Flu Epidemic, Limited Attention and Analyst Forecast Behavior

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ABSTRACT

This study provides the direct evidence that limited attention caused by exogenous distraction influences financial market participants. Specifically, we examine the changes of analyst forecast behavior during influenza epidemics when analysts are facing attention limits resulted from the distraction of experiencing flu symptoms by themselves, family members, relatives or colleagues. This paper finds that higher flu intensity in the New York and New Jersey region is associated with lower degree of disagreement on target-price forecasts among financial analysts. More interestingly, analysts are more likely to over-predict target-price for high-performing stocks and under-predict target-price for low-performing stocks. We verify this result using an alternative measure of exogenous distraction that limits analysts' attention: vaccine side-effect incidence, and we find consistent evidence supporting the hypothesis that the limited attention or effort allocated to their work affects analysts' forecast behavior; as a result, their ability to act as an important source of information revelation is reduced for at least a short period of time.

Keywords: limited attention, flu epidemic, analyst forecast, behavior finance

JEL Codes: G10, G14

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Despite a large body of empirical studies on how human beings are limited in their ability to process information and to perform multiple tasks simultaneously[1], prior literature of examining the relation between limited attention and financial markets is scarce, and little research has been done into aspects of limited attention due to exogenous reasons. In previous studies, the focus is on the empirical effects of investor sentiment on the stock market assuming that sentiment is exogenous (Baker and Wurgler 2007). In a comprehensive survey of behavior finance research, Subrahmanyam (2007) suggests that much work remain to be done to answer a specific question of which agents are biased and whose biases affect prices. This paper attempts to provides direct evidence that limited attention caused by exogenous distraction influences financial market participants. Specifically, we examine the changes of analyst forecast behavior during influenza epidemics when analysts are facing attention limits resulted from the distraction of experiencing flu symptoms by themselves, family members, relatives or colleagues. Because of this limited attention or effort allocated to their analysis work, financial analysts' ability to act as an important source of information revelation is reduced for at least a short period of time.

The financial market plays a central role of price discovery and the majority of prior research only studies the effect of market makers' behavior on price formation, for example, Corwin and Coughenour (2005) who argue that limited attention influences transaction costs by showing that specialist attention gets diverted to the most active stocks in their portfolio, thus raising transaction costs and leading to less frequent price movements in the less active ones. This article seeks to present a contribution by focusing on a temporary irrational behavior exhibited by a special group of market participants that can influence other participants' investment decisions. Such an update in the literature is critical to assess the impact of limited attention on the information revelation process in the financial market.

Hirshleifer and Teoh (2003) and Peng and Xiong (2006) are among the early theoretical studies stress the idea of limited attention, whereby cognitively overloaded investors pay attention to only a subset of publically available information. The existing literature examining the impact of limited attention on asset prices can be classified into two types: 1) to use investor inattention to explain the predictability of stock returns (Hong, Torous and Valkanov 2007, Cohen and Frazzini 2008), and 2) to reveal the impact of investor inattention on asset prices (DellaVigna and Pollet 2009, Hirshleifer, Lim and Teoh 2009, Loh 2010). Along with the

[1] See Kahneman (1973) and Pashler (1998).

literature in the second category, Hong and Stein (2007) suggest that the response of prices to market news will be larger when it is broadcast in an "attention-grabbing" manner. Following this line of arguments they also suggest that a news release will have less effect if investors with limited attention are distracted for some reason. Klibanoff, Lamont and Wizman (1998) document that the prices of close-end country funds respond more strongly to changes in the funds' net asset values when the country in question is also featured on the front page of the New York Times. DellaVigna and Pollet (2006) find that when a firm announces its earnings on Friday, the stock price reacts less than for the announcements on other days of the week. They attribute this finding to the distraction over the weekend. When investors return to work on the next Monday, they tend to forget the implications of the news, or at least may not feel a strong urge to react. Other studies including Engelberg, Kurov (2010), Louis and Sun (2010), Mian and Sankaraguruswamy (2012), and Sasseville and Williams (2012) provide consistent evidence supporting the limited attention hypothesis as surveyed in Hong and Stein (2007). This paper is more related to the work in this second category but with a difference: it studies the analyst forecast behavior when setting 12-month-ahead target-price, and compare the price with the actual stock price realized one year later. In other words, prior research is focused on how irrational investors set the price, whereas this paper is interested in how irrational analysts predict the stock price assuming the price will be rationally set by the market in the next year.

It is noted that Hong and Stein (2007) do not provide any reason why investors or financial market participants in general had limited attention or being distracted in the first place. For example, in DellaVigna and Pollet (2006), it could well be the case that Friday is considered to be an unlucky day to trade. In this paper, we focus on the exogenous shocks that can distract market participants' attention, and study the consequence of the induced-limited attention. Specifically, it finds that higher flu intensity in the New York and New Jersey region is associated with lower degree of disagreement on the 12-month-ahead target-price forecasts among financial analysts. More interestingly, analysts are more likely to over-predict target-price for high-performing stocks and under-predict target-price for low-performing stocks. We verify this result using an alternative measure of exogenous distraction that limits analysts' attention: vaccine side-effect incidence, and we find consistent evidence supporting the limited attention hypothesis.

We do not argue that the flu-induced pain, such as runny nose, sneezing, sore throat, coughing, muscle pains, and fevers, impairs the stock markets directly during flu epidemics.

Instead, it is likely that the flu symptoms distract the attention of financial market participants (analysts), and in turn they are unable to act as an additional source of information revelation during these periods, offering more optimistic recommendations for the high-performing stocks and more pessimistic recommendations for the low-performing stocks. This interpretation is similar to the conclusion in McTier, Tse and Wald (2013) that the incidence of influenza in the greater New York City area affects stock traders and in turn reduces trading activity and volatility.

The remainder of the paper is organized as follows. Section II presents the sample data and measurement choice. Section III introduces the empirical method. Section IV evaluates the results. Section V discusses the robustness. Section VI concludes.

II. DATA

Our primary data source is the percentage of positive flu samples test by week and U.S. region from the Center for Disease Control and Prevention (CDC). The sample spans from the third quarter of 1998 to the third quarter of 2011. The CDC data are divided to ten HHS regions defined by the U.S. Department of Health & Human Services. To study the impact of influenza on analyst forecast behavior, we focus on the flu incidence data in Region 2 (New York and New Jersey), because most of the Wall Street financial analysts live and work in this specific geographic region. We take the flu incidence data in Region 7 (Iowa, Kansas, Missouri and Nebraska) as a benchmark, and calculate the *flu intensity* as the percentage difference of positive flu incidences between Region 2 and Region 7 scaled by the average level of positive flu incidences in both regions.

$$Flu\ Intensity_{week} = \frac{\Delta Flu\%_{week} - \overline{\Delta Flu\%}_{year}}{Flu\%_{week} - \overline{Flu\%}_{year}}$$

where $\Delta Flu\%_{week} = Flu\%_{week,region2} - Flu\%_{week,region7}$

$$Flu\%_{week} = \frac{Flu\%_{week,region2} + Flu\%_{week,region7}}{2}$$

$$\overline{\Delta Flu\%}_{year} = mean_{year}(\Delta Flu\%_{week})$$

$$\overline{Flu\%}_{year} = mean_{year}(Flu\%_{week})$$

We also create a binary variable named *flu dummy* with its value being one if the level of positive flu incidences in Region 2 is higher than Region 7 and the average level of positive flu incidences in both regions is above the historical mean.

$$Flu\,Dummy_{week} = 1 \text{, if } \Delta Flu\%_{week} > \overline{\Delta Flu\%}_{year} \text{ and } Flu\%_{week} > \overline{Flu\%}_{year}$$

$$Flu\,Dummy_{week} = 0 \text{, otherwise}$$

As a robustness check, we collect the vaccine side-effect data from the HHS VAERS database to measure the painfulness of being sick. This database records many different types of adverse events occur after vaccination, describes mild adverse events such as fever, local reactions, crying, irritability, life-threatening conditions, hospitalization, permanent disability, or death. We define a dummy variable *vaccine side-effect* with its value being one if the ratio of vaccine adverse events reported by Region 2 and Region 7 is higher than the historical monthly mean.

$$Vaccine\,Side\text{-}effect_{week} = 1 \text{, if } \Delta Side\text{-}effect_{month} = \overline{\Delta Side\text{-}effect}_{month}$$

$$\text{where } \Delta Side\text{-}effect_{month} = \frac{\Delta Side\text{-}effect_{month,region2}}{\Delta Side\text{-}effect_{month,region7}} - 1$$

$$\overline{\Delta Side\text{-}effect}_{month} = mean_{month}(\Delta Side\text{-}effect_{month})$$

$$Vaccine\,Side\text{-}effect_{week} = 0 \text{, otherwise}$$

To study the analyst forecast behavior, first we obtain the 12-month-ahead target-price forecasts for all individual analysts from the I/B/E/S database and aggregate the target-prices for each calendar month. Then, we obtain the actual stock prices realized in 1-year from the CRSP database, and define a variable *forecast surprise* as the absolute value of the percentage difference between the realized stock price and the 1-year-ahead target price forecast. We also create a *forecast dispersion* variable to proxy for the degree of disagreement among financial analysts. It is defined as the standard deviation of all analyst forecasts of 1-year-ahead target-price scaled by the average target-price for each firm.

In addition, we gather variables that control for factors, other than the health condition of financial analysts that influence analyst forecast accuracy. We obtain firms' financial accounting information from the Compustat database and calculate the log total assets, financial leverage, market-to-book ratio, ROA, and R&D-to-asset ratio. This approach is consistent with the analyst forecast literature. Table I provides summary statistics including means, standard deviations, and extreme values on our variables of interest.

[Insert Table I here]

We report the Pearson's correlations in Table II. An examination of the correlation matrix indicates that correlations between independent variables are generally smaller than 0.4. The low correlation among the covariates helps prevent the problem of multicollinearity that causes high standard errors and low significance levels when both variables are included in the same regression. Further diagnostics (VIF) indicate no obvious evidence of serious multicollinearity among the covariates.

[Insert Table II Here]

III. METHODOLOGY

We use pooled OLS regressions to measure the effect of flu epidemics on analyst forecast behavior after controlling for firm specific factors that also impact forecast accuracy. The unit of observation in the regressions is the Firm-Forecast. We use flu intensity for measuring the limited attention of financial analysts, the absolute value of forecast surprise for forecast accuracy, and forecast diversion for the degree of disagreement among analysts. For robustness, we also measure the limited attention by using the vaccine side-effect incidences. Previous research suggests firm size, leverage, profitability, growth opportunity, and R&D investment as important factors of analyst forecasts, and hence we include these variables to control for this effect. Finally, consistent with past literature, year, month and industry fixed effects are included and standard errors are clustered at the firm level. These dependent and control variables are used for the pooled cross sectional regressions that follow.

$$
\begin{aligned}
ForecastDispersion_i = {} & \beta_0 + \beta_1 \times Flu_i + \beta_2 \times NumForecasts_i + \beta_3 \times Assets_i + \beta_4 \times M2B_i + \beta_5 \times Leverage_i + \beta_6 \times ROA_i \\
& + \beta_7 \times R\&D_i + \varepsilon_i
\end{aligned}
$$

$$
\begin{aligned}
ForecastSurprise_i = {} & \beta_0 + \beta_1 \times Flu_i + \beta_2 \times NumForecasts_i + \beta_3 \times ForecastDispersion_i + \beta_4 \times Assets_i + \beta_5 \times M2B_i \\
& + \beta_6 \times Leverage_i + \beta_7 \times ROA_i + \beta_8 \times R\&D_i + \varepsilon_i
\end{aligned}
$$

IV. RESULTS

To begin our analysis, we fit our primary regression specification using only forecast dispersion, flu dummy, flu intensity, and the number of forecasts with year, month, and industry fixed-effects. Specifications (1) and (2) of Table III report the estimated coefficients of this baseline model.

[Insert Table III Here]

The statistically significant negative effect of flu dummy and flu intensity suggests during flu seasons, analysts tend to agree with each other on their 12-month-ahead target-price forecasts. This is consistent with the limited attention hypothesis that analysts are paying less attention on the company and exerting less effort on their analysis work. However, this result does not reveal whether the limited attention caused by coughing, muscle pains or even fevers from influenza illness make analysts more or less likely to make irrational forecasts. To answer this specific question, we regress forecast surprise on the same set of variables as the ones in previous specifications, and the coefficient estimates are reported in specifications (3) and (4) of Table III. It appears that flu has no effect on forecast outcomes. Then, we break down the sample to two subsamples. The first one is for high-performance firms with 1-year realized stock price higher than the average analyst forecast and the second one is for low-performance firms with 1-year realized stock price lower than the average analyst forecast. Specifications (5) and (6) report the estimated coefficients for the sample of high-performance firms, and specifications (7) and (8) report the estimated coefficients for the sample of low-performance firms. The negative coefficients on both flu dummy and flu intensity for the high-performance firms and the positive coefficients for the low performance firms imply that during flu seasons analysts are more likely to over-forecast the performance for the "strong" firms and under-forecast the performance for the "weak" firms. In other words, flu-distracted analysts tend to be more optimistic when analyzing the high-performance company stocks and more pessimistic when analyzing the low-performance company stocks. We attribute this behavior to the limited attention or effort that analysts paid to their research due to the distraction from influenza-induced pains.

It should be noted that the above results do no control for firm characteristics; therefore, we add other factors being documented in prior research that can also influence analyst forecast behavior, such as firm size (log total assets), profitability (ROA), leverage (asset to equity ratio), growth opportunity (market to book ratio), and investment (R&D expense to asset ratio). We re-run the regressions and report the results in Table IV.

[Insert Table IV Here]

Specifications (1) to (8) provide similar coefficient estimates for the variables of interest, and hence we conclude that flu affects analyst forecast behavior in a significant way even after controlling for firm characteristics.

V. ROBUSTNESS

It can be argued and observed that not everybody caught the flu in the flu seasons because they may have been vaccinated. In other words, we are concerned with possible robustness in the actual occurrence of flu-induced pain and distraction during flu epidemics in the New York Metropolitan area (NY and NJ). To specifically address this concern, we obtain the vaccine side-effect data and examine whether the pains caused by the vaccine not necessarily the flu itself can affect analyst forecast behavior. The regression specifications in Table V are similar to the ones in Table III and IV.

[Insert Table V Here]

The coefficient estimates for flu dummy and flu intensity in Table IV confirm the findings that are reported in previous section.

VI. CONCLUSION

Despite a large body of empirical studies on how human beings are limited in their ability to process information and to perform multiple tasks simultaneously, prior literature of examining the relation between limited attention and financial markets is scarce, and little research has been done into aspects of limited attention due to exogenous reasons. This study provides the direct evidence that limited attention caused by exogenous shocks influences financial market participants. Specifically, we examine the changes of analyst forecast behavior during flu epidemics when analysts are facing attention limits resulted from the distraction of experiencing flu symptoms by themselves, family members, relatives or colleagues. Because of this limited attention or effort allocated to their analysis work, financial analysts' ability to act as an important source of information revelation is reduced for at least a short period of time.

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We do not argue that the flu-induced pain, such as coughing, muscle pains, or fevers, impairs the stock markets directly during flu epidemics. Instead, it is likely that the flu symptoms distract the attention of these financial market participants (analysts), and in turn make them unable to act as an additional source of information revelation during these periods, offering more optimistic recommendations for the high-performing stocks and more pessimistic recommendations for the low-performing stocks. This interpretation is similar to the prior findings that the incidence of influenza in the greater New York City area reduces trading activity and volatility.

Given that the financial market plays a central role of price discovery and the majority of prior research only studies the effect of market makers' behavior on price formation, this article seeks to present a contribution by focusing on a temporary irrational behavior exhibited by a special group of market participants that can influences other participants' investment decisions. Such an update in the literature is critical to assess the impact of limited attention on the information revelation process in the financial market.

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Table I. Variable definitions and summary statistics

Variable	Definition	Mean	Standard Deviation	Min	Max
Forecast Dispersion	Standard deviation of all analyst forecasted target prices divided by the average target price	0.155	0.133	0	3.457
Forecast Surprise	Absolute difference between the realized stock price in one year and the forecasted target price divided by the average target price	0.527	3.072	0	798.9
Forecast Surprise with Sign	Difference between the realized stock price in one year and the forecasted target price divided by the average target price	0.101	3.116	-19.77	798.9
Flu Dummy	Dummy variable with value being one if the difference between the flu incidence levels in NY/NJ and IA/KS/MO/NE regions is above average, flu intensity	0.205	0.404	0	1
Flu Intensity (%)	Actual difference between the flu incidence levels in NY/NJ and IA/KS/MO/NE regions	-0.074	3.243	-19.16	17.41
Vaccine Side-effect	Dummy variable with value being one if the difference between the vaccine adverse incidence levels in NY/NJ and IA/KS/MO/NE regions is above average	0.299	0.458	0	1
Number of Forecasts	Number of analysts providing forecast for target price	5.642	4.914	1	49
Log Total Assets	Natural log of total assets	7.110	1.959	0.001	14.94
Leverage	Total assets divided by total equities	10.11	673.5	1	87,701
Market to Book	Equity market value divided by the book value	5.426	248.4	0	44,843
ROA	Net income divided by total assets	0.016	0.516	-11.66	184.2
R&D to Asset	R&D expenses divided by total assets	0.039	0.094	0	3.704

Table II. Correlation matrix

	Forecast Dispersion	Forecast Surprise	Forecast Surprise with Sign	Flu Dummy	Flu Intensity	Vaccine Side-effect	Number of Forecasts	Log Total Assets	Leverage	Market to Book	ROA
Forecast Surprise	0.077										
Forecast Surprise with Sign	-0.018	0.871									
Flu Dummy	-0.032	0.010	-0.003								
Flu Intensity	-0.003	-0.002	-0.007	0.260							
Vaccine Side-effect	0.059	0.048	-0.005	-0.186	-0.099						
Number of Forecasts	-0.023	-0.047	0.000	-0.028	-0.001	-0.037					
Log Total Assets	-0.164	-0.066	0.052	-0.002	-0.004	-0.020	0.481				
Leverage	0.002	-0.000	-0.002	-0.001	-0.000	0.001	-0.004	0.005			
Market to Book	-0.000	-0.000	-0.001	-0.001	-0.001	0.000	-0.001	0.001	0.892		
ROA	-0.244	-0.016	0.117	-0.000	-0.001	-0.027	0.105	0.195	-0.007	-0.001	
R&D to Asset	0.193	0.029	-0.068	0.002	-0.000	0.005	-0.034	-0.367	-0.004	0.001	-0.459

Table III. Regressions of analyst forecasts and flu epidemics

The dependent variable is analyst forecast dispersion in specifications (1) and (2) and forecast surprise in specifications (3) to (8). Analyst forecast dispersion is measured by the standard deviation of all analyst forecasted target prices divided by the average target price. Forecast surprise is measured by the absolute difference between the realized stock price in one year and the forecasted target price divided by the average target price. Specifications (3) and (4) include both positive and negative forecast surprises, whereas specifications (5) and (6) only include high-performing stocks and specifications (7) and (8) only include low-performing stocks. The independent variables include the flu dummy variable with value being one if the difference between the flu incidence levels in NY/NJ and IA/KS/MO/NE regions is above average, flu intensity (actual difference between the flu incidence levels in NY/NJ and IA/KS/MO/NE regions, the number of analysts providing forecasts for each firm in a month, and forecast dispersion defined above. All specifications use OLS regression with year, month and industry fixed effects and firm-level clustered standard error. t-statistics are shown in the parentheses with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Dependent Variable:	Forecast Dispersion		Forecast Surprise (1-year Realized Price relative to Target Price)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Flu Dummy	-0.012*** (-19.08)		-0.0012 (-0.297)		-0.019** (-2.336)		0.026*** (16.73)	
Flu Intensity		-0.0001** (-2.012)		0.0002 (0.617)		-0.0026*** (-4.247)		0.0022*** (17.10)
Number of Forecasts	-0.001*** (-5.568)	-0.001*** (-5.579)	-0.008*** (-4.806)	-0.008*** (-4.806)	-0.012*** (-3.120)	-0.012*** (-3.121)	-0.006*** (-17.29)	-0.006*** (-17.26)
Forecast Dispersion			0.329*** (6.192)	0.330*** (6.196)	0.641*** (4.419)	0.643*** (4.429)	0.341*** (32.29)	0.339*** (32.13)
Constant	0.130*** (9.680)	0.124*** (9.173)	0.666*** (5.062)	0.666*** (5.056)	0.923*** (6.406)	0.912*** (6.324)	0.397*** (4.579)	0.416*** (4.803)
Year Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE (Firm ID)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	304,971	304,971	304,971	304,971	125,888	125,888	178,684	178,684
Adj. R-square	0.106	0.105	0.045	0.045	0.071	0.071	0.226	0.226

Table IV. Regressions of analyst forecasts and flu epidemics with firm characteristics

The dependent variable is analyst forecast dispersion in specifications (1) and (2) and forecast surprise in specifications (3) to (8). Analyst forecast dispersion is measured by the standard deviation of all analyst forecasted target prices divided by the average target price. Forecast surprise is measured by the absolute difference between the realized stock price in one year and the forecasted target price divided by the average target price. Specifications (3) and (4) include both positive and negative forecast surprises, whereas specifications (5) and (6) only include high-performing stocks and specifications (7) and (8) only include low-performing stocks. The independent variables include the flu dummy variable with value being one if the difference between the flu incidence levels in NY/NJ and IA/KS/MO/NE regions is above average, flu intensity (actual difference between the flu incidence levels in NY/NJ and IA/KS/MO/NE regions, the number of analysts providing forecasts for each firm in a month, forecast dispersion defined above, log total assets, market-to-book ratio, leverage, ROA, and R&D expense to total asset ratio. All specifications use OLS regression with year, month and industry fixed effects and firm-level clustered standard error. t-statistics are shown in the parentheses with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Dependent Variable:	Forecast Dispersion		Forecast Surprise (1-year Realized Price relative to Target Price)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Flu Dummy	-0.012*** (-19.40)		-0.0016 (-0.398)		-0.021** (-2.531)		0.026*** (16.57)	
Flu Intensity		-0.0001** (-2.067)		0.0002 (0.674)		-0.0026*** (-4.210)		0.0022*** (17.58)
Number of Forecasts	0.001*** (3.347)	0.001*** (3.334)	-0.004* (-1.776)	-0.004* (-1.776)	-0.007 (-1.528)	-0.008 (-1.530)	0.001** (2.152)	0.001** (2.184)
Forecast Dispersion			0.312*** (5.451)	0.312*** (5.453)	0.692*** (4.393)	0.694*** (4.402)	0.233*** (20.43)	0.231*** (20.27)
Log Total Assets	-0.006*** (-7.879)	-0.006*** (-7.875)	-0.021*** (-2.651)	-0.020*** (-2.651)	-0.031* (-1.676)	-0.030* (-1.673)	-0.028*** (-22.07)	-0.028*** (-22.08)
Market to Book	-5.0e-06** (-2.298)	-5.1e-06** (-2.333)	3.9e-06 (0.480)	3.9e-06 (0.479)	-5.3e-05 (-0.459)	-5.4e-05 (-0.464)	1.9e-05*** (4.049)	1.9e-05*** (3.957)
Leverage	1.7e-06*** (2.596)	1.7e-06*** (2.620)	-1.5e-06 (-0.546)	-1.4e-06 (-0.545)	2.4e-05 (0.444)	2.5e-05 (0.450)	-1.9e-06** (-2.406)	-1.9e-06** (-2.341)
ROA	-0.139*** (-9.062)	-0.139*** (-9.063)	0.0606 (1.567)	0.0606 (1.566)	0.606*** (3.401)	0.606*** (3.401)	-0.195*** (-7.445)	-0.195*** (-7.442)
R&D to Asset	0.0764*** (3.394)	0.0763*** (3.390)	0.156* (1.729)	0.156* (1.728)	0.582* (1.727)	0.581* (1.726)	-0.000736 (-0.0223)	-0.000531 (-0.0161)
Constant	0.172*** (10.97)	0.166*** (10.52)	0.789*** (5.268)	0.788*** (5.261)	1.035*** (5.122)	1.022*** (5.062)	0.594*** (6.801)	0.613*** (7.020)
Year Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE (Firm ID)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	304,971	304,971	304,971	304,971	125,888	125,888	178,684	178,684
Adj. R-square	0.156	0.155	0.046	0.046	0.073	0.073	0.283	0.282

Table V. Regressions of analyst forecasts and vaccine side-effects

The dependent variable is analyst forecast dispersion in specifications (1) and (2) and forecast surprise in specifications (3) to (8). Analyst forecast dispersion is measured by the standard deviation of all analyst forecasted target prices divided by the average target price. Forecast surprise is measured by the absolute difference between the realized stock price in one year and the forecasted target price divided by the average target price. Specifications (3) and (4) include both positive and negative forecast surprises, whereas specifications (5) and (6) only include high-performing stocks and specifications (7) and (8) only include low-performing stocks. The independent variables include the vaccine side-effect dummy variable with value being one if the difference between the vaccine adverse incidence levels in NY/NJ and IA/KS/MO/NE regions is above average, the number of analysts providing forecasts for each firm in a month, forecast dispersion defined above, log total assets, market-to-book ratio, leverage, ROA, and R&D expense to total asset ratio. All specifications use OLS regression with year, month and industry fixed effects and firm-level clustered standard error. t-statistics are shown in the parentheses with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Dependent Variable:	Forecast Dispersion		Forecast Surprise (1-year Realized Price relative to Target Price)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Vaccine side-effect	0.003*** (7.415)	0.003*** (7.593)	-0.004 (-1.524)	-0.004 (-1.406)	-0.008 (-1.301)	-0.008 (-1.332)	0.016*** (15.03)	0.017*** (16.27)
Number of Forecasts	-0.001*** (-5.571)	0.001*** (3.343)	-0.008*** (-4.807)	-0.004* (-1.776)	-0.012*** (-3.120)	-0.008 (-1.528)	-0.006*** (-17.24)	0.001** (2.232)
Forecast Dispersion			0.330*** (6.199)	0.312*** (5.455)	0.643*** (4.432)	0.694*** (4.405)	0.339*** (32.07)	0.231*** (20.20)
Log Asset		-0.006*** (-7.878)		-0.021*** (-2.651)		-0.030* (-1.674)		-0.028*** (-22.11)
Market to Book		-5.1e-06** (-2.324)		3.8e-06 (0.478)		-5.3e-05 (-0.465)		1.9e-05*** (4.014)
Leverage		1.7e-06*** (2.613)		-1.5e-06 (-0.544)		2.5e-05 (0.450)		-1.9e-06** (-2.410)
ROA		-0.139*** (-9.061)		0.0606 (1.567)		0.606*** (3.402)		-0.195*** (-7.440)
R&D to Asset		0.0763*** (3.390)		0.156* (1.728)		0.581* (1.724)		-0.001 (-0.0162)
Constant	0.122*** (9.025)	0.164*** (10.39)	0.668*** (5.076)	0.791*** (5.286)	0.921*** (6.346)	1.032*** (5.114)	0.397*** (4.580)	0.594*** (6.788)
Year Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE (Firm ID)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	304,971	304,971	304,971	304,971	125,888	125,888	178,684	178,684
Adj. R-square	0.105	0.155	0.045	0.046	0.070	0.073	0.226	0.282