Firm Uncertainty and Financial Analysts' Activity

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Abstract

Using implied volatility surfaces provided by the Optionmetrics database for the period 2003–2007, this study documents the strong, positive relation between investor perceptions of firm uncertainty and financial analysts' activity. Granger causality tests reveal that an increase in perceived uncertainty leads to a subsequent increase in financial analysts' activity, but this increase in activity does not seem to lead to lower firm uncertainty perceptions. The results from a sample of merger and acquisition transactions completed by S&P500 firms confirm a positive relation between firm uncertainty perceptions and financial analysts' subsequent activity.

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1. Introduction

Financial markets undergo strong uncertainty variations; for example, the standard deviation of the S&P500 return index during 1980–2008 displays three peaks (see Figure 1): the 1987 market crash, the Internet bubble, and the recent financial crisis. During these episodes, the standard deviation reached (and even exceeded) 20% annually, almost twice its historical average during that period (11.7%). Investors inevitably face such uncertainty jumps. But do they react? In particular, does financial analysts' activity indicate a response, and if so, how do financial analysts' actions affect investors' perceptions of future uncertainty? We address these questions herein.

To analyze the interaction between financial analysts' activity and firm perceived uncertainty, we begin by considering the role of information in capital markets. Uncertainty about future events is the root of risk, from an investor perspective. Merton (1987) studies the relation between incomplete information and the cost of capital, and Easley and O'Hara (2004) use the probability of informed-based trading as a proxy of firm informational context to highlight how information contributes to lower costs of capital. Doukas et al. (2008) show that when an abnormally high number of financial analysts follow a particular firm, it displays a higher valuation ratio. In the same vein, Cheng and Subramanyam (2008) specify that more intense firm activity tracking by financial analysts improves the firm's rating. From the opposite side, Chang et al. (2006) show that firms largely ignored by financial analysts issue new shares less frequently. Moreover, perceived uncertainty appears to condition investors' willingness to participate in financial markets (Bowen et al., 2008). Yet the effect of financial analysts' activity on investor uncertainty perceptions is more complicated, in at least some realms. First, we must capture investors' ex-ante perceptions of uncertainty, not its ex-post realization. Second, the question actually is twofold: Does uncertainty attract (or repeal) financial analysts, and does their activity really affect perceptions of uncertainty by investors?

When we clarify the question this way, we realize that prior academic literature provides some conflicting evidence. Many empirical studies offer indirect evidence that financial analysts reduce information asymmetry between firms and their investors, mostly based on a positive correlation between financial analysts' activity and firm characteristics that reportedly are associated with more information asymmetry. Lang and Lundholm (1996) reveal that high growth firms attract more follow-up by financial analysts, and the same holds true for firms with more intangible assets (Barth et al. (2001)) and high-technology firms (with higher research and development expenses; Barron et al. (2002); Kimbrough (2007)). Matolcsy and Wyatt (2006) provide consistent evidence derived from Australian data about intangible assets.

In contrast, Li et al. (2009) hold that inexperienced financial analysts look for more transparent firms to build a reputation, and Irvine (2001) argues that the behavior of financial analysts is driven by their fees and commissions. O'Brien et al. (2005) show that financial analysts affiliated with institutions in charge of firms' equity offerings are more active, though this association does not mean necessarily that their recommendations are systematically biased.[1] Firms may actively seek to attract financial analysts, such as by organizing press conferences (Francis and Soffer (1997)) or telephone contacts (Bowen et al. (2002)).[2] Other factors could alter activity outputs as well, such as constraints due to the work organization. Gilson et al. (2001) stress that financial institutions rarely allocate an analysts' follow-up activities to more than one firm. Duru and Reeb (2002) also point out that a domestic market focus and industry specialization makes it more difficult for financial analysts to follow large and internationally diversified firms. Internationalization brings about its own set of problems, including less frequent contacts with foreign firm managers (Ashbaugh and Pincus (2001)) and difficulties interpreting various accounting methods (Bae et al. (2008)). Behn and Choi (2008) suggest the reputation of the firm auditor ultimately determines financial analysts' follow-up decisions.

Thus, though previous contributions provide various insights into financial analysts' activity, no clear picture emerges regarding the interaction between financial analysts' activity and investors' perceptions of firm uncertainty. Many factors probably affect financial analysts' day-to-day activity and firm perceived uncertainty simultaneously. The resulting net contribution to investors' information is therefore an empirical matter.

We consider the Optionmetrics database as a unique means to undertake a direct empirical investigation of the relationship between investors' perceptions of uncertainty and financial analysts' activity. Optionmetrics provides volatility surfaces for all U.S. exchange–listed equities, including U.S. listed indices, with their corresponding measures of implied volatility. Bargeron et al. (2009) use this measure of implied volatility to study the effect of mergers and acquisitions on bidders' uncertainty; we similarly adopt this method to study the interaction between financial analysts' activity and firm perceived uncertainty. The main strength of this empirical approach is that the use of implied volatility reveals investors' ex-ante perception of uncertainty; it is not an ex-post measure of realized volatility. However, it relies on the model chosen to extract the implied volatility from the observed option prices (Optionmetrics mentions the use of "American or European models where

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[1] Ertimur et al. (2007) argue that the new Securities and Exchange Commission Fair Disclosure regulation reinforced the integrity of financial analysts' recommendations, and Jacob et al. (2008) claim forecasts by investment banks' financial analysts are more accurate.

[2] The Fair Disclosure regulation seems to have mitigated this issue (Chen and Matsumoto (2006); Ke et al. (2008)).

appropriate"[3]), such that it may be influenced by the chosen model's shortcomings. If we suspect these biases correlate significantly with financial analysts' activity determinants, the shortcomings essentially represent a source of noise (measurement errors) in cross-sectional studies.

Therefore, using the implied volatility measure provided by Optionmetrics and information from I/B/E/S, we investigate whether there is a positive or negative correlation between the level of firm perceived uncertainty and financial analysts' activity, as well as whether there is a causal link in the relationship between firm perceived uncertainty and financial analysts' activity. Our sample includes 521 U.S. listed firms that belonged to the S&P500 Index at some point during 2003–2007 (i.e., S&P500 firms). We focus on these S&P500 firms because we need sufficient listed options for each firm to find the implied volatility measure in Optionmetrics. Furthermore, the S&P500 firms systematically attract the attention of financial analysts, which is an important requirement for this study. We select 2003–2007 as a period after the Internet bubble but before the financial crisis, two major events that could create concerns about the representativeness of results obtained during those periods. We begin by studying the correlation coefficient between the level of financial analysts' activity (i.e., number of financial analysts issuing forecasts revisions) and firm monthly average implied volatility. We then investigate the dynamic between financial analysts' activity and firm uncertainty by performing a Granger (1969) causality test, which enables us to analyze whether uncertainty drives financial analysts' activity or vice versa. Moreover, the Granger causality test relies on the autoregressive behavior of variables and prevents us from controlling explicitly for known determinants of implied volatility and financial analysts' activity. Finally, we test a sample of merger and acquisition transactions completed by the sample of S&P500 firms. Although Granger causality can only uncover statistical relations between variables, even when this statistical causality appears significant, the use of exogenous shocks on firm implied volatility offers a means to investigate if financial analysts' activity variation represents a response to these shocks. We use a sample of 346 significant merger and acquisition (M&A) transactions undertaken by the S&P500 firms during 2003–2007 period as exogenous shocks to the firm's level of uncertainty (quasi-experiment). By studying the associated response that constitutes financial analysts' activity, we implement a differences-in-differences (DD) test of the causal relation between firm uncertainty and financial analysts' activity.

We find a clear relation between the level of firm perceived uncertainty and financial analysts' activity. In Figure 2, we present, by size decile, the average number of financial analysts who issue earnings per share (EPS) forecast revisions for a given firm and the associated average level of firm abnormal implied volatility. A clear and striking pattern emerges: High perceptions of firm

[3] All option calculations use historical LIBOR/Eurodollar rates for interest rate inputs and correctly incorporate discrete dividend payments (see www.optionsmetrics.com/ivydbus.html).

uncertainty (i.e., high implied volatility) coincide with low financial analysts' activity, and vice versa. Firm perceived uncertainty and financial analysts' activity also interact with firm size, such that small firms present higher levels of perceived uncertainty and initiate far less financial analyst activity (and again, vice versa). We investigate whether this apparent negative correlation between firm perceived uncertainty and financial analysts' activity correctly depicts the dynamic between these variables and provides insights into their causal relations. The Granger causality test offers unambiguous evidence. Whether we use the number of financial analysts issuing EPS forecasts revisions or the number of EPS forecast revisions to proxy for the intensity of financial analysts' activity, we find that prior variations:

- in firm perceived uncertainty are positively associated with current variations in financial analysts activity (i.e., investors' increasing perceptions of firm uncertainty attract more financial analysts' activity).
- in financial activity are not significantly associated with current variations of firm perceived uncertainty (i.e., financial analysts' increasing activity does not lead to a decrease in investors' perceptions of firm uncertainty).

The Granger causality thus reveals a positive dynamic relation, from firm uncertainty perceptions to financial analysts' activity. But this one-way relation suggests financial analysts' activity does not contribute significantly to uncertainty resolution.

To confirm these Granger causality test results, we use a sample of M&A transactions undertaken by S&P500 firms. The results unambiguously confirm that M&A transactions increase acquirer implied volatility, which is our measure of investors' uncertainty perceptions (see also Bargeron et al. (2009)). This exogenous increase in firm uncertainty is associated with an increase in financial analysts' activity, consistent with our Granger causality tests.

Finally, we undertake robustness checks, which enable us to verify comparable results when we (1) introduce contemporaneous explanatory variables in our Granger causality tests, (2) use two alternative autoregressive specifications (to test if our results are sensitive the chosen lag structure), (3) use average implicit volatility instead of average abnormal implicit volatility (to determine if our results depend on the approach used to compute abnormal implicit volatility), (4) use monthly median abnormal implicit volatility instead of monthly average abnormal implicit volatility (to investigate if our results are sensitive to the presence of outliers), and (5) work with seasonally unadjusted financial analysts' activity (to ascertain if our results are driven by a seasonal adjustment procedure). These robustness checks confirm our findings overall.

We organize the remainder of this paper as follows: In the next section, we consider the statistical relation between firm perceived uncertainty and financial analysts' activity. We describe the data and variables, then introduce the Granger causality test and present our main results. For our analysis of financial analysts' behavior around M&A announcements, we start by describing the sample of M&As undertaken by our sample of S&P500 firms during 2003–2007, then proceed to an analysis of the relations between changes in investors' perceptions of firm uncertainty and changes in financial analysts' activity using a DD approach. After we present our robustness checks, we conclude with some implications and directions for further research.

2. Statistical Relation Between Firm Perceived Uncertainty and Financial Analysts' Activity

In this section, we investigate the statistical relation between firm perceived uncertainty and financial analysts' activity.

2.1. Sample and data sources

We form our firm sample by identifying all firms that belonged to the S&P500 index at some point during 2003–2007 (i.e., S&P500 firms). We focus on these S&P500 firms; this selection criterion ensures the sample firms have enough traded options that we can obtain implied volatility measures from the Optionmetrics database and are likely to be followed by financial analysts. Our initial sample consists of 614 firms, but we exclude 93 for missing data; our criteria require at least 36 monthly consecutive observations of firm implied volatility and at least one financial analyst revision by year/firm. To avoid the Internet bubble and recent financial crisis—two events that are specific enough to raise concerns about the representativeness of analyses including them—we limit our analysis to 2003–2007. The component lists of the S&P500 index appear in the Datastream database on a yearly basis. The market values come from the Center for Research in Security Prices (CRSP) database. We obtain financial analysts' information (i.e., number of analysts issuing revisions by firms, number of EPS forecasts issued by firms) from the I/B/E/S database. Implied volatility measures come from the Optionmetrics database.

Table 1 includes the descriptive statistics for our sample, including the number of firms by year, the aggregate market value of our sample at the end of each year (million USD), the percentage of aggregate U.S. stock market capitalization[4] that our sample represents, and the ratios of the average S&P500 firm size to the average U.S. listed firm size and of the median S&P500 firm size to the median U.S. listed firm size. The S&P500 firms account for more than half of the U.S. stock market capitalization each year; our S&P500 firms sample is economically significant. Furthermore, the S&P500 firms clearly tend to be large, and a few very large firms drive these reports.

2.2. Variables

2.2.1. Firm uncertainty

[4] We use the CRSP universe of listed firms to compute aggregate U.S. stock market values at the end of each year.

We use firm abnormal implied volatility as a proxy of firm perceived uncertainty. We obtain the firm implied volatility from Optionmetrics, which reports on a per firm basis the daily volatility surfaces and associated implied volatility measures. We follow Bargeron et al. (2009) and select in-the-money call and put options with 91 days' maturity. Optionmetrics estimates implied volatility through inversion of American or European models[5] and uses linear interpolation between the set of implied volatility estimates obtained from the listed options. We collect daily implied volatility $IV_{i,t}$ measures for each firm, then compute, for each firm, the monthly average implied volatility:

$$AIV_{i,m} = \frac{\sum_{t \in m} IV_{i,t}}{\#m}, \quad (1)$$

where i indicates firm i, t refers to day t , m represents month m , and $\#m$ is the number of trading days in that month. A Dickey-Fuller test of stationarity reveals that $AIV_{i,m}$ is not stationary though,[6] so we use monthly variations of $AIV_{i,m}$ (first differences of $IV_{i,t}$):

$$\Delta AIV_{i,m} = AIV_{i,m} - AIV_{i,m-1}. \quad . \quad (2)$$

We obtain the monthly variations of abnormal implied volatility, $\Delta AAIV_{i,t}$, by regressing the firm monthly variation of implied volatility, $\Delta AIV_{i,m}$, on the concomitant monthly variation of market implied volatility ($\Delta MIV_{m},$), using the OEX index[7] (i.e., the S&P 100 Option Index) as a market proxy. The monthly variations of abnormal implied volatility, $\Delta AAIV_{i,m}$, are estimated residuals of the following regression:

$$\Delta AIV_{i,m} = \alpha_0 + (\alpha_1 \times \Delta MIV_m) + \varepsilon_{i,m}$$

$$\Delta AAIV_{i,m} = \hat{\varepsilon}_{i,m} . \quad (3)$$

In turn, $\Delta AAIV_{i,m}$ is our main proxy for firm perceived uncertainty. In Section 4, we test the robustness of our results to variations of this definition.

2.2.2. Financial analysts' activity

We use two measures of the importance of financial analysts' activity for a given firm: the number of financial analysts issuing one- or two-year EPS forecast revisions for the focal firm during the month of interest ($\#FA_{i,m}$) and the number of one- or two-year EPS forecast revisions issued by these same financial analysts during the same period ($\#FOR_{i,m}$).

In Table 1, we report the ratio of the number of financial analysts issuing forecast revisions on the S&P500 firms to the number of financial analysts' EPS forecast revisions present in the I/B/E/S database by year. The S&P500 firms draw approximately half of financial analysts' activity, though

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[5] See www.optionsmetrics.com/ivydbus.html.
[6] The regression of on yields a slope coefficient of .94, not significantly different from 1 at the usual level of confidence.
[7] This approach is analogous to the use of the market model return-generating process in short-term event studies (see Brown and Warner (1985)).

this proportion decreases slightly during 2003–2007. Our S&P500 firm sample therefore represents a significant fraction of financial analysts' industry activity during the analyzed period.

With Table 2 we present descriptive statistics about the financial analysts' activity and firm uncertainty by size deciles. For each firm, we compute its average market value and thereby assign firms to corresponding size deciles. By the tenth decile, the average firm size gets driven up by a few very large firms, and according to the data in Table 2, financial analysts' activity clearly correlates with firm size (Bhushan, 1989). The smallest S&P500 firms attract an average of 3.53 financial analysts (who issue forecast revisions on the firms' EPS), but the largest ones attract an average of 9.69 analysts. According to the fifth column in Table 2, investors' perceptions of firm uncertainty also correlate with firm size. In particular, the average $IV_{i,t}$ is significantly higher for small firms, and firms in the first (smallest) decile display an average implied volatility almost 50% higher than firms included in the tenth (largest) decile. We build Figure 2 using the statistics in Table 2. The negative correlation between the level of financial analysts' activity and firm perceived uncertainty is striking: The smallest S&P500 firms display the highest implied volatility values and are followed by the fewest financial analysts (and vice versa). The univariate correlation coefficient between the number of financial analysts issuing EPS forecast revisions and the average implied volatility in the corresponding size decile is –.87. Does this negative correlation accurately depict the dynamic between these variables and provide insights about their causal relations?

2.3. The Granger causality test

Financial analysts' activity displays a strong seasonal pattern (Ivkovi and Jegadeesh (2004)), so we remove the seasonal pattern in $\#FA_{i,m}$ and $\#FOR_{i,m}$. For each firm included in our sample, we remove, from the observed values of $\#FA_{i,m}$ (or $\#FOR_{i,m}$), the average value of $\#FA_{i,m}$ (or $\#FOR_{i,m}$) for firm i in month m. We then conduct our analyses on the seasonally adjusted values of $\#FA_{i,m}$ and $\#FOR_{i,m}$. We follow a similar procedure to remove potential seasonal patterns in the average abnormal implied volatility variations ($\Delta AAIV_{i,m}$). In Section 4, we describe our tests of the robustness of our results to this adjustment procedure.

Using this measure of seasonally adjusted financial analysts' activity, we investigate the statistical relation between financial analysts' activity and firm perceived uncertainty, with the framework introduced by Granger (1969), who states that a variable x causes (or Granger causes) a variable y if the forecasts of y improve when the lagged values of x appear in the information set available to predict y. To test for the presence of Granger causality, we adopt the following bivariate autoregressive specification:

$$\Delta AAIV_{i,m} = c_{1,i} + \alpha_{1,i}^{1}\Delta AAIV_{i,m-1} + \cdots + \alpha_{3,i}^{1}\Delta AAIV_{i,m-3} + \beta_{1,i}^{1}\#FA_{i,m-1} + \cdots + \beta_{3,i}^{1}\#FA_{i,m-3} + u_{i,m}, \text{ and} \quad (4.1)$$

$$\#FA_{i,m} = c_{2,i} + \alpha_{1,i}^2 \#FA_{i,m-1} + \cdots + \alpha_{3,i}^2 \#FA_{i,m-3} + \beta_{1,i}^2 \Delta AAIV_{i,m-1} + \cdots + \beta_{3,i}^2 \Delta AAIV_{i,m-3} + v_{i,m}, \tag{4.2}$$

where i refers to firm i , and m indicates month m. The analysis of the relation between $\Delta AAIV_{i,m}$ and $\#FOR_{i,m}$ follows the same specification, with $\#FOR_{i,m}$ substituted for $\#FA_{i,m}$. We estimate this bivariate model firm by firm, with the important assumption that the autoregressive process is of the third order. (We test the robustness of our results to this assumption in Section 4.) We also estimate an alternative bivariate specification, in which we include contemporaneous values of $\#FA_{i,m}$ (Equation 5.1) and $\Delta AAIV_{i,m}$ (Equation 5.2) to control for the contemporaneous correlation of the two variables:

$$\Delta AAIV_{i,m} = c_{1,i} + \alpha_{1,i}^1 \Delta AAIV_{i,m-1} + \cdots + \alpha_{3,i}^1 \Delta AAIV_{i,m-3} + \beta_{0,i}^1 \#FA_{i,m} + \beta_{1,i}^1 \#FA_{i,m-1} + \cdots + \beta_{3,i}^1 \#FA_{i,m-3} + u_{i,m}, \text{ and} \tag{5.1}$$

$$\#FA_{i,m} = c_{2,i} + \alpha_{1,i}^2 \#FA_{i,m-1} + \cdots + \alpha_{3,i}^2 \#FA_{i,m-3} + \beta_{0,i}^2 \Delta AAIV_{i,m} + \beta_{1,i}^2 \Delta AAIV_{i,m-1} + \cdots + \beta_{3,i}^2 \Delta AAIV_{i,m-3} + v_{i,m}. \tag{5.2}$$

We also follow Hamilton (1996) and implement a formal Granger causality test for each firm. For a given firm i, the three-step procedure is (using the example of Equation 4.1):

(i) Estimate by ordinary least squares the full model:

$$\Delta AAIV_{i,m} = c_{1,i} + \alpha_{1,i}^1 \Delta AAIV_{i,m-1} + \cdots + \alpha_{3,i}^1 \Delta AAIV_{i,m-3} + \beta_{1,i}^1 \#FA_{i,m-1} + \cdots + \beta_{3,i}^1 \#FA_{i,m-3} + u_{i,m}, \tag{6}$$

and compute the corresponding residual sum of squares ($RSS_{1,i}$).

(ii) Estimate by ordinary least squares the restricted model:

$$\Delta AAIV_{i,m} = c_{1,i} + \alpha_{1,i}^1 \Delta AAIV_{i,m-1} + \cdots + \alpha_{3,i}^1 \Delta AAIV_{i,m-3} + u_{i,m}, \tag{7}$$

and compute the corresponding the residual sum of squares ($RSS_{0,i}$).

(iii) Compute the S_i statistic:

$$S_i = \frac{(RSS_{0,i} - RSS_{1,i})/p}{RSS_{1,i}/(N_i - 2p - 1)}, \tag{8}$$

where p is the lag length (3 in the current specification), and N_i is the number of observations for firm i.

The S_i statistic follows $F(p, N_i - 2p - 1)$.

Following firm-by-firm Granger causality tests, we can test two different null hypotheses:

(i) Strong rejection of Granger causality: Are all firm Granger causality tests simultaneously statistically insignificant? If so, it indicates the strong absence of Granger causality in the sample of observations. Hurlin (2005) provides the adequate statistic, and we denote this test H.

(ii) Weak rejection of Granger causality: On average, is the sum of the lagged coefficient of the independent variable not significantly different from 0? This test of the presence of Granger causality on average in the sample is denoted SC.

We are mostly interested in the results of the SC test, because the strong rejection of Granger causality is a very strict requirement. Therefore, to implement the H test, we compute the Wald statistic, as suggested by Hurlin (2005):

$$W_H = \frac{p}{N} \sum_{i=1}^{N} S_i \ , \tag{9}$$

where N is the number of firms in the sample. Hurlin (2005) shows that $E(W_H) \cong p \left(\frac{N_i - 2p - 1}{N_i - 2p - 3}\right)$ and $Var(W_{HV}) \cong 2p \left(\frac{(N_i - 2p - 1)^2 \ (N_i - 2p - 3)}{(N_i - 2p - 3)^2 \ (N_i - 2p - 5)}\right)$. Therefore, $Z_H = \sqrt{\frac{N(W_H - E(W_H))}{Var(W_H)}}$ follows asymptotically a $N(0,1)$.

We next build the SC test by summing, for each firm, the estimated regression coefficients of the lagged variables (for the case of Equation 4.1):

$$\hat{\beta}_{i,1-3} = \sum_{l=1}^{3} \hat{\beta}_{i,l} \ . \tag{10}$$

We then standardize the sum of the firm-by-firm estimated coefficients by their corresponding standard deviation, using an ordinary least squares variance–covariance estimator:

$$\hat{t}_{i,1-3} = \frac{\hat{\beta}_{i,1-3}}{SE(\hat{\beta}_{i,1-3})} \ . \tag{11}$$

Finally, we compute the SC test as the average of the firm-by-firm standardized sum of coefficients:

$$t_{SC} = \frac{\frac{\sum_i^N \hat{t}_{i,1-3}}{N}}{\frac{\sigma_{\hat{t}_{i,1-3}}}{\sqrt{N}}} \ . \tag{12}$$

The SC statistic asymptotically follows a $N(0,1)$ under the null hypothesis that the sum of the coefficients is equal to 0.

2.4. Results

We report the tests of Granger causality between financial analysts' activity and firm perceived uncertainty in Tables 3–5. Tables 3 and 5 use the number of financial analysts ($\#FA_{i,m}$) issuing EPS forecast revisions as a measure of financial analysts' activity, whereas in Table 4, the number of one- and two-year EPS forecast revisions ($\#FOR_{i,m}$) issued by these financial analysts is the measure. In all three tables, our proxy for firm perceived uncertainty is the variation of the monthly average abnormal implied volatility ($\Delta AAIV_{i,m}$). Tables 3 and 4 exclude contemporaneous effects in the model specification (Equations 4.1 and 4.2), whereas Table 5 represents the estimation of the autoregressive model with contemporaneous effects (Equations 5.1 and 5.2). In all three tables, the Panels A test whether firm perceived uncertainty Granger causes financial analysts' activity, whereas the Panels B determine whether financial analysts' activity Granger causes firm perceived uncertainty. We report the average coefficients of the full and restricted model estimates, the number of observations, the percentage of significant Fisher statistics of each estimate, the corresponding average R^2, the H Granger causality test, and the SC Granger causality test.

Because the H Granger causality tests across all panels are highly significant, we can clearly reject the null hypothesis of the simultaneous absence of Granger causality between financial analysts' activity and firm perceived uncertainty for all firms in the sample (strong rejection of Granger causality). The SC statistic indicates the average significance and sign of these Granger relations: Tables 3 and 4 show that an increase in the average abnormal volatility leads to an increase in financial analysts' activity, whether we proxy for it by the number of financial analysts issuing EPS forecast revisions ($\#FA_{i,m}$) or by the number of EPS forecast revisions ($\#FOR_{i,m}$). This result also is robust to the inclusion of contemporaneous effects in the model specification (Table 5). Furthermore, the results in Tables 3 and 4, Panels B, suggest a positive and significant SC test that implies that an increase in financial analysts' activity actually increases average abnormal volatility. However, when we control for the contemporaneous correlation between financial analysts' activity and firm perceived uncertainty in Table 5 (Panel B), the SC test loses its statistical significance. That is, the results in Tables 3 and 4 are driven by contemporaneous correlation (combined with average abnormal implied volatility shock persistence).

We therefore can conclude that an increase in past firm perceived uncertainty leads to an increase in current financial analysts' activity. Financial analysts react to increased firm uncertainty perceptions by issuing more EPS forecast revisions. However, this increase in financial analysts' activity does not really help lower future firm uncertainty perceptions. We note the contemporaneous correlation between $\Delta AAIV_{i,m}$ and $\#FA_{i,m}$ in Table 5 (Panel B) and the significant first lag coefficient of $\#FA_{i,m-1}$ in Tables 3–5, which are consistent with the results Loh and Stulz (2010) report. They show that influential financial analysts' recommendation changes have positive impacts on ex-post observed firm volatility, generated by the large forecast revisions by those analysts who follow their influential peers.

Because the Granger causality test is a statistical test of causality, our results essentially indicate that variations in firm uncertainty can predict future financial analysts' activity. Beyond the limits inherent to the statistical assumptions on which the Granger causality test rely, our results might capture some statistical relations derived from latent factors that induce both firm perceived uncertainty and financial analysts' activity. Motivations for such behaviors appear in prior literature, ranging from reputation building (Li et al. (2009)) to information cost processing (Gilson et al. (2001); Duru and Reeb (2002)). Only an assessment of financial analysts' activity in response to exogenous shocks in firm uncertainty can enable us to determine if the data support causal relation between firm perceived uncertainty variations and financial analysts' activity. In Section 3, we therefore use M&As to investigate this issue.

3. Financial Analysts' Activity and Firm Uncertainty Around Mergers and Acquisitions

After we present our data source and summary statistics about M&A transactions completed by the sample S&P500 firms during 2003–2007, we introduce the differences-in-differences approach and report our results.

3.1. Data

We collect, from the Thomson-Reuters SDC database, M&A transactions completed by the 521 firms in our S&P500 firm sample (see Section 2.1), using the following criteria:

(i) Deal size above USD1 million;

(ii) Announcement date between January 1, 2003, and December 31, 2007; and

(iii) Completed transaction.

Our 521 firms undertook and completed 1,472 M&A transactions during this period, as we list in Table 6 by firm size decile. We form these deciles using the average firm market value during the study period, and we report the aggregate number of M&A deals completed by firms in each decile, the average and median M&A deal size, average relative deal size (i.e., ratio of deal size to firm size), and the percentages of public and private targets acquisitions in each decile. The number of M&A transactions grows steadily with firm size: Large firms (decile 10) completed 320 M&As during 2003–2007, almost three times as many as small firms (108 deals, decile 1). Unsurprisingly, transactions completed by large firm are also larger (USD2,256 million average, USD828 million median) than transactions completed by small firms (USD230 million average, USD165 million median). The average relative M&A deal size ratio decreases with firm size deciles (13% for small firms to 2% for large firms), highlighting that firm size grows faster than deal size. These known facts have been well documented in prior academic literature. In addition, the percentage of public targets appears to increase with firm size, but we observe the reverse behavior for the percentage of private targets. Again, this result is not surprising, because private targets are smaller firms on average (Fuller et al. (2002); Table 1), and smaller acquirers (decile 1) engage in smaller acquisitions (nearly ten times smaller average deal size).

For our multivariate analyses, we restrict the sample to the 346 significant transactions for which the deal size represents at least 5% of the acquirer market value. We impose this last restriction to ensure that we focus on transactions large enough to generate an exogenous shock on the acquirer firms' uncertainty.

3.2. The differences-in-differences estimation

The differences-in-differences (DD) estimation technique has been applied widely in finance and economics; as Bertrand et al. (2004, p. 1) state, "DD consists of identifying a specific intervention or treatment. One compares the difference in outcome after and before the intervention for groups affected by it to this difference for unaffected groups." We consider the decision to undertake an M&A as the treatment, such that the outcomes are the abnormal implied volatility (to check whether M&A decisions increase investors' perceptions of firm uncertainty; see Bargeron et al. (2009)) and the financial analysts' activity (to study their response to the exogenous shock on firm uncertainty). More formally, our DD estimation approach takes the following form:

$$Y_{i,t} = c_i + c_t + \beta_1 X_{i,t} + \beta_2 \left(T_{i,t} \times X_{i,t}\right) + \varepsilon_{i,t} \,, \tag{13}$$

where i is the firm index; t is the period index; $Y_{i,t}$ is the outcome variable (either $\#FA_{i,t}$ or $\#FOR_{i,t}$ for financial analysts' activity and $AIV_{i,t}$ for firm perceived uncertainty) for firm i during period t; c_i and c_t are firm- and period-fixed effects, respectively; $X_{i,t}$ is a dummy variable that takes a value of 1 for the after-treatment period (after M&A completion) and 0 otherwise; and $T_{i,t}$ is a dummy variable that takes a value of 1 if firm i has completed a M&A (treatment) and 0 otherwise. The interaction $T_{i,t} \times X_{i,t}$ thus identifies the after-treatment period for firms that have completed an M&A.

For a given M&A transaction, assuming only one M&A transaction is available in our sample for the given month and that information is available for all 521 firms in the sample for that month, we collect 521 observations in two periods: before and after the official M&A announcement date. Before that date, for a firm i that completes the deal, $T_{i,t}$ equals 1, and for the 520 remaining firms, $T_{i,t}$ equals to 0, but for all 521 firms, $X_{i,t}$ is 0. In contrast, after the official announcement, for the firm i that completed the deal, $T_{i,t}$ equals 1, and for the 520 remaining firms, $T_{i,t}$ equals 0. For these 521 firms, $X_{i,t}$ is 1. We find that the 521 S&P500 firms completed 346 M&A transactions during 2003–2007, so we estimated Equation 8 with 39,748 observations. We use six-month windows, before and after the treatment effect periods.[8]

The appeal of the DD estimation technique relates to its ability to control for unobservable explanatory variables and the typical endogeneity issues that arise in comparisons of observations undergoing some type of treatment. The point estimates of the Equation 13 coefficients can be obtained by ordinary least squares, but as Bertrand et al. (2001**{AU: should this be 2004?}**) emphasize, ordinary least square standard errors can be very misleading if the dependent variable is serially correlated. In Tables 3 and 4 (Panels A and B), we report autoregressive coefficients up to the third order for $\#FA_{i,m}$,, $\#FOR_{i,m}$, and $\Delta AAIV_{i,m}$ (restricted model); they are all highly significant.

[8] We obtained similar results using 12-month windows around the M&A announcement date.

Our dependent variables therefore are serially correlated. We adopt the randomize inference test advocated by Bertrand et al. (2004) to solve this issue. The intuition of this test is that we generate random placebo treatments and use the empirical distribution of the resulting estimated effects to obtain *p*-values for the coefficients of interest. Specifically,

(i) For a given month, we select the subsample of firms that does not undertake any M&A transactions during the window starting six months before to six months after the selected month. We use this placebo subsample to build the empirical distribution of the statistics of interest under the null hypothesis of no shocks. With this procedure, we can keep the same distribution of M&A transactions over time as observed in reality.

(ii) For a given month, we generate by random drawing in the placebo subsample the placebo transactions. For each placebo transaction, we assign a value 1 to $\mathrm{T_{i,t}}$. The remaining firms in the placebo subsample are assigned the value 0 for $T_{i,t}$;.

(iii) We replicate this procedure for each month of the study period, which provides the bootstrap sample. We replicate the full procedure 1000 times.

(iv) For each of the 1,000 bootstrap samples, we estimate Equation 13 by ordinary least squares and collect the estimated placebo coefficients and corresponding t-statistics.

(v) We build the empirical distribution of the estimated placebo t-statistics and use it to obtain randomized *p*-values for the coefficients of interest.

3.3. Results

In Table 7, we report the DD estimates obtained from the sample of 346 M&A transactions completed by the 521 S&P500 firms included in our sample during 2003–2007. The focus in Panel A is on firm perceived uncertainty (variation of average abnormal implied volatility, $\Delta AAIV_{i,t}$). In Panel B, we display results for financial analysts' activity (number of financial analysts issuing one- or two-year EPS forecast revisions, $\#FA_{i,t}$, and corresponding number of EPS forecast revisions, $\#FOR_{i,t}$).

The results confirm Bargeron et al.'s (2009) findings: M&A transactions significantly increase investors' perception of firm uncertainty. The coefficient of $\left(T_{i,t} \times X_{i,t}\right)$, which refers to the after–M&A announcement date period for firms that completed an M&A deal, is .0067 with an associated *p*-value of .04. That is, on average, the level of abnormal implied volatility for firms completing M&A transactions is 2.5% higher than that for firms that do not undertake transactions during the period, and M&A transactions thus generate an exogeneous shock on firm uncertainty. How do financial analysts respond?

The results in Panel B of Table 7 offer an unambiguous answer: They increase their forecast revisions. Both the number of financial analysts issuing EPS forecast revisions and the total number EPS forecast revisions issued increase significantly in the period after the M&A announcement. The increase in the former measure averages .342 (p = .01). Thus, financial analysts respond to an increase in firm perceived uncertainty by increasing their activity. This result confirms the results from our Granger causality tests. The notorious difficulty of predicting M&A decision strengthens this interpretation: The M&A transaction-generated shock on firm perceived uncertainty is not subject to anticipation by financial analysts.

4. Robustness Checks

In this section, we study the robustness of our results even when we vary the econometric specifications and variable definitions. We start by testing whether we obtain comparable results with different autoregressive specifications. We then replicate the Granger causality test for the variation of the average abnormal implied volatility ($\Delta AAIV_{i,m}$) and the number of financial ($\#FA_{i,m}$) using the average unadjusted implied volatility and median abnormal implied volatility. We finally investigate whether our results are sensitive to the chosen seasonal adjustment procedure.

4.1. Granger causality test with AR(1) and AR(6) specifications

Hamilton (1994) stresses that the results of the empirical test of Granger causality can be surprisingly sensitive to the choice of the lag length of the autoregressive specification. We therefore consider whether the results in Table 3 are robust to the adoption of first- and sixth-order autoregressive (AR) specifications. For the AR(1) specification, Equations 6 and 7 (again using the model specified in Equation 4.1) become:

$$\Delta AAIV_{i,m} = c_1 + \alpha_1^1 \Delta AAIV_{i,m-1} + \beta_1^1 \#FA_{i,m-1} + u_{i,m}, \text{ and} \tag{14}$$

$$\Delta AAIV_{i,m} = c_1 + \alpha_1^1 \Delta AAIV_{i,m-1} + u_{i,m}. \tag{15}$$

For the AR(6) specification, these equations become:

$$\Delta AAIV_{i,m} = c_1 + \alpha_1^1 \Delta AAIV_{i,m-1} + \cdots + \alpha_6^1 \Delta AAIV_{i,m-6} + \beta_1^1 \#FA_{i,m-1} + \cdots + \beta_6^1 \#FA_{i,m-6} + u_{i,m}, \text{ and} \tag{16}$$

$$\Delta AAIV_{i,m} = c_1 + \alpha_1^1 \Delta AAIV_{i,m-1} + \cdots + \alpha_6^1 \Delta AAIV_{i,m-6} + u_{i,m}. \tag{17}$$

With Table 8, we confirm that using an AR(1) specification provides results consistent with the AR(3) specification in Table 3. In Table 9, we focus on the AR(6) specification. The Panel A results are consistent with the parallel findings in Table 3, namely, an increase in average abnormal implied volatility ($\Delta AAIV$) leads to an increase in financial analysts' activity ($\#FA$). However, the findings in Panel B indicate that when we adopt an AR(6) specification, the SC test loses significance (.0003, p = .47). Therefore, financial analysts' activity no longer affects future firm uncertainty significantly. This result reinforces the evidence from Table 5, which showed that introducing contemporaneous effects in the Granger causality test specification leads to the loss of significance for the SC test.

4.2. Average unadjusted implied volatility and median abnormal implied volatility

The abnormal implied volatility ($AIV_{i,t}$) comes from a regression of firm implied volatility on the concomitant daily average implied volatility of the market, obtained using the OEX index. We test whether our results are robust to the chosen adjustment procedure by replicating the Table 3 results in Table 10 with the variation of the average unadjusted daily implied volatility as a proxy for firm perceived uncertainty. The average daily unadjusted implied volatility is:

$$AUIV_{i,m} = \frac{\sum_{t \in m} IV_{i,t}}{\#m}, \quad (18)$$

where i is the firm index, m indicates month m , and $\#m$ refers to the number of trading days in the month. The corresponding monthly variation is:

$$\Delta AUIV_{i,m} = AUIV_{i,m} - AUIV_{i,m-1}, \ . \quad (19)$$

In Table 10, Panels A and B, we thus confirm the robustness of the Table 3 results to the chosen regression procedure for computing abnormal implied volatility.

In Section 2.2, we also chose to obtain the monthly abnormal implied volatility measure by taking the arithmetic average of the daily abnormal implied volatility estimates (see Equation 2). The arithmetic average may be affected by presence of outliers, and such outliers could be present in the monthly implied volatility measure at the firm level.[9] Therefore, we replicate these results using the variation of the median abnormal implied volatility, such that Equations 1–3 become, respectively:

$$mIV_{i,m} = median\left(IV_{i,t}\right), \quad (13)$$

$$\Delta mIV_{i,m} = mIV_{i,m} - mIV_{i,m-1} \qquad \text{, and} \quad (14)$$

$$\Delta mIV_{i,m} = \alpha_0 + (\alpha_1 \times \Delta MIV_m) + \varepsilon_{i,m}$$

$$\Delta AmIV_{i,m} = \hat{\varepsilon}_{i,m} \ . \quad (15)$$

In Table 11, Panels A and B, we confirm that our results are not driven by the presence of outliers.

4.3. Granger causality test with seasonal adjustment

Because financial analysts' activity displays a known seasonal pattern (Ivkovi and Jegadeesh (2004)), we removed this effect in Section 2.3 by eliminating the observed values of $\#FA_{i,m}$ (or $\#FOR_{i,m}$) and the average value of $\#FA_{i,m}$ for firm i in month m). In this section, we test whether our results depend on the chosen seasonal adjustment procedure. As we report in Table 12, the results we obtain using the same specification but working with seasonally unadjusted variables are consistent with those results in Table 3.

[9] The monthly implied volatility of our 521 firms display an average kurtosis of 5.75.

5. Conclusion

With this research, we study the dynamic relation between financial analysts' activity and investors' perceptions of firm uncertainty. Specifically, we investigate whether increases in firm perceived uncertainty lead to increases in financial analyst activity, as well as whether financial analysts' activity influence future investors' perceptions of firm uncertainty. We use, as a proxy of firm perceived uncertainty, option-based implicit volatility measures provided by the Optionmetrics database. Our proxies of financial analysts' activity rely on EPS forecast revisions, which appear in the I/B/E/S database. We track a sample of 521 firms that belonged to the S&P500 index during the period from 2003 to 2007.

The Granger causality tests deliver unambiguous results: An increase in firm perceived uncertainty leads to an increase in financial analysts' activity, but this increase in activity does not contribute significantly to reducing investors' perceptions of firm uncertainty. We also confirm the statistically significant positive relation from firm perceived uncertainty to financial analysts' activity using a sample of 327 M&A transactions undertaken by our 521 S&P500 firms as a quasi-experiment.

To the best of our knowledge, this article is the first to provide a direct empirical test of the relation between financial analysts' activity and investors' perceptions of firm uncertainty. The Granger causality approach does not allow us to pinpoint the channels through which the causal interactions flow though. Even if our results indicate that the increase in financial analysts' activity does not decrease firm uncertainty, as perceived by investors, they cannot suggest that financial analysts offer no contribution at all. Rather, on average, the limits and/or biases that affect their activity are constraining enough to prevent the detection of any beneficial impact. Another issue that we do not address is the nature of potential financial analysts' contributions. Are they collecting new information and broadcasting it to investors, or do they limit themselves to broadcasting existing, unnoticed information? This question persists, though empirical evidence provided by Altinkilic et al. (2010) seems consistent with the latter view.

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Figure 1

S&P 500 Index return standard deviation (yearly basis), 1980–2008.

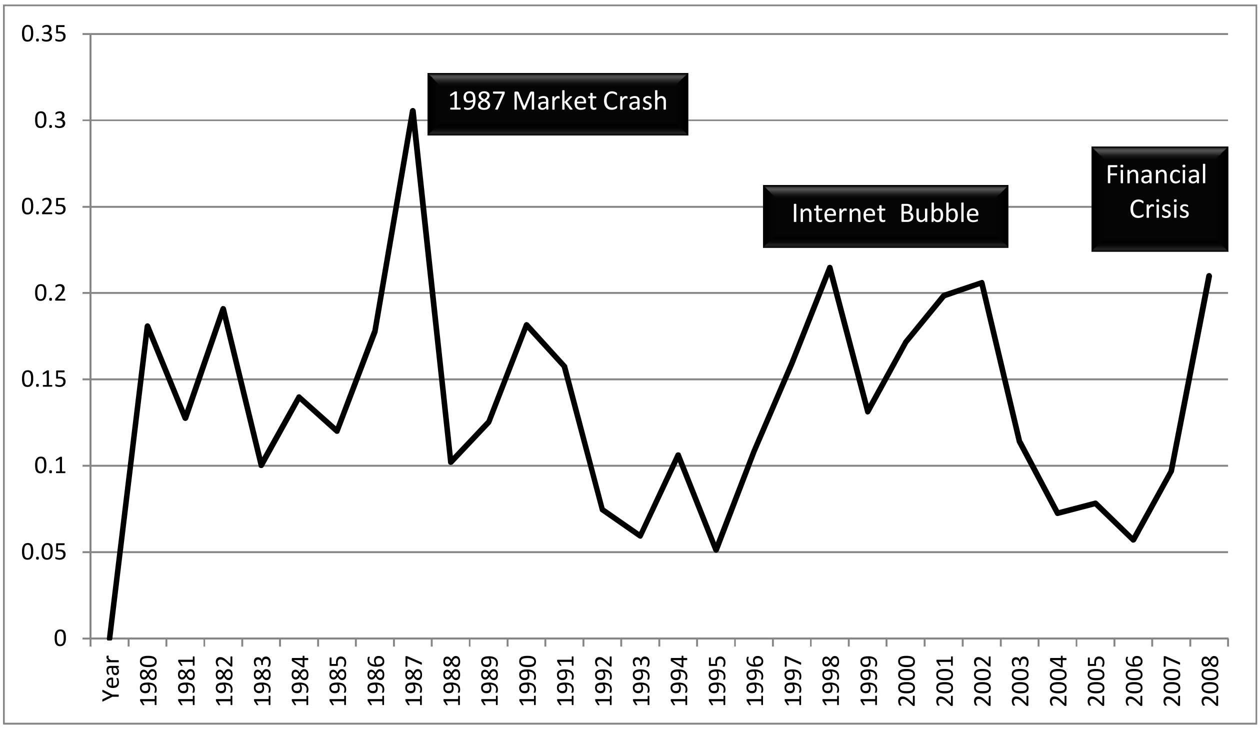

Figure 2

Firm uncertainty and financial analysts' activity.

For the sample of 521 firms that belonged at some time to the S&P500 index during 2003–2007, this figure shows the average level of abnormal implied volatility and average number of financial analysts who issued EPS forecast revisions, by firm size decile. Implied volatility is from Optionmetrics; the abnormal implied volatility computation follows the procedure described in Section 1. The number of financial analysts issuing EPS forecast revisions comes from I/B/E/S. Firm size deciles are obtained using firm market values.

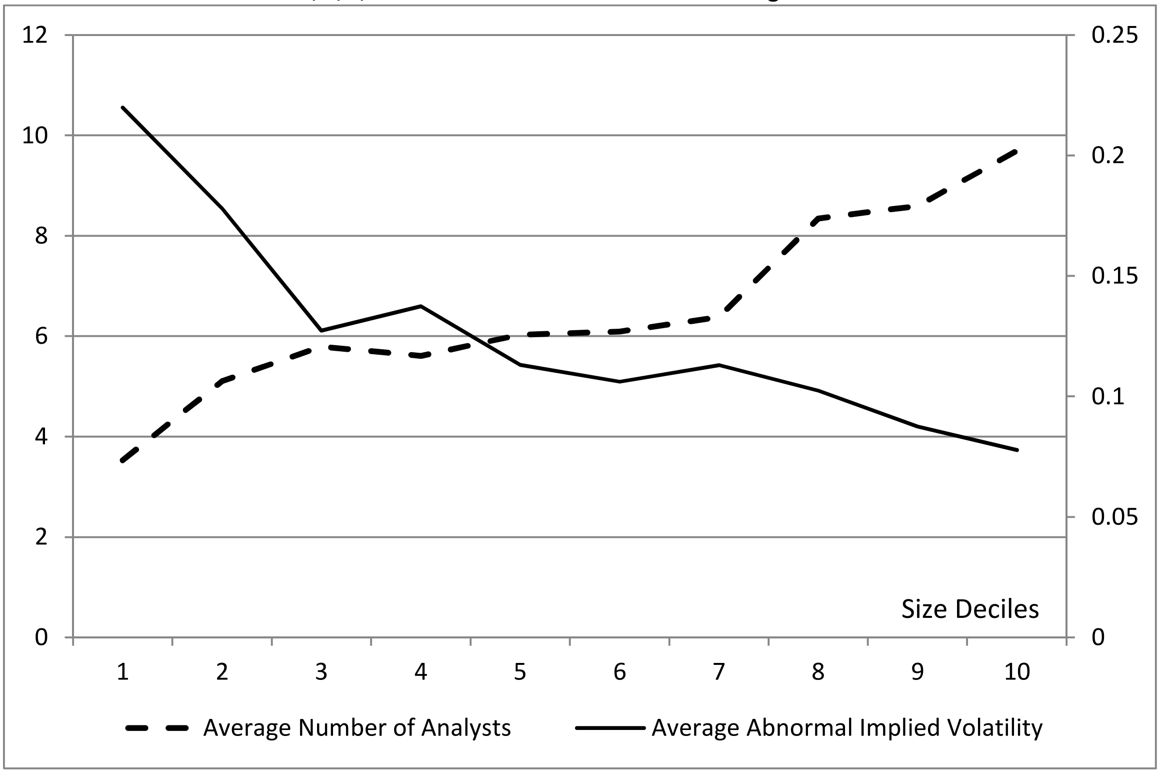

Table 1

Sample description.

Column 1 reports the number of firms by year, Column 2 contains the aggregate market value of our sample at the end of each year (million USD), and Column 3 is the percentage of aggregate U.S. stock market capitalization that the sample represents. Columns 4 and 5 provide the ratios of the average S&P500 firm size to the average U.S. listed firm size and of the median S&P500 firm size to the median U.S. listed firm size, respectively. Column 6 reports the ratio of the number of financial analysts issuing EPS forecast revisions about S&P500 firms to the number issuing EPS forecast revisions in the whole I/B/E/S database for a given year.

Year	Number of Firms	S&P500 Firms Aggregate Market Value (Million USD)	% of Aggregate U.S. Stock Market Capitalization	Average Firm Size Ratio	Median Firm Size Ratio	% Analysts
	(1)	(2)	(3)	(4)	(5)	(6)
2003	516	10,367,525	69.54%	8.25	31.06	53.18%
2004	522	11,625,139	68.64%	8.08	30.83	52.05%
2005	522	12,346,981	68.57%	8.10	34.56	51.29%
2006	500	13,557,236	66.72%	8.32	33.47	48.97%
2007	473	13,700,057	64.76%	8.76	41.24	45.56%

Table 2

Financial analysts' activity and firm perceived uncertainty

Column 1 reports the average market value of firms in each decile (million USD), and Column 2 provides the corresponding median value (Million USD). $\overline{\#FA}$ is the average number of financial analysts issuing one- or two-year EPS forecast revisions for firms in each decile, and $\overline{\#FOR}$ is the corresponding average number of EPS forecast revisions. $\overline{IV}$ is the average monthly implied volatility for firms included in each decile.

Size Decile	Average Market Value (Million USD)	Median Market Value (Million USD)	$\overline{\#FA}$	$\overline{\#FOR}$	$\overline{IV}$
	(1)	(2)	(3)	(4)	(5)
1 (Low)	2,197	2,086	3.71	7.17	0.35
2	3,860	3,750	5.02	9.21	0.32
3	5,160	5,009	5.74	11.75	0.29
4	6,733	6,578	5.78	11.64	0.29
5	8,457	8,281	6.15	12.06	0.27
6	10,821	10,605	6.19	12.11	0.26
7	13,995	13,237	6.06	10.76	0.26
8	18,534	17,723	9.00	18.71	0.25
9	29,586	28,577	8.43	16.34	0.25
10 High)	98,489	70,276	9.98	19.69	0.24

Table 3

Granger causality test: Number of financial analysts versus abnormal Implied volatility.

The number of financial analysts issuing EPS forecasts revisions ($\#FA_{i,m}$) is a measure of financial analysts' activity, and the variation of the firm monthly average abnormal implied volatility ($\Delta AAIV_{i,m}$) is the proxy for firm perceived uncertainty. Variables are defined in Section 2.2. The *% of sign. Fisher* is the percentage of firm regressions for which the Fisher statistic is significant at the conventional significance level. The Sum of coeff. SC and Hurlin Granger Causality test H are described in Section 2.3. Panel A tests whether firm perceived uncertainty Granger-causes financial analysts' activity; Panel B tests if financial analysts' activity Granger-causes firm perceived uncertainty.

Panel A: Dependent variable: $\#FA_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$	-0.0601	*0.00*	-0.0664	*0.00*
$\#FA_{i,m-2}$	0.0126	*0.02*	0.0157	*0.01*
$\#FA_{i,m-3}$	0.2125	*0.00*	0.2116	*0.00*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$			5.8156	*0.00*
$\Delta AAIV_{i,m-2}$			0.9146	*0.34*
$\Delta AAIV_{i,m-3}$			-1.6401	*0.20*
Number of Obs.	521		521	
% of sign. Fisher	50.29%		47.02%	
Average R^2	15.99%		22.19%	
Sum of coeff. test *SC*: 5.09 (p-*value : 0.00*)				
Hurlin Granger causality test *H*: 6.91 (p-*value : 0.00*)				

Panel B: Dependent variable: $\Delta AAIV_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$			0.0003	*0.00*
$\#FA_{i,m-2}$			0.0000	*0.17*
$\#FA_{i,m-3}$			0.0001	*0.74*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$	-0.0980	*0.00*	-0.0978	*0.00*
$\Delta AAIV_{i,m-2}$	-0.0969	*0.00*	-0.0972	*0.00*
$\Delta AAIV_{i,m-3}$	0.0210	*0.00*	0.0113	*0.11*
Number of Obs.	521		521	
% of sign. Fisher	20.15%		18.62%	
Average R^2	7.11%		13.28%	
Sum of coeff. test *SC*: 0.0004 (p-*value : 0.02*)				
Hurlin Granger causality test *H*: 3.31 (p-*value : 0.00*)				

Table 4

Granger causality test: Number of EPS forecasts revisions versus abnormal implied volatility.

The number of one- and two-year EPS forecast revisions issued by financial analysts following the firm ($\#FOR_{i,m}$) is the measure of financial analysts' activity, and the variation of the firm monthly average abnormal implied volatility ($\Delta AAIV_{i,m}$) is the proxy for firm perceived uncertainty. Variables are defined in Section 2.2. . The *% of sign. Fisher* is the percentage of firm regressions for which the Fisher statistic is significant at the conventional significance level. The Sum of coeff. SC and Hurlin Granger Causality test H are described in Section 2.3. Panel A tests whether firm perceived uncertainty Granger-causes financial analysts' activity; Panel B tests if financial analysts' activity Granger-causes firm perceived uncertainty.

Panel A: Dependent variable: $\#FOR_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of EPS forecasts				
$\#FOR_{i,m-1}$	-0.0532	*0.00*	-0.0609	*0.00*
$\#FOR_{i,m-2}$	0.0140	*0.02*	0.0122	*0.04*
$\#FOR_{i,m-3}$	0.2114	*0.00*	0.2093	*0.00*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$			15.5989	*0.00*
$\Delta AAIV_{i,m-2}$			4.8471	*0.09*
$\Delta AAIV_{i,m-3}$			0.2651	*0.99*
Number of Obs.	521		521	
% of sign. Fisher	50.48%		44.34%	
Adjusted R²	15.56		21.51%	
Sum of coeff. test *SC*: 20.71 (p-*value : 0.00*)				
Hurlin Granger causality test *H*: 4.96 (p-*value : 0.00*)				

Panel B: Dependent variable: $\Delta AAIV_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of EPS forecasts				
$\#FOR_{i,m-1}$			0.0002	*0.00*
$\#FOR_{i,m-2}$			0.0000	*0.26*
$\#FOR_{i,m-3}$			0.0001	*0.10*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$	-0.0980	*0.00*	-0.0988	*0.00*
$\Delta AAIV_{i,m-2}$	-0.0969	*0.00*	-0.0980	*0.00*
$\Delta AAIV_{i,m-3}$	0.0210	*0.00*	0.0091	*0.00*
Number of Obs.	521		521	
% of sign. Fisher	20.15%		19.58%	
Adjusted R²	7.11%		15.93%	
Sum of coeff. test *SC*: 0.0003 (p-*value : 0.00*)				
Hurlin Granger causality test *H*: 5.09 (p-*value : 0.00*)				

Table 5

Granger causality test: Number of EPS forecasts versus abnormal implied volatility with contemporaneous explanatory variables

The number of financial analysts issuing EPS forecast revisions ($\#FA_{i,m}$) is the measure of financial analysts' activity, and the variation of the firm monthly average abnormal implied volatility ($\Delta AAIV_{i,m}$) is the proxy for firm perceived uncertainty. Variables are defined in Section 2.2. . The *% of sign. Fisher* is the percentage of firm regressions for which the Fisher statistic is significant at the conventional significance level. The Sum of coeff. SC and Hurlin Granger Causality test H are described in Section 2.3. Panel A tests whether firm perceived uncertainty Granger-causes financial analysts' activity; Panel B tests if financial analysts' activity Granger-causes firm perceived uncertainty.

Panel A: Dependent variable: $\#FA_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$	-0.0601	*0.00*	-0.0674	*0.00*
$\#FA_{i,m-2}$	0.0126	*0.02*	0.0178	*0.00*
$\#FA_{i,m-3}$	0.2125	*0.00*	0.2139	*0.00*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m}$			9.0617	*0.00*
$\Delta AAIV_{i,m-1}$			6.7134	*0.00*
$\Delta AAIV_{i,m-2}$			1.6159	*0.09*
$\Delta AAIV_{i,m-3}$			-1.9234	*0.14*
Number of Obs.	521		521	
% of sign. Fisher	50.29%		45.49%	
Adjusted R^2	15.99%		24.25%	

Sum of coeff. test *SC*: 6.41 (p-*value : 0.00*)
Hurlin Granger causality test *H*: 8.33 (p-*value : 0.00*)

Panel B: Dependent variable: $\Delta AAIV_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m}$			0.0005	*0.00*
$\#FA_{i,m-1}$			0.0003	*0.00*
$\#FA_{i,m-2}$			0.0000	*0.14*
$\#FA_{i,m-3}$			0.0000	*0.12*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$	-0.0980	*0.00*	-0.1041	*0.00*
$\Delta AAIV_{i,m-2}$	-0.0969	*0.00*	-0.0986	*0.00*
$\Delta AAIV_{i,m-3}$	0.0210	*0.00*	0.0108	*0.12*
Number of Obs.	521		521	
% of sign. Fisher	20.15%		30.33%	
Adjusted R^2	7.11%		15.74%	

Sum of coeff. test *SC*: 0.0002 (p-*value : 0.38*)
Hurlin Granger causality test *H*: 4.46 (p-*value : 0.00*)

Table 6

S&P500 firms' mergers and acquisitions.

Firm size is the average firm market value during 2003–2007. Mergers and acquisitions transactions were collected from the Thomson-Reuters SDC database. Column 1 reports the aggregate number of M&A deals completed by firms in each size decile. Columns 2 and 3 display, respectively, the average and median M&A deal size; Column 4 provides the corresponding average relative M&A deal sizes (ratio of deal size to firm size). Columns 5 and 6 display the percentage of public and private target acquisitions in each firm size decile.

Size Decile	$\#Deal$	Average Deal Size (Million USD)	Median Deal Size (Million USD)	Average Relative Size	% of Public Target	% of Private Target
	(1)	(2)	(3)	(4)	(5)	(6)
1 (Low)	118	230.21	158.05	0.12	19%	36%
2	100	258.27	146.08	0.07	13%	38%
3	100	755.09	277.26	0.22	26%	40%
4	112	564.33	329.21	0.10	25%	32%
5	158	927.98	432.57	0.13	33%	22%
6	136	764.21	303.02	0.10	25%	39%
7	139	1,335.37	380.00	0.12	29%	24%
8	113	1,140.64	264.63	0.04	31%	31%
9	188	1,737.91	624.76	0.07	25%	23%
10 (High)	308	2,256.35	1,042.51	0.03	36%	30%

Table 7

Differences-in-differences test of firm uncertainty and financial analysts' activity around M&A activity

The sample consists of 346 M&A transactions completed by the 521 S&P500 firms during 2003–2007. The differences-in-differences estimation approach is described in Section 3.2. $\Delta AAIV$ is the variation of the abnormal average implied volatility. $\#FA$ is the number of financial analysts issuing one- or two-year EPS forecast revisions, and $\#FOR$ is the corresponding number of EPS forecasts revisions (see Section 2.2 for definitions). $X_{i,t}$ is a dummy variable equal to 1 if t refers to the after–M&A announcement date period for firm i and 0 otherwise, with six-month event windows. $T_{i,t}$ is a dummy variable equal to 1 if firm i completed a M&A and 0 otherwise. $T_{i,t} \times X_{i,t}$ identifies the after–M&A announcement date period for firms that completed an M&A. Firms and periods fixed effects are included but not reported. The *p*-values are obtained using a randomized inference test (Bertrand et al. (2001**{AU: please check date}**)).

Panel A: Firm uncertainty ($\Delta AAIV$)

	$\Delta AAIV$	
	coef	p-*value*
$X_{i,t}$	-0.0098	*0.57*
$T_{i,t}$	-0.0076	*0.00*
$(T_{i,t} \times X_{i,t})$	0.0067	*0.04*
Number of Obs.	39,748	
Fisher Statistic	204.426	*0.00*
Adjusted R^2	76.3%	

Panel B: Financial analysts' activity ($\#FA$ or $\#FOR$)

	$\#FA$		$\#FOR$	
	coef	p-*value*	coef	p-*value*
$X_{i,t}$	-0.1668	*0.55*	-0.1729	*0.52*
$T_{i,t}$	-0.2817	*0.01*	-0.5699	*0.02*
$(T_{i,t} \times X_{i,t})$	0.3422	*0.01*	0.8341	*0.01*
Number of Obs.	39,748		39,748	
Fisher Statistic	244.689	*0.00*	233.249	*0.00*
Adjusted R^2	79.40%		78.60%	

Table 8

Granger causality test with AR(1) specification.

Table 8 replicates the results of Table 3 using the Granger causality with AR(1) specification. The number of financial analysts issuing EPS forecast revisions ($\#FA_{i,m}$) is the measure of financial analysts' activity, and the variation of the firm monthly average abnormal implied volatility ($\Delta AAIV_{i,m}$) is the proxy for firm perceived uncertainty. Variables are defined in Section 2.2. The *% of sign. Fisher* is the percentage of firm regressions for which the Fisher statistic is significant at the conventional significance level. The Hurlin Granger Causality test H is described in Section 2.3.

Panel A: Dependent variable: $\#FA_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$	-0.0230	*0.02*	-0.0274	*0.01*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$			6.5318	*0.00*
Number of Obs.	521		521	
% of sign. Fisher	33.01%		29.94%	
Average R^2	4.91%		7.35%	
Hurlin Granger causality test *H*: 6.58 (p-*value : 0.00*)				

Panel B: Dependent variable: $\Delta AAIV_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$			0.0002	*0.00*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$	-0.0691	*0.00*	-0.0701	*0.00*
Number of Obs.	521		521	
% of sign. Fisher	14.78%		16.51%	
Average R^2	2.17%		4.30%	
Hurlin Granger causality test *H*: 3.03 (p-*value : 0.00*)				

Table 9

Granger causality test with AR(6) specification.

Table 9 replicates the results of Table 3 using Granger causality with the AR(6) specification. The number of financial analysts issuing EPS forecast revisions ($\#FA_{i,m}$) is the measure of financial analysts' activity, and the variation of the firm monthly average abnormal implied volatility ($\Delta AAIV_{i,m}$) is the proxy for firm perceived uncertainty. Variables are defined in Section 2.2. The *% of sign. Fisher* is the percentage of firm regressions for which the Fisher statistic is significant at the conventional significance level. The Sum of coeff. SC and Hurlin Granger Causality test H are described in Section 2.3.

Panel A: Dependent variable: $\#FA_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$	-0.0697	*0.00*	-0.0749	*0.00*
$\#FA_{i,m-2}$	0.0000	*0.82*	-0.0030	*0.89*
$\#FA_{i,m-3}$	0.1817	*0.00*	0.1792	*0.00*
$\#FA_{i,m-4}$	0.0236	*0.00*	0.0275	*0.00*
$\#FA_{i,m-5}$	0.0311	*0.00*	0.0364	*0.00*
$\#FA_{i,m-6}$	0.0529	*0.00*	0.0576	*0.00*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$			5.7485	*0.00*
$\Delta AAIV_{i,m-2}$			1.3683	*0.22*
$\Delta AAIV_{i,m-3}$			-1.9700	*0.10*
$\Delta AAIV_{i,m-4}$			3.2394	*0.00*
$\Delta AAIV_{i,m-5}$			0.4998	*0.88*
$\Delta AAIV_{i,m-6}$			1.0410	*0.31*
Number of Obs.	521		521	
% of sign. Fisher	40.12%		37.43%	
Average R^2	21.77%		33.79%	
Sum of coeff. test *SC*: 5.75 (p-*value : 0.00*)				
Hurlin Granger causality test *H*: 5.76 (p-*value : 0.00*)				

Panel B: Dependent variable: $\Delta AAIV_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$			0.0004	*0.00*
$\#FA_{i,m-2}$			0.0000	*0.75*
$\#FA_{i,m-3}$			0.0001	*0.95*
$\#FA_{i,m-4}$			-0.0003	*0.00*
$\#FA_{i,m-5}$			-0.0001	*0.25*
$\#FA_{i,m-6}$			0.0001	*0.36*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$	-0.1026	*0.00*	-0.1027	*0.00*
$\Delta AAIV_{i,m-2}$	-0.1162	*0.00*	-0.1182	*0.00*
$\Delta AAIV_{i,m-3}$	0.0082	*0.17*	0.0000	*0.94*
$\Delta AAIV_{i,m-4}$	-0.1119	*0.00*	-0.1238	*0.00*
$\Delta AAIV_{i,m-5}$	0.0197	*0.00*	0.0170	*0.00*
$\Delta AAIV_{i,m-6}$	-0.0124	*0.02*	-0.0213	*0.00*
Number of Obs.	521		521	
% of sign. Fisher	15.36%		27.26%	
Average R^2	13.40%		26.86%	

Sum of coeff. test *SC*: 0.0003 (p-*value : 0.47*)
Hurlin Granger causality test *H*: 5.84 (p-*value : 0.00*)

Table 10

Granger causality test: Average implied volatility.

Table 10 replicates the results of Table 3 using the variation of the average unadjusted implied volatility $\Delta AUIV_{i,m}$ as a proxy of firm perceived uncertainty. The number of financial analysts issuing EPS forecast revisions ($\#FA_{i,m}$) is the measure of financial analysts' activity. Variables are defined in Sections 2.2 and 4.3. The *% of sign. Fisher* is the percentage of firm regressions for which the Fisher statistic is significant at the conventional significance level. The Sum of coeff. SC and Hurlin Granger Causality test H are described in Section 2.3.

Panel A: Dependent variable: $\#FA_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$	-0.0601	*0.00*	-0.0686	*0.00*
$\#FA_{i,m-2}$	0.0126	*0.02*	0.0101	*0.06*
$\#FA_{i,m-3}$	0.2125	*0.00*	0.2077	*0.00*
Variation of Abnormal Implied Volatility				
$\Delta AUIV_{i,m-1}$			3.5679	*0.00*
$\Delta AUIV_{i,m-2}$			0.4248	*0.45*
$\Delta AUIV_{i,m-3}$			-0.3424	*0.75*
Number of Obs.	521		521	
% of sign. Fisher	50.29%		47.60%	
Average R^2	15.99%		22.08%	

Sum of coeff. test *SC*: 3.65 (p-*value : 0.00*)
Hurlin Granger causality test *H*: 6.54 (p-*value : 0.00*)

Panel B: Dependent variable: $\Delta AUIV_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$			0.0004	*0.00*
$\#FA_{i,m-2}$			0.0000	*0.14*
$\#FA_{i,m-3}$			0.0002	*0.38*
Variation of Abnormal Implied Volatility				
$\Delta AUIV_{i,m-1}$	0.0400	*0.00*	0.0349	*0.00*
$\Delta AUIV_{i,m-2}$	-0.1223	*0.00*	-0.1274	*0.00*
$\Delta AUIV_{i,m-3}$	0.0952	*0.00*	0.0801	*0.00*
Number of Obs.	521		521	
% of sign. Fisher	28.21%		28.02%	
Average R^2	8.08%		14.95%	

Sum of coeff. test *SC*: 0.0006 (p-*value : 0.00*)
Hurlin Granger causality test *H*: 7.54 (p-*value : 0.00*)

Table 11

Granger causality test: Median abnormal implied volatility.

Table 11 replicates the results of Table 3 using the variation of the median abnormal implied volatility ($\Delta MAIV_{i,m}$) as a proxy of firm perception uncertainty. The number of financial analysts issuing EPS forecast revisions ($\#FA_{i,m}$) is the measure of financial analysts' activity. Variables are defined in Sections 2.2 and 4.3. The *Sum of Coeff*. statistic tests whether the sum of lagged coefficients is equal to zero. The *% of sign. Fisher* is the percentage of firm regressions for which the Fisher statistic is significant at the conventional significance level. The Sum of coeff. SC and Hurlin Granger Causality test H are described in Section 2.3.

Panel A: Dependent variable: $\#FA_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	Coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$	-0.0601	*0.00*	-0.0574	*0.00*
$\#FA_{i,m-2}$	0.0126	*0.02*	0.0159	*0.01*
$\#FA_{i,m-3}$	0.2125	*0.00*	0.2125	*0.00*
Variation of Abnormal Implied Volatility				
$\Delta MAIV_{i,m-1}$			3.4469	*0.00*
$\Delta MAIV_{i,m-2}$			2.0162	*0.05*
$\Delta MAIV_{i,m-3}$			3.0737	*0.02*
Number of Obs.	521		521	
% of sign. Fisher	50.29%		50.10%	
Average R^2	15.99%		22.33%	
Sum of coeff. test *SC*: 8.54 (p-*value : 0.00*)				
Hurlin-Venet Granger causality test *H*: 7.56 (p-*value : 0.00*)				

Panel B: Dependent variable: $\Delta MAIV_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$			0.0003	*0.00*
$\#FA_{i,m-2}$			0.0000	*0.20*
$\#FA_{i,m-3}$			0.0001	*0.95*
Variation of Abnormal Implied Volatility				
$\Delta MAIV_{i,m-1}$	-0.2057	*0.00*	-0.2028	*0.00*
$\Delta MAIV_{i,m-2}$	-0.1479	*0.00*	-0.1519	*0.00*
$\Delta MAIV_{i,m-3}$	-0.0536	*0.00*	-0.0626	*0.00*
Number of Obs.	521		521	
% of sign. Fisher	45.10%		38.00%	
Average R^2	11.56%		17.43%	
Sum of coeff. test *SC*: 0.0002 (p-*value : 0.05*)				
Hurlin-Venet Granger causality test *H*: 2.67 (p-*value : 0.01*)				

Table 12

Granger causality test: Without seasonal adjustment of financial analyst activity.

Table 12 replicates the results of Table 3 without adjustment for seasonal patterns in financial analyst activity. The average abnormal implied volatility ($\Delta AAIV_{i,m}$) is the proxy of firm perceived uncertainty. The number of financial analysts issuing EPS forecast revisions ($\#FA_{i,m}$) is the measure of financial analysts' activity. Variables are defined in Sections 2.2 and 4.3. The *% of sign. Fisher* is the percentage of firm regressions for which the Fisher statistic is significant at the conventional significance level. The Sum of coeff. $SC$and Hurlin Granger Causality test H are described in Section 2.3.

Panel A: Dependent variable: $\#FA_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$	-0.2541	*0.00*	-0.2606	*0.00*
$\#FA_{i,m-2}$	-0.1764	*0.00*	-0.1801	*0.00*
$\#FA_{i,m-3}$	0.4053	*0.00*	0.4031	*0.00*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$			11.3466	*0.00*
$\Delta AAIV_{i,m-2}$			2.7248	*0.04*
$\Delta AAIV_{i,m-3}$			-1.6295	*0.24*
Number of Obs.	521		521	
% of sign. Fisher	92.71%		88.48%	
Average R^2	40.66%		44.47%	

Sum of coeff. test *SC*:12.44 (p-*value : 0.00*)
Hurlin Granger causality test *H*: 3.07 (p-*value : 0.00*)

Panel B: Dependent variable: $\Delta MAIV_{i,m}$

	Restricted Model		Full Model	
	coef	p-*value*	coef	p-*value*
Number of Financial Analysts				
$\#FA_{i,m-1}$			0.0000	*0.80*
$\#FA_{i,m-2}$			0.0001	*0.63*
$\#FA_{i,m-3}$			0.0003	*0.00*
Variation of Abnormal Implied Volatility				
$\Delta AAIV_{i,m-1}$	-0.0801	*0.00*	-0.0806	*0.00*
$\Delta AAIV_{i,m-2}$	-0.0910	*0.00*	-0.0891	*0.00*
$\Delta AAIV_{i,m-3}$	0.0405	*0.00*	0.0226	*0.00*
Number of Obs.	521		521	
% of sign. Fisher	21.69%		14.01%	
Average R^2	7.40%		12.22%	

Sum of coeff. test *SC*: 0.0004 (p-*value : 0.04*)
Hurlin Granger causality test *H*: 3.58 (p-*value : 0.00*)