we repeated the tests reported in both table 5 and table 6 on only the largest half of our firms. The results are qualitatively similar, with no increase in mean negative serial correlation for the one day return interval. Our inferences appear unlikely influenced by bid-ask bounce.

[28] While earnings related information is not the only information encompassed by Regulation FD, it is clearly a primary target. For example, the text of the regulation lists earnings information first when enumerating different types of information addressed and provides specific guidance on how to make a “planned disclosure of material information, such as an earnings release”.

and around voluntary public forecasts of earnings' related information (often referred to as 'pre-announcements' in the financial press) pertaining both to the firm under consideration and all other firms in the same industry. If Regulation FD has resulted in periods of non-disclosure punctuated by infrequent public announcements containing large amounts of previously unreleased information (e.g. see Cramer, 2001), we should see bigger price reactions to such public announcements.

3.3.1 Volatility Around Earnings Announcements and Pre-announcements

We first compare abnormal return volatility around earnings information releases in our post-FD quarter to those in our pre-FD quarter. For each earnings announcement, we define the announcement window as the three trading days (-1 through +1) centered on the announcement day. We also employ a similar three-day window around every voluntary earnings-related disclosure (pre-announcement) reported in the First-Call database during the fourth quarters of 2000 and 1999. Unlike the earnings announcement windows, which arise only once every quarter for every firm, the number of pre-announcement windows per firm-quarter can vary considerably across firms and quarters. If a firm does not pre-announce in a given quarter, then no pre-announcement observation enters our data set for that firm-quarter. If a firm pre-announces more than once during a quarter, we include all its pre-announcements, without double counting overlapping days, if any. Formally, earnings announcement abnormal return volatility for firm *i*, quarter *q* is measured as follows:

$$\textit{Earnings Announcement } ARV_{i,q} = \sum_{s=t-1}^{t+1}\left(\hat{e}_{i,s,q}\right)^2 \tag{6}$$

where day $t = 0$ is the day containing the earnings announcement. Likewise, earnings pre-announcement abnormal return volatility for firm *i*, quarter *q* is

$$\textit{Pre-Announcement } ARV_{i,q} = \sum_{j=1}^{J_{i,q}}\left[\sum_{s=t-1}^{t+1}\left(\hat{e}_{i,s,q,j}\right)^2\right] \tag{7}$$

where $J_{i,q}$ is the number of pre-announcements in quarter *q* by firm ***i*****.** Overlapping days are summed only once to avoid double counting.

Panel A of table 7 reports cross-sectional mean and median abnormal return volatility around earnings announcements and pre-announcements for the fourth quarter of 2000 and the fourth quarter of 1999. Consistent with Heflin, Subramanyam, and Zhang (2001), return volatility around earnings' announcements is *lowe*r post-FD. Both mean and median abnormal return volatilities during the earnings announcement window are significantly lower during the fourth quarter of 2000 than the fourth quarter of 1999, suggesting that earnings' information was actually *better* anticipated by the market post-FD. A possible explanation for this result is that the earnings information was pre-empted by increased pre-announcements post FD. Indeed, Heflin, Subramanyam, and Zhang (2001) report a marked increase in the number of pre-announcements after Regulation FD. Thus, it is possible that the post-FD decline in return volatility around earnings announcements is offset by increased volatility around pre-announcements. The tenor of the criticism of Regulation FD, however, is that volatility would increase post-FD, which implies that the increase in volatility due to increased pre-announcements should more than offset any decline in volatility around earnings announcements.

The evidence, reported in Panel A of table 7, supports the conjecture of increased volatility due to pre-announcements, but not the conjecture that this increased volatility overshadows the decline in volatility we observe around earnings announcements, leading to an increase in overall volatility. Specifically, the mean abnormal return volatility around pre-announcements occurring in the post-FD quarter is nearly double the mean around announcements occurring in the pre-FD quarter and the difference is statistically significant.[29] Of additional interest is the magnitude of the difference between the abnormal return volatility for the fourth quarter of 2000 and the fourth quarter of 1999. At 0.0028, it is very nearly equal to the decline in abnormal volatility of 0.0020 around earnings' announcements. Thus, our evidence suggests that Regulation FD has resulted in substitution of information flows from

[29] The medians are zero for both the pre and post-FD quarters because less than half of the sample firms released pre-announcements in either quarter.

earnings announcements to pre-announcements. However, the mean increase in pre-announcement volatility is insufficient to explain the increased overall volatility reported in section two.[30]

3.3.2 Volatility from Information Transfers

Existing research suggests the release of information by one firm in an industry can precipitate stock price movements for other firms in the same industry.[31] Thus, it is possible that the announcements and pre-announcements by some firms result in increased volatility for other firms in the same industries. We label the three days surrounding the earnings announcements by another firm in the same industry (defined by four digit SIC code) as the 'earnings information transfer window' and compute earnings information transfer abnormal return volatility for firm *i*, quarter *q*, analogously to equation (7), except that $J_{i,q}$ is the number of announcements of actual earnings in quarter q by firms in the same four digit SIC code as firm *i*. Similarly, we label the three days surrounding pre-announcements by another firm in the same industry as the 'pre-announcement information transfer window'. Formally,

$$\textit{Earnings Information Transfer ARV}_{i,q} = \sum_{j=1}^{K_{i,q}} \left[\sum_{s=t-1}^{t+1} \left(\hat{e}_{i,s,q,j} \right)^2 \right] \quad (8)$$

where $K_{i,q}$ is the number of announcements of actual earnings in quarter q by firms in the same four digit SIC code as firm *i* and

$$\textit{Pre-Announcement Information Transfer ARV}_{i,q} = \sum_{j=1}^{L_{i,q}} \left[\sum_{s=t-1}^{t+1} \left(\hat{e}_{i,s,q,j} \right)^2 \right] \quad (9)$$

where $L_{i,q}$ is the number of pre-announcements in quarter q by firms in the same four digit SIC code as firm *i*.

The cross sectional means and medians of abnormal return volatilities during these information transfer windows for the pre- and post-FD quarters are also presented in panel A of table 7. Both mean

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[30] The median volatility around pre-announcements is zero for both quarters. This is because the typical firm in either quarter did not pre-announce. The median volatility around *earnings* announcements, however, did decline post-FD.

[31] See Foster (1981), Clinch and Sinclair (1987), and Docking, Hirschey, and Jones (1996).

and median volatility induced by earnings' announcements by same-industry firms is significantly lower for the fourth quarter of 2000 than for the fourth quarter of 1999. However, volatility induced by pre-announcements of earnings by same-industry firms is *higher* for pre-announcements of fourth quarter 2000 earnings than for fourth quarter 1999 earnings. Similar to own firm announcements, the magnitude of the decrease in volatility for earnings' announcement information transfers is approximately equal to the increase in volatility for pre-announcement information transfers. Our conclusions from information transfers are similar to that of the own-firm announcements: return volatility induced by pre-announcements is higher post-FD, but can not explain the general increase in return volatility.

3.3.3 Information Day and Non-Information Day Volatility

Overall, return volatility around earnings announcements (and related information transfers) is lower post-FD, while return volatility around pre-announcements (and related information transfers) is higher. Moreover the magnitude of the increased pre-announcement volatility is similar to the magnitude of the decreased volatility during earnings announcements, both for own firm announcements and for announcements by firms in the same industry. This is consistent with the notion that Regulation FD shifted volatility from actual earnings announcements to pre-announcements, rather than induced an increase in total volatility. To provide a more formal analysis of whether earnings information releases can explain the increase in total volatility we observe (reported in section two), we partition each quarter's total volatility into that attributable to information days and, separately, non-information days.

We define an information day as any day included in any of the earnings announcement, pre-announcement, earnings information transfer, or pre-announcement information transfer windows. Total information day volatility is, for each firm-quarter, the sum of the return volatility across all information days (i.e. the sum of equations (6) through (9)). Non-information days are all remaining days and, therefore, include days without any earnings-related information events. Total non-information day volatility, for firm i and quarter q, is total return volatility less total information day volatility (i.e. equation (1) minus the sum of equations (6) through (9)). If earnings-related information volatility explains the post-FD increase in total return volatility we find in section two, we should observe an increase in abnormal return volatility for information days and no corresponding increase for non-information days.

The results shown in panel A of table 7 suggests otherwise. Both the mean and median abnormal return volatility on non-information days are significantly higher for the fourth quarter of 2000 (post-FD) than the fourth quarter of 1999 (pre-FD). The mean (median) increase in return volatility of 0.0135 (0.0029) attributable to non-information days explains a substantial proportion of the increase in mean (median) total return volatility of 0.0179 (0.0040) from the pre- to the post-FD quarter. On the contrary the mean increase in return volatility during information release days, at 0.0044, although significant, is substantially smaller than the mean increase on non-information days.

3.3.4. A Closer Look at Additional Volatility from Pre-Announcements

As documented by Heflin, Subramanyam, and Zhang (2001), the number of pre-announcements during the fourth quarter of 2000 is markedly higher than during the fourth quarter of 1999. Thus, there are more pre-announcement information days and pre-announcement information transfer days in our post-FD quarter, than our pre-FD quarter.[32] This will mechanically attribute more return volatility to pre-announcements and their related information transfers during the post-FD quarter simply because there are more days included in the pre-announcement and related information transfer windows. Thus, results in panel A of table 7 are not very useful at comparing pre-announcement volatility (and thus total information day volatility) across quarters. Therefore, we adjust the abnormal return volatilities reported in panel A by removing an estimate of each firm's expected abnormal return volatility for the window under consideration. We estimate daily expected abnormal return volatility by the average daily abnormal return volatility during the fourth quarter of 1999. We then multiply estimated expected daily abnormal return volatility by the size (in days) of the window under consideration to obtain the expected abnormal return volatility for that window. Formally, the adjusted abnormal return volatility for an announcement or an information transfer is:

$$AARV_{i,q} = ARV_{i,q} - \left(D_{i,q}\right)\frac{\sum_{s=1}^{M_{i,1999}}\left(\hat{e}_{i,s,1999}\right)^2}{M_{i,1999}} \tag{10}$$

where $AARV_{i,q}$ is the adjusted abnormal return volatility for either an earnings announcement, pre-announcement, earnings information transfer, or pre-announcement information transfer for firm *i*, quarter *q*, $D_{i,q}$ is the total number of days in the window for the associated type of information event and all other variables are as defined earlier.[33] Thus, adjusted abnormal return volatility ($AARV_{i,q}$) is standardized to zero. Announcements precipitating return volatility greater (less) than the average volatility for the fourth quarter of 1999 will produce adjusted abnormal return volatilities that are greater (less) than zero.

Results employing adjusted abnormal return volatility are presented in panel B of table 7. Directionally, the results are similar to the unadjusted volatility results reported in panel A for each of the earnings announcement, pre-announcements and associated information transfer windows.[34] The return volatility around earnings announcements (and associated information transfers) is, like in panel A, significantly lower post-FD. Despite the adjustment to remove the impact of including additional days in the pre-announcement and related information transfer windows (due to the increased number of pre-announcements) in the post-FD quarter, the return volatility around pre-announcements (and related

[32] This is evident in our sample as the average number of days per firm classified as pre-announcement information days (pre-announcement information transfer days) during 2000 was 3.412 (12.171) compared to 3.215 (7.940) during 1999.

[33] In other words, in computing $AARV_{i,q}$ for pre-announcements, $D_{i,q}$ is the total number of days in firm i's abnormal return volatility windows in quarter q. For example, if firm i makes four pre-announcements during quarter q and none of the three day windows centered on the announcements overlap, $D_{i,q}$ would be 12. If two of the days overlap, $D_{i,q}$ would be 11, since each day is used only once in computing abnormal return volatility. $D_{i,q}$ is computed analogously for earnings announcements, earnings information transfers, and pre-announcement information transfers.

[34] Note that the change in total volatility (column 2) reported in panel B of table 7 is not the same as reported in panel A, because the number of days in the fourth quarter of 2000 is slightly smaller than the fourth quarter of 1999. Thus, expected total volatility for the fourth quarter of 2000 is smaller than for the fourth quarter of 1999 because expected daily volatility is multiplied by a smaller number of days. Note also that total adjusted abnormal return volatility for the fourth quarter of 1999 is zero by construction.

information transfers) is, like in panel A, significantly higher. However, in panel B of table 7, the magnitude of the differences between the pre- and post-FD volatilities associated with pre-announcements and pre-announcement information transfers, are smaller than in panel A. For example, the mean increase in pre-announcement information transfer volatility is only 0.0047 (column 6) in panel B, while it is 0.0127 (also column 6) in panel A. Consequently, the abnormal return volatility attributable to total information days in panel B of table 7 is substantially lower than in panel A: both the mean and median adjusted abnormal return volatility attributable to information days is *lower* post-FD, although the mean difference is not statistically significant at conventional levels. Thus, once we adjust for the normal volatility associated with the greater number of pre-announcement days post-FD, there is no evidence of an increase in return volatility associated with earnings related information events. Additionally, volatility attributable to non-information days (column 8) is higher post-FD in panel B of table 7, just as it is in panel A. These results suggest that the increased volatility in the post-FD quarter is unlikely caused by changes in the information environment precipitated by the regulation.

Finally, in table 8, we present results from incorporating controls into our tests regarding abnormal return volatilities around the various types of earnings information releases. Specifically, we estimate the following OLS regression:

$$\begin{aligned} ARV_{i,q} &= a_0 + a_1 POSTFD_q + a_2 LOSS_{i,q} + a_3 SIGNUE_{i,q} + a_4 ABSUE_{i,q} \\ &\quad + a_5 SIGNCAR_{i,q} + a_6 ABSCAR_{i,q} + a_7 VAR_i + a_8 D_{i,q} + a_9 D_{i,q} * VAR_i + e_{i,q} \end{aligned} \tag{11}$$

where all variables are as previously defined. We estimate equation (11) six times, once for each of the six different abnormal return volatilities presented in panel A of table 7, i.e. earnings announcements, earnings pre-announcements, earnings announcement information transfers, earnings pre-announcement information transfers, total earnings information days, and non-information release days. We include the number of days (i.e. $D_{i,q}$) in the window used to construct the dependent variable and the number of days times the average daily volatility from the fourth quarter of 1999 (i.e. $D_{i,q}*VAR_i$) to capture the impact on abnormal return volatility from additional pre-announcements in the fourth quarter of 2000.[35]

The inferences from these regressions are identical to those drawn from the univariate results presented in table 7. The coefficients on $POSTFD_q$ are all significantly different from zero with signs that are consistent with the univariate results presented in table 7. When total information day abnormal return volatility is the dependent variable, the coefficient on $POSTFD_q$ is positive, but insignificant. The positive coefficient on $POSTFD_q$ when total non-information day abnormal return volatility again suggests information releases do not explain the increase in total volatility we observed in section two. In sum, we conclude our earlier inferences are largely unaffected by the inclusion of these control variables.

3.4 Sensitivity to abnormal returns estimation techniques

We use the standard market model for determining abnormal returns. In section two we discuss the reasons for using the market model. In this section, we examine the sensitivity of our results to alternative methods for estimating abnormal returns.

One issue in estimating the market model is measurement error in estimated betas. As we note in section two, Campbell, Lettau, Malkiel and Xu (2001) invent an approach wherein they are able to eschew estimation of betas when determining average volatility. Implicitly setting the market model beta to one and constraining the intercept to zero, they define the abnormal component of return as the difference between an individual stock's return and the return on a market index determined from within the sample (i.e. market adjusted returns). Since our analysis entails aggregation of returns across different periods for different firms, it does not lend itself directly to the Campbell, Lettau, Malkiel and Xu methodology. Nonetheless, we replicate our results using market adjusted returns, which we define as the

[35] We omit $D_{i,q}$ and $D_{i,q}*VAR_{i,q}$ from equation (11) when abnormal return volatility around earnings announcements is the dependent variable (since there is only one actual announcement of earnings each quarter, the total number of earnings announcement window days in the fourth quarter of 1999 must equal the total number in the fourth quarter of 2000).

difference between individual stocks' returns and the return on the CRSP value-weighted index, and find no qualitative differences in our results.

Another potential limitation to the market model is that it models stock returns as a function of only market returns. Market returns have been shown to explain a decreasing proportion of individual stock returns, while both industry-wide and idiosyncratic shocks play an increasingly prominent role (Campbell, Lettau, Malkiel and Xu, 2001). Although inclusion of an industry index may hinder our ability to detect an impact on volatility from FD (see footnote 15), the inability of the market model to capture industry-level movements in stock prices may create measurement error in our volatility estimates and potentially contaminate our inferences regarding idiosyncratic return volatility. Accordingly, we replicate all our analyses after estimating abnormal returns using the following combined market and industry model:

$$R_{i,t} = \alpha_i + \beta_{1,i} M_t + \sum_{j=1}^{12} \gamma_{j,i} I_{j,t} + e_{i,t} \tag{12}$$

where $R_{i,t}$ is firm i's return on day t, M_t is the CRSP value-weighted index, and the $I_{j,t}$ are industry return indices. We classify all firms in the CRSP database as belonging to one of 12 industry groupings, based on SIC code, and compute 12 value-weighted industry return indices.[36] Rather than *ex ante* identifying the industry listing of a firm, we regress the individual firm's return on all twelve indices, in addition to the market index, thereby allowing each firm's returns to determine to which of (or combination of) the 12 industry groupings that firm belongs.

Using equation (12) to generate abnormal returns, we find that post-FD increase in adjusted volatility (table 7 panel B) is generally lower for each of the information day and non-information day windows, and in the aggregate for the entire quarter. Because of this, there are a few differences in terms of the significance levels, although the tenor of our results is essentially unchanged.[37] The multivariate

[36] To categorize firms into the twelve industry groupings, we employ the classification scheme available on Professor Ken French's website, http://mba.tuck.dartmouth.edu/pages/faculty/ken.french.

[37] The change in mean adjusted volatility over the entire quarter is still significantly positive, although the magnitude of the increase is less than half of that using the market model returns, while the median change is

results (table 8) are also qualitatively similar although, as with our univariate results, there are a few changes in the significance levels.[38]

4. Conclusion

Critics of Regulation FD suggest that private communication to analysts is an important source of information to the capital markets. They argue that, by prohibiting private communication between firms and analysts, Regulation FD will adversely affect the flow of corporate information to the capital markets resulting in increased stock return volatility. It is alleged that Regulation FD will result in (a) more discrete information flows, where periods of relative silence are punctuated by significant information releases, resulting in larger price shocks, and/or (b) less total information disclosed to capital market participants resulting in increased speculative trading and pricing errors and, therefore, greater volatility due to price reversals.

In this paper, we investigate whether stock return volatility increased following implementation of Regulation FD. We find higher abnormal return volatility on average after the implementation of Regulation FD. Subsequent analyses suggests the increased volatility is unlikely a consequence of Regulation FD. We see neither an increase in the incidence of days with extreme returns nor an increase in negative serial correlation in stock returns. We also find the increased volatility does not occur around firm-specific information flows, such as earnings announcements, pre-announcements or related information transfers from firms in the same industry. Overall, our results suggest it unlikely that Regulation FD caused an increase in return volatility.

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insignificant. Also, the mean change in volatility during information days is significantly negative (insignificant when using market model returns).

[38] The major difference is that there is no significant change in volatility during information days, while there is a significant increase using market model returns.

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Table 1
Abnormal Return Volatility—Univariate Analysis

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Total Abnormal Return Volatility One-Day		Average One-Day Abnormal Return Volatility		Average Two-Day Abnormal Return Volatility		Average Three-Day Abnormal Return Volatility		Average Five-Day Abnormal Return Volatility	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Panel A: Undeflated										
Pre-FD: 1999 4th Quarter	0.1519	0.0799	0.0020	0.0011	0.0040	0.0021	0.0059	0.0030	0.0096	0.0047
Post-FD: 2000 4th Quarter	0.1698	0.0889	0.0023	0.0013	0.0044	0.0024	0.0064	0.0034	0.0102	0.0055
Change	0.0179	0.0040	0.0003	0.0001	0.0004	0.0001	0.0004	0.0002	0.0007	0.0005
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.02)	(0.00)
Panel B: Deflated by Firm Specific Volatility During Estimation Period										
Pre-FD: 1999 4th Quarter	102.7210	82.8213	1.4155	1.1559	2.8010	2.2488	4.1096	3.2418	6.6184	5.0445
Post-FD: 2000 4th Quarter	117.0700	91.8081	1.6411	1.3221	3.1655	2.5121	4.6881	3.6518	7.7488	5.9146
Change	14.3492	4.6544	0.2256	0.0933	0.3645	0.1498	0.5786	0.2578	1.1304	0.5539
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Panel C: Deflated by Absolute Abnormal Returns During Quarter										
Pre-FD: 1999 4th Quarter	0.3952	0.3393	0.0053	0.0047	0.0105	0.0090	0.0153	0.0129	0.0249	0.0198
Post-FD: 2000 4th Quarter	0.6279	0.4266	0.0085	0.0060	0.0160	0.0113	0.0235	0.0164	0.0376	0.0263
Change	0.2327	0.0489	0.0032	0.0008	0.0055	0.0015	0.0081	0.0021	0.0126	0.0041
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

The sample consists of 2,340 December fiscal year end firms with necessary data available in 1999 and 2000. Variables are winsorized at 99th percentile of their absolute value of their respective distributions, resulting in fewer observations in specific cells. Each firm contributes one observation each from the fourth quarters of 1999 and 2000. Each quarter is the period from the third trading day after the third quarter's earnings announcement to the second trading day after the fourth quarter's earnings announcement. Rows labeled 'change' present the mean and median within-firm change from the fourth quarter of 1999 to the fourth quarter of 2000. P-values are two-sided and, for means, are from t-tests and, for medians, are from sign tests. Abnormal returns are equal weighted index market model prediction errors. The market model estimation period is the year ending the day before the start of the relevant quarter.

Panel A presents, for each quarter, cross sectional means and medians of the total abnormal return volatility, and the average one, two, three, and five-day abnormal return volatilities. The one, two, three, and five-day abnormal return volatilities are the squared cumulative abnormal returns over the corresponding moving windows respectively. Total abnormal return volatility, for each firm and quarter, is the summation, across the quarter, of the firm's daily abnormal return volatilities. Panel B presents cross sectional means (medians) for the set of metrics in Panel A deflated by firm specific average daily volatility during the fourth quarter 1999's estimation period. Panel C presents means (medians) for the set of metrics in Panel A deflated by the mean (median) of the cumulative abnormal return of the 2,340 sample firms over the window from the third trading day after previous quarter's earnings announcement to the second trading day after current quarter's earnings announcement.

Table 2
Abnormal Return Volatility—Multivariate Analysis

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable	Coefficient Estimates (p-values below in parentheses) on:								
	Intercept	$POSTFD_q$	$LOSS_{i,q}$	$SIGNUE_{i,q}$	$ABSUE_{i,q}$	$SIGNCAR_{i,q}$	$ABSCAR_{i,q}$	VAR_i	R^2%
Total $ARV_{i,q}$	-0.0258	0.0277	0.0734	0.0098	0.5337	-0.0001	0.1738	60.3904	49.25%
	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.99)	(0.00)	(0.00)	
One-Day Ave. $ARV_{i,q}$	-0.0003	0.0004	0.0010	0.0001	0.0056	0.0000	0.0023	0.7932	48.69%
	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.76)	(0.00)	(0.00)	
Two-Day Ave. $ARV_{i,q}$	-0.0004	0.0006	0.0019	0.0002	0.0069	-0.0003	0.0056	1.5018	51.11%
	(0.00)	(0.00)	(0.00)	(0.19)	(0.00)	(0.01)	(0.00)	(0.00)	
Three-Day Ave. $ARV_{i,q}$	-0.0006	0.0008	0.0029	0.0001	0.0116	-0.0006	0.0089	2.1366	50.91%
	(0.00)	(0.00)	(0.00)	(0.55)	(0.00)	(0.00)	(0.00)	(0.00)	
Five-Day Ave. $ARV_{i,q}$	-0.0010	0.0012	0.0044	0.0001	0.0180	-0.0012	0.0166	3.2099	50.38%
	(0.00)	(0.00)	(0.00)	(0.63)	(0.00)	(0.00)	(0.00)	(0.00)	

The sample consists of 2,340 December fiscal year end firms with necessary data available in 1999 and 2000. Variables are winsorized at 99th percentile of the absolute value of their respective distributions, resulting in fewer observations in specific regressions.

For each of the dependent variables, we estimate:

$$ARV_{i,q} = a_0 + a_1 POSTFD_q + a_2 LOSS_{i,q} + a_3 SIGNUE_{i,q} + a_4 ABSUE_{i,q} + a_5 SIGNCAR_{i,q} + a_6 ABSCAR_{i,q} + a_7 VAR_i + e_{i,q}$$

Each firm contributes one observation each from the fourth quarters of 1999 and 2000. Each quarter is the period from the third trading day after the third quarter's earnings announcement to the second trading day after the fourth quarter's earnings announcement. For the first estimation, the dependent variable is the total abnormal return volatility for firm *i* and quarter *q*. For the second through fifth estimations, the dependent variables are average one, two, three, and five-day abnormal return volatilities respectively for firm *i* and quarter *q*. One, two, three, and five-day abnormal return volatilities are measured as the cumulative squared abnormal returns over the corresponding rolling windows. Total abnormal return volatility for each firm and quarter is the sum, across the quarter, of the firm's daily abnormal return volatilities. $POSTFD_q$ equals one if the observation is from the fourth quarter of 2000 and zero otherwise. $LOSS_{i,q}$ equals one if earnings is negative and zero otherwise. $ABSUE_{i,q}$ is the absolute value of the seasonal change in earnings. $SIGNUE_{i,q}$ equals one if the seasonal change in earnings is negative and zero otherwise. $ABSCAR_{i,q}$ is the absolute value of the cumulative abnormal return over the quarter. $SIGNCAR_{i,q}$ equals one if this $ABSCAR_{i,q}$ is negative and zero otherwise. VAR_i is the average daily volatility during the estimation period for the fourth quarter of 1999. Abnormal returns are equal weighted index market model prediction errors. The market model estimation period is the year ending the day before the start of the relevant quarter. Coefficient estimates are OLS and p-values, in parentheses below the estimates, are two-sided.

Table 3
Analysis of Extreme Volatility in Abnormal Returns—Univariate Analysis

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	One-Day		Two-Day		Three-Day		Five-Day	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Panel A: Firm Specific Kurtosis of Abnormal Returns								
Pre-FD: 1999 4th Quarter	3.354	1.805	2.309	1.273	1.708	0.886	0.959	0.422
Post FD: 2000 4th Quarter	2.985	1.614	2.053	1.149	1.539	0.804	0.887	0.375
Change	-0.369	-0.212	-0.256	-0.107	-0.169	-0.078	-0.071	-0.008
(p-value)	(0.01)	(0.00)	(0.01)	(0.01)	(0.03)	(0.07)	(0.22)	(0.88)
Panel B: Extreme Firm Specific One-Day Abnormal Return Volatility as Proportion of Total Volatility During the Quarter								
	Extreme 1%		Extreme 5%					
1999 4th Quarter	0.190	0.158	0.436	0.417				
2000 4th Quarter	0.186	0.156	0.430	0.413				
Change	-0.004	-0.002	-0.006	-0.006				
(p-value)	(0.20)	(0.34)	(0.05)	(0.13)				

The sample consists of 2,340 December fiscal year end firms with necessary data available in 1999 and 2000. Variables are winsorized at 99th percentile of their absolute value of their respective distributions, resulting in fewer observations in specific cells. Each firm contributes one observation each from the fourth quarters of 1999 and 2000. Each quarter is the period from the third trading day after the third quarter's earnings announcement to the second trading day after the fourth quarter's earnings announcement. Rows labeled 'change' present the mean and median within-firm change from the fourth quarter of 1999 to the fourth quarter of 2000. P-values are two-sided and, for means, are from t-tests and, for medians, are from sign tests. Abnormal returns are equal weighted index market model prediction errors. The market model estimation period is the year ending the day before the start of the relevant quarter.

Panel A presents, for each quarter, cross sectional means and medians of kurtosis from the firm specific distributions of average one-day, two-day, three-day, and five-day abnormal returns. Panel B presents, for each quarter, cross sectional means and medians of the proportion of each firm's total abnormal return volatility during the quarter that is contributed by the most extreme one and five-percent of that firm's within quarter distribution of daily abnormal return volatilities. Total abnormal return volatility for each firm and quarter is the sum, across the quarter, of the firm's daily abnormal return volatilities.

Table 4
Analysis of Extreme Volatility in Abnormal Returns—Multivariate Analysis

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable	Coefficient Estimates (p-values below in parentheses) on:								
	Intercept	$POSTFD_q$	$LOSS_{i,q}$	$SIGNUE_{i,q}$	$ABSUE_{i,q}$	$SIGNCAR_{i,q}$	$ABSCAR_{i,q}$	VAR_i	R^2%
Kurtosis One-Day Return	2.9130	-0.5328	-0.1182	0.6327	5.4141	-0.4242	1.3818	61.6950	1.54%
	(0.00)	(0.00)	(0.60)	(0.00)	(0.06)	(0.01)	(0.00)	(0.30)	
Kurtosis Two-Day Return	2.0652	-0.4378	0.0146	0.3742	8.1540	-0.5362	0.7203	118.6810	2.73%
	(0.00)	(0.00)	(0.92)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
Kurtosis Three-Day Return	1.5239	-0.3273	0.0734	0.2517	7.8111	-0.4575	0.4065	119.5850	3.09%
	(0.00)	(0.00)	(0.54)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	
Kurtosis Five-Day Return	0.7866	-0.1840	0.0420	0.1829	6.5807	-0.3053	0.3571	79.3710	2.89%
	(0.00)	(0.00)	(0.64)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	
Proportion of Volatility: Extreme 1%	0.1889	-0.0095	-0.0014	0.0116	0.0722	-0.0176	0.0264	1.1580	1.64%
	(0.00)	(0.00)	(0.77)	(0.00)	(0.23)	(0.00)	(0.00)	(0.36)	

The sample consists of 2,340 December fiscal year end firms with necessary data available in 1999 and 2000. Variables are winsorized at 99th percentile of the absolute value of their respective distributions, resulting in fewer observations in specific regressions.

For each of the dependent variables, we estimate:

$$EXTREME_{i,q} = a_0 + a_1 POSTFD_q + a_2 LOSS_{i,q} + a_3 SIGNUE_{i,q} + a_4 ABSUE_{i,q} + a_5 SIGNCAR_{i,q} + a_6 ABSCAR_{i,q} + a_7 VAR_i + e_{i,q}$$

Each firm contributes one observation each from the fourth quarters of 1999 and 2000. Each quarter is the period from the third trading day after the third quarter's earnings announcement to the second trading day after the fourth quarter's earnings announcement. The dependent variables, i.e. the $EXTREME_{i,q}$, are, for the first four estimations, kurtosis from the firm and quarter specific distributions of average one-day, two-day, three-day, and five-day abnormal returns respectively and, for the fifth estimation, the proportion of each firm's total abnormal return volatility during the quarter that is contributed by the most extreme one and five-percent of that firm's within quarter distribution of daily abnormal return volatilities. Total abnormal return volatility for each firm and quarter is the sum, across the quarter, of the firm's daily abnormal return volatilities. $POSTFD_q$ equals one if the observation is from the fourth quarter of 2000 and zero otherwise. $LOSS_{i,q}$ equals one if earnings is negative and zero otherwise. $ABSUE_{i,q}$ is the absolute value of the seasonal change in earnings. $SIGNUE_{i,q}$ equals one if the seasonal change in earnings is negative and zero otherwise. $ABSCAR_{i,q}$ is the absolute value of the cumulative abnormal return over the quarter. $SIGNCAR_{i,q}$ equals one if this $ABSCAR_{i,q}$ is negative and zero otherwise. VAR_i is the average daily volatility during the estimation period for the fourth quarter of 1999. Abnormal returns are equal weighted index market model prediction errors. The market model estimation period is the year ending the day before the start of the relevant quarter. Coefficient estimates are OLS and p-values, in parentheses below the estimates, are two-sided.

Table 5
Analysis of Serial Correlation in Returns—Univariate Analysis

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	One-Day		Two-Day		Three-Day		Five-Day	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Panel A: Firm Specific Autocorrelation in Daily Abnormal Returns (One Lag)								
Pre-FD: 1999 4th Quarter	-0.040	-0.031	-0.082	-0.079	-0.110	-0.113	-0.151	-0.159
Post FD: 2000 4th Quarter	-0.048	-0.041	-0.061	-0.063	-0.061	-0.061	-0.091	-0.095
Change	-0.008	-0.005	0.021	0.024	0.049	0.045	0.060	0.060
(p-value)	(0.07)	(0.20)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Panel B: Firm Specific Abnormal Return Variance Ratio								
Pre-FD: 1999 4th Quarter			0.9617	0.9703	0.9255	0.9164	0.8499	0.8169
Post FD: 2000 4th Quarter			0.9556	0.9646	0.9320	0.9246	0.9069	0.8626
Change			-0.0062	-0.0011	0.0065	0.0054	0.0570	0.0486
(p-value)			(0.17)	(0.82)	(0.32)	(0.31)	(0.00)	(0.00)

The sample consists of 2,340 December fiscal year end firms with necessary data available in 1999 and 2000. Variables are winsorized at 99th percentile of their absolute value of their respective distributions, resulting in fewer observations in specific cells. Each firm contributes one observation each from the fourth quarters of 1999 and 2000. Each quarter is the period from the third trading day after the third quarter's earnings announcement to the second trading day after the fourth quarter's earnings announcement. Rows labeled 'change' present the mean and median within-firm change from the fourth quarter of 1999 to the fourth quarter of 2000. P-values are two-sided and, for means, are from t-tests and, for medians, are from sign tests. Abnormal returns are equal weighted index market model prediction errors. The market model estimation period is the year ending the day before the start of the relevant quarter.

Panel A presents, for each quarter, cross sectional means and medians of firm specific autocorrelation coefficients (one lag) for one, two, three, and five-day abnormal returns respectively. Panel B presents the cross sectional means and medians of abnormal return variance ratios for two, three, and five-day return intervals. The two day abnormal return variance ratio for firm *i* and quarter *q* is the estimated variance of two day abnormal returns, for firm *i* in quarter *q*, divided by twice the estimated one day abnormal return variance for firm *i* and quarter *q*. Three and five day variance ratios are computed analogously.

Table 6
Multivariate Analysis of Negative Serial Correlation in Returns

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent Variable	Coefficient Estimates (p-values below in parentheses) on:								
	Intercept	$POSTFD_q$	$LOSS_{i,q}$	$SIGNUE_{i,q}$	$ABSUE_{i,q}$	$SIGNCAR_{i,q}$	$ABSCAR_{i,q}$	VAR_i	R^2%
Autocorrelation—One-Day Return	-0.0380	-0.0047	0.0179	-0.0211	-0.2519	-0.0071	0.0829	-9.6400	2.21%
	(0.00)	(0.39)	(0.02)	(0.00)	(0.01)	(0.20)	(0.00)	(0.00)	
Autocorrelation—Two-Day Return	-0.0725	0.0214	0.0125	-0.0158	-0.0807	-0.0063	0.0494	-9.9770	1.42%
	(0.00)	(0.00)	(0.11)	(0.01)	(0.41)	(0.26)	(0.00)	(0.00)	
Autocorrelation—Three-Day Return	-0.1064	0.0496	0.0126	-0.0036	-0.2153	-0.0049	0.0633	-10.3860	2.87%
	(0.00)	(0.00)	(0.13)	(0.56)	(0.04)	(0.42)	(0.00)	(0.00)	
Autocorrelation—Five-Day Return	-0.1475	0.0626	0.0115	-0.0096	-0.2045	0.0015	0.0509	-10.3090	2.62%
	(0.00)	(0.00)	(0.23)	(0.18)	(0.09)	(0.83)	(0.00)	(0.00)	
Variance Ratio—Two-Day	0.9723	-0.0080	0.0228	-0.0195	-0.2100	-0.0286	0.0916	-8.2540	2.87%
	(0.00)	(0.15)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	
Variance Ratio—Three-Day	0.9501	0.0004	0.0319	-0.0289	-0.1544	-0.0494	0.1146	-11.6580	2.80%
	(0.00)	(0.96)	(0.00)	(0.00)	(0.28)	(0.00)	(0.00)	(0.00)	
Variance Ratio—Five-Day	0.8941	0.0440	0.0466	-0.0311	-0.1277	-0.0801	0.1589	-19.8780	4.17%
	(0.00)	(0.00)	(0.00)	(0.00)	(0.50)	(0.00)	(0.00)	(0.00)	

The sample consists of 2,340 December fiscal year end firms with necessary data available in 1999 and 2000. Variables are winsorized at 99^{th} percentile of the absolute value of their respective distributions, resulting in fewer observations in specific regressions.

For each of the dependent variables, we estimate:

$$SERIAL_{i,q} = a_0 + a_1 POSTFD_q + a_2 LOSS_{i,q} + a_3 SIGNUE_{i,q} + a_4 ABSUE_{i,q} + a_5 SIGNCAR_{i,q} + a_6 ABSCAR_{i,q} + a_7 VAR_i + e_{i,q}$$

Each firm contributes one observation each from the fourth quarters of 1999 and 2000. Each quarter is the period from the third trading day after the third quarter's earnings announcement to the second trading day after the fourth quarter's earnings announcement. The dependent variables, i.e. the $SERIAL_{i,q}$, are, for the first four estimations, firm and quarter specific autocorrelation coefficients (one lag) for one, two, three, and five-day abnormal returns respectively, and, for the last three estimations, firm and quarter specific abnormal return variance ratios for two, three, and five-day return intervals. The two day abnormal return variance ratio for firm i and quarter q is the estimated variance of two day abnormal returns, for firm i in quarter q, divided by twice the estimated one day abnormal return variance for firm i and quarter q. Three and five day variance ratios are computed analogously. Daily abnormal return volatility is the squared daily market model prediction error. Total abnormal return volatility for each firm and quarter is the sum, across the quarter, of the firm's daily squared market model prediction errors. $POSTFD_q$ equals one if the observation is from the fourth quarter of 2000 and zero otherwise. $LOSS_{i,q}$ equals one if earnings is negative and zero otherwise. $ABSUE_{i,q}$ is the absolute value of the seasonal change in earnings. $SIGNUE_{i,q}$ equals one if the seasonal change in earnings is negative and zero otherwise. $ABSCAR_{i,q}$ is the absolute value of the cumulative abnormal return over the quarter. $SIGNCAR_{i,q}$ equals one if this $ABSCAR_{i,q}$ is negative and zero otherwise. VAR_i is the average daily volatility during the estimation period for the fourth quarter of 1999. Abnormal returns are equal weighted index market model prediction errors. The market model estimation period is the year ending the day before the start of the quarter. Coefficient estimates are OLS and p-values, in parentheses below the estimates, are two-sided.

Table 7

Decomposition of Total Daily Abnormal Return Volatility During Pre- and Post-FD Quarters—Univariate Analysis

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Abnormal Return Volatility							
		Information Days					
		Announcement Days		Information Transfer Days			
	Total Volatility	Earnings	Preannouncement	Earnings	Preannouncement	Total	Non-Information Days
Mean							
1999 4th Quarter	0.1519	0.0113	0.0038	0.0239	0.0128	0.0518	0.1001
2000 4th Quarter	0.1698	0.0093	0.0065	0.0149	0.0255	0.0562	0.1137
Change	0.0179	-0.0020	0.0028	-0.0090	0.0127	0.0044	0.0135
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Median							
1999 4th Quarter	0.0799	0.0037	0	0.0038	0.0009	0.0153	0.0564
2000 4th Quarter	0.0889	0.0027	0	0.0026	0.0038	0.0164	0.0608
Change	0.0040	-0.0005	0	-0.0003	0.0002	0.0008	0.0029
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Panel B: Adjusted (for Average Abnormal Return Volatility in Pre-FD Quarter) Abnormal Return Volatility							
Mean							
1999 4th Quarter	0	0.0052	0.0029	0.0019	-0.0011	0.0089	-0.0089
2000 4th Quarter	0.0196	0.0032	0.0053	-0.0064	0.0037	0.0058	0.0138
Change	0.0196	-0.0020	0.0024	-0.0082	0.0047	-0.0031	0.0227
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.20)	(0.00)
Median							
1999 4th Quarter	0	0.0002	0	0	0	0.0016	-0.0016
2000 4th Quarter	0.0047	-0.0004	0	-0.0004	0	0.0004	0.0016
Change	0.0047	-0.0005	0	-0.0002	0	-0.0005	0.0068
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)

The sample consists of 2,340 December fiscal year end firms with necessary data available in 1999 and 2000. Variables are winsorized at 99th percentile of their absolute value of their respective distributions, resulting in fewer observations in specific cells. Each firm contributes one observation each from the fourth quarters of 1999 and 2000. Each quarter is the period from the third trading day after the third quarter's earnings announcement to the second trading day after the fourth quarter's earnings announcement. Rows labeled 'change' present the mean and median within-firm change from the fourth quarter of 1999 to the fourth quarter of 2000. P-values are two-sided and, for means, are from t-tests and, for medians, are from sign tests. Abnormal returns are equal weighted index market model prediction errors. The market model estimation period is the year ending the day before the start of the relevant quarter.

The table presents, for each quarter, cross sectional means and medians of the abnormal return volatility and adjusted abnormal return volatility for earnings-announcement days, pre-announcement days, earnings announcement information transfer days, pre-announcement information transfer days, total information days, and non information days respectively. Earnings-announcement (pre-announcement) days include the period from one trading day before earnings announcement (pre-announcement) to one trading after. Earnings-announcement (pre-announcement) information transfer days include all the three days surrounding the earnings announcement (pre-announcement) by other firms in the same industry (defined by four-digit SIC code). Total information days include all the above days. All other trading days within the quarter are classified as non-information days. If a firm's pre-announcement is issued within two trading days of that firm's earnings announcement, it is not included in the pre-announcement window. Similarly, any information transfer days that overlap the pre-announcement or earnings announcement days, are not included in the information transfer days. Abnormal return volatility for an announcement or information transfer (adjusted abnormal return volatility) is calculated as the summation of daily abnormal return volatilities (daily adjusted abnormal return volatilities) over the announcement's or transfer's window. Daily abnormal return volatility is the squared daily abnormal return. Daily adjusted abnormal return volatility is the daily abnormal return volatility minus the average daily abnormal return volatility during the fourth quarter of 1999.

Table 8
Decomposition of Total Daily Abnormal Return Volatility During Pre- and Post-FD Quarters—Multivariate Analysis with Controls

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent Variable	Coefficient Estimates (p-values below in parentheses) on:										
	Intercept	$POSTFD_q$	$LOSS_{i,q}$	$SIGNUE_{i,q}$	$ABSUE_{i,q}$	$SIGNCAR_{i,q}$	$ABSCAR_{i,q}$	VAR_i	$D_{i,q}$	$D_{i,q}*VAR_i$	R^2%
Earnings Announcement Window	0.0017 (0.05)	-0.0016 (0.01)	-0.0010 (0.29)	0.0017 (0.01)	0.0518 (0.00)	-0.0002 (0.77)	0.0128 (0.00)	2.8948 (0.00)			9.28%
Pre-Announcement Window	-0.0053 (0.00)	0.0014 (0.08)	0.0011 (0.35)	0.0013 (0.13)	-0.0156 (0.28)	0.0038 (0.00)	0.0102 (0.00)	-0.4513 (0.15)	0.0014 (0.00)	5.0541 (0.00)	27.42%
Earnings Announcement Information Transfer Window	-0.0027 (0.05)	-0.0062 (0.00)	0.0079 (0.00)	-0.0014 (0.18)	0.0176 (0.32)	-0.0063 (0.00)	0.0363 (0.00)	-1.6643 (0.00)	0.0011 (0.00)	0.7085 (0.00)	48.84%
Pre-Announcement Information Transfer Window	-0.0104 (0.00)	0.0050 (0.00)	0.0088 (0.00)	0.0008 (0.48)	0.0043 (0.82)	0.0028 (0.01)	0.0230 (0.00)	-2.3247 (0.00)	0.0008 (0.00)	1.1705 (0.00)	47.00%
Total Information Days	-0.0270 (0.00)	0.0028 (0.16)	0.0155 (0.00)	0.0041 (0.05)	0.0305 (0.40)	0.0024 (0.25)	0.0864 (0.00)	0.2994 (0.80)	0.0011 (0.00)	0.7964 (0.00)	51.99%
Non-Information Days	-0.0370 (0.00)	0.0256 (0.00)	0.0553 (0.00)	0.0044 (0.20)	0.3708 (0.00)	-0.0039 (0.25)	0.0783 (0.00)	-10.7622 (0.00)	0.0005 (0.00)	0.9657 (0.00)	42.01%

The sample consists of 2,340 December fiscal year end firms with necessary data available in 1999 and 2000. Variables are winsorized at 99^{th} percentile of the absolute value of their respective distributions, resulting in fewer observations in specific regressions.

For each of the dependent variables, we estimate:

$$ARV_{i,q} = a_0 + a_1 POSTFD_q + a_2 LOSS_{i,q} + a_3 SIGNUE_{i,q} + a_4 ABSUE_{i,q} + a_5 SIGNCAR_{i,q} + a_6 ABSCAR_{i,q} + a_7 VAR_i + D_{i,q} + D_{i,q} * VAR_i + e_{i,q}$$

The dependent variables are abnormal return volatility for earnings-announcement days, pre-announcement days, earnings announcement information transfer days, pre-announcement information transfer days, total information days, and non information days respectively. Earnings-announcement (pre-announcement) days include the period from one trading day before earnings announcement (pre-announcement) to one trading after. Earnings-announcement (pre-announcement) information transfer days include all the three days surrounding the earnings announcement (pre-announcement) by other firms in the same industry (defined by four-digit SIC code). Total information days include all the above days. All other trading days within the quarter are classified as non information days. If a firm's pre-announcement is issued within two trading days of that firm's earnings announcement, it is not included in the pre-announcement window. Similarly, any information transfer days that overlap the pre-announcement or earnings announcement days, are not included in the information transfer days. Abnormal return volatility for an announcement or information transfer (adjusted abnormal return volatility) is calculated as the summation of daily abnormal return volatilities (daily adjusted abnormal return volatilities) over the announcement's or transfer's window. Daily abnormal return volatility is the squared daily abnormal return. Daily adjusted abnormal return volatility is the daily abnormal return volatility minus the average daily abnormal return volatility during the fourth quarter of 1999.

$POSTFD_q$ equals one if the observation is from the fourth quarter of 2000 and zero otherwise. $LOSS_{i,q}$ equals one if earnings is negative and zero otherwise. $ABSUE_{i,q}$ is the absolute value of the seasonal change in earnings. $SIGNUE_{i,q}$ equals one if the seasonal change in earnings is negative and zero otherwise. $ABSCAR_{i,q}$ is the absolute value of the cumulative abnormal return over the quarter. $SIGNCAR_{i,q}$ equals one if this $ABSCAR_{i,q}$ is negative and zero otherwise. VAR_i is the average daily volatility during the estimation period for the fourth quarter of 1999. Abnormal returns are equal weighted index market model prediction errors. $D_{i,q}$ is the number of days in the window used to construct the dependent variable. The market model estimation period is the year ending the day before the start of the quarter. Coefficient estimates are OLS and p-values, in parentheses below the estimates, are two-sided.