

# Market efficiency in real time<sup>☆</sup>

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## Abstract

The Morning Call and Midday Call segments on CNBC TV provide a unique opportunity to study the efficient market hypothesis. The segments report analysts' views about individual stocks and are broadcast when the market is open. We find that prices respond to reports within seconds of initial mention, with positive reports fully incorporated within one minute. Trading intensity doubles in the first minute, with a significant increase in buyer- (seller-) initiated trades after positive (negative) reports. Traders who execute within 15 seconds of the initial mention make small but significant profits by trading on positive reports during the Midday Call. © 2002 Elsevier Science B.V. All rights reserved.

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## 1. Introduction

Beginning with Fama (1970), an efficient capital market is characterized as one in which security prices fully reflect all available information. In practice, prices do not respond instantaneously to news, and several studies gauge market efficiency by the speed with which prices react. For example, Patell and Wolfson (1984), Jennings and Starks (1985), and Barclay and Litzenberger (1988) examine the price response to corporate announcements, including earnings, dividends, and seasoned equity offerings, and Dann et al. (1977) study the price response to large trades. These

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studies find that prices incorporate news within five to 15 minutes, which the authors consider to be “very quick.” Other work examines the price response to analyst recommendations. Lloyd Davies and Canes (1978) find that the publication of analyst recommendations significantly impacts prices for two days. More recently, Kim et al. (1997) find that stock prices reflect the information in buy recommendations released before the market opens within five to 15 minutes after the opening.

Profound changes have taken place in securities markets since the early studies of market efficiency. Financial information is more readily available to market participants, trading costs have fallen considerably, and technology has accelerated the pace at which markets operate. A liquid stock can trade hundreds of times in five minutes. Does it still take five minutes for prices to incorporate information? How long do short-term trading opportunities exist? In this article we examine a unique data set of intraday information releases, coupled with trade and quote data, to shed light on market efficiency within the trading day.

Specifically, we study the response of stock prices and trading when a stock is featured on the Morning Call or Midday Call segment on the cable television financial news provider CNBC. The segments report the opinions of security analysts and are designed to inform viewers of developments affecting individual stocks or the market as a whole. Our sample is unique because the CNBC call segments air while the stock market is open, and we can record precisely when the stocks are discussed. The data enable us to extend previous research by studying the second-by-second process through which prices incorporate the wide dissemination of analysts’ views.

Summarizing the results, we analyze 322 stocks featured on the Morning Call and Midday Call segments. We find that stocks discussed positively experience a statistically and economically significant price impact beginning seconds after the stock is first mentioned and lasting approximately one minute. The response to negative reports is more gradual, lasting 15 minutes, perhaps due to the higher costs of short selling. Overall, the price response pattern is similar to the pattern of abnormal performance in work on traditional analyst recommendations, such as Womack (1996), only measured in minutes instead of days or months.

We also find compelling evidence that some viewers trade based on the information in the segments. Trading intensity more than doubles in the minute after the stock is first mentioned, with a significant increase in the number of buyer-(seller-) initiated trades following positive (negative) reports. Furthermore, after controlling for trading costs we find that traders who execute a trade within 15 seconds of the initial mention generate small but significant short-term profits following positive reports during the Midday Call. In contrast, Barber et al. (2001) find that transaction costs subsume all abnormal returns associated with trading strategies based on consensus analyst recommendations. However, Barber et al.’s (2001) strategies transact at the closing price on the day of the recommendation, rather than within seconds of the news.

As technological advancements in financial markets have shortened our perception of “very quickly” since Patell and Wolfson (1984), our results show that the amount of time necessary for prices to incorporate news has also decreased.

In addition, we highlight the role that active traders play in ensuring that prices respond quickly to information. The small profits available to very short horizon traders are consistent with compensation for continuously monitoring information sources, as modeled in a broader sense by Grossman and Stiglitz (1980).

The remainder of the paper proceeds as follows. Section 2 describes the information releases, the quote and trade data, and the methodology. Section 3 examines the speed at which prices incorporate the information and describes characteristics of the price impact. Section 4 examines trading activity and the profitability of short-term trading strategies. Section 5 concludes.

## **2. Data and methodology**

We examine the intraday broadcast of analyst opinions on the cable television financial news provider CNBC. CNBC TV was launched in 1989 as the Consumer News and Business Channel and has steadily gained prominence as a provider of financial news. According to Nielsen ratings, CNBC became the most-watched network for business day programming during the fourth quarter of 1999, surpassing CNN. Although viewership data are unavailable for viewers outside the home, widespread anecdotal evidence testifies to CNBC's impact on the financial community. For instance, Kurtz (2000) states "television sets across the [NYSE] trading floor flicker with [CNBC host] Bartiromo's image, her screen presence more powerful than the slight figure on the floor would suggest. One reason CNBC began using closed captioning in its telecasts was that brokers complained they had trouble hearing the program on the floor."

CNBC provides business and financial news throughout the day. For simplicity and consistency we focus on the Morning Call and Midday Call analyst call segments. The Morning Call typically airs between 11:05 a.m. and 11:10 a.m. EST, whereas the Midday Call airs between 2:53 p.m. and 2:58 p.m. EST. The segments usually last less than two minutes. During our sample period the segments are hosted exclusively by two anchors. Consuelo Mack hosts the Morning Call and Maria Bartiromo hosts the Midday Call. A sample Midday Call segment, along with the corresponding price response, can be viewed at [www.bus.emory.edu/cgreen/cnbc.html](http://www.bus.emory.edu/cgreen/cnbc.html).

The titles "Morning Call" and "Midday Call" derive from the name given to security analysts' notes distributed audibly over public announcement systems within their firms and later to the firm's customers. Womack (1996) provides a more detailed discussion of analyst calls. In each segment the host reports the opinions of one or more security analysts. The reports are designed to inform viewers of market developments affecting individual stocks or the market as a whole. Topics include macroeconomic conditions as well as information about a firm or a number of firms. For example, analyst topics discussed during the Midday Call might include initiations of coverage, confirmation or refutation of rumors about impending earnings releases, or optimism about an upcoming company meeting with analysts.

The call segment hosts anchor (or co-anchor) the news desk at the time of the segment. Before their programs air or during commercial breaks, the segment hosts

telephone their contacts at investment banks (and their customers) to obtain information for the upcoming analyst call segment. In their role as financial news reporters, the CNBC anchors would like to provide new information to their viewers, which creates a dilemma for analysts. Analysts must choose between providing information first to CNBC or to their customers. The benefit of giving CNBC first access to information is exposure, both for the analyst and the firm. For example, although clients of Goldman Sachs want access to analysts' opinions before they see them on CNBC, Goldman maintains its prominence as an investment bank in part through exposure in media like CNBC. Beneish (1991) provides a lengthier discussion of the incentives of analysts to provide information to financial reporters ahead of their customers. Financial reporters display skill through the quality of their network of contacts and by discerning which pieces of information are pertinent to the market (i.e., filtering out noise).

To collect our sample, we videotape CNBC each trading day from June 12 through October 27, 2000, a 20-week period during which the market was relatively flat (the S&P 500 and Nasdaq 100 indexes fell by 4.5% and 15.4%, respectively, but most of the losses accumulated during October). Segments do not air when the host is not present, and neither segment airs on market holidays. The sample consists of 322 stock reports over 84 different trading days. We record the starting time of each report (to the second) when the ticker symbol is initially shown on screen or verbalized, and we define this as time zero in event time. If a ticker symbol is not given, we record the time at which the name of the company is first disclosed.

To determine the precise time at which the segment airs, we intersperse recordings of CNBC with recordings of the TV Guide Channel (which continuously displays time of day). We then use the videocassette-recorder counter to measure the elapsed time from the TV Guide Channel benchmark. Since the TV Guide Channel clock is inaccurate at times, each day we measure the difference between the TV Guide Channel clock and the time shown on [www.time.gov](http://www.time.gov) (an atomic clock that is very precise), and then factor this into our time stamps. After numerous trial recordings, we are confident that we record the timing of the broadcasts to within a few seconds.

In addition to recording the time at which each segment airs, we record the stock price if it is disclosed (on screen or verbally) and whether a historical price chart for the company is shown. We also record the change in the Dow Jones Industrial Average from the previous day's 4:00 p.m. close and the change in the Nasdaq Composite Index from the previous day's 4:00 p.m. close, both of which are always shown on screen.

We assess whether the sentiment of each stock report is positive or negative. Although our assessment is subjective, the tone of the report is usually unambiguous. We do however exclude 22 reports because the sentiment expressed during the segment is mixed. From Bloomberg we obtain the exchange listing for each stock (NYSE, AMEX, or Nasdaq), the number of shares outstanding (to compute market capitalization), the North American Industry Classification System (NAICS) code, and whether the company has positive or negative earnings at the time of the airing.

Table 1 provides descriptive statistics of the stock reports. Compared to the Morning Call, the Midday Call reports on fewer, smaller firms during each segment.

Table 1

Descriptive statistics of CNBC call reports

The table shows characteristics of on-air stock reports during the Morning Call and Midday Call segments on CNBC. The data cover 322 stock reports from June 12, 2000 through October 27, 2000.

	Morning Call	Midday Call
<i>Panel A: Report characteristics</i>		
Stock reports	174	148
Average reports per segment	4.3	2.3
Positive reports	155	125
Negative reports	19	23
Price chart displayed	11	78
Price chart not displayed	163	70
Nasdaq index up for the day	85	79
Nasdaq index down for the day	89	69
Dow index up for the day	74	89
Dow index down for the day	100	59
<i>Panel B: Firm characteristics</i>		
NYSE-listed	102	109
Nasdaq-listed	71	39
AMEX-listed	1	0
Median market capitalization (in \$millions)	47,807	16,680

Both programs typically report positive information about firms, consistent with the usual sentiment of analyst recommendations. The small number of negative reports decreases the power of our tests to detect significant price changes following negative information. The CNBC reports focus on large companies—more than 80% of the stock reports discuss firms that are in the top two NYSE market capitalization deciles. Since large firms are generally more liquid, our results represent an upper bound on the speed with which prices respond to information.

### 2.1. Price data and methodology

The intraday price and transaction data are from the Trade and Quote (TAQ) database, which is made available by the NYSE. TAQ provides time-stamped trades and quotes observed on the NYSE, Nasdaq, and other regional exchanges. TAQ does not have information on bulletin board stocks, and we omit one stock report for this reason. Unless otherwise noted, we measure returns as the percentage price change from the midquote (average of the bid and ask prices) in effect at the time considered. Chordia et al. (2001) point out that TAQ contains autoquotes (passive quotes by secondary market dealers), which do not reflect actual trading costs. As in Chordia et al. we filter out passive autoquotes by using only primary market quotes.<sup>1</sup>

<sup>1</sup> By omitting all quotes from secondary exchanges, we likely overstate trading costs, since a regional exchange could post the National Best Bid or Offer.

We use NYSE quotes for NYSE-listed securities, AMEX quotes for AMEX-listed securities, and Nasdaq inside quotes for Nasdaq-listed securities.

When examining intraday price changes, we calculate raw percentage price changes, although the results from using abnormal returns are not materially different. When considering daily price changes, we measure abnormal returns two ways. First, we take the difference between the total stock return and the return on an equal-weighted portfolio of stocks with the same Standard Industrial Classification (SIC) code and from the same NYSE market capitalization decile. Like Womack (1996), we match stocks based on four-digit SIC codes. If fewer than two stocks match the size and SIC code criteria, we match based on size and three-digit SIC code. Our second measure of daily abnormal performance is the residual from a market model regression of stock returns against the Center for Research in Security Prices (CRSP) value-weighted NYSE/AMEX/Nasdaq market portfolio.

We calculate standard errors for daily measures of abnormal performance using standard event-study methodology (see, for example, Brown and Warner, 1985). Since intraday returns are not normally distributed, we rely on the nonparametric bootstrap algorithm in Barclay and Litzenberger (1988) to determine the statistical significance of mean intraday price changes. Specifically, consider  $n$  cross sectional returns  $(R_1, R_2, \dots, R_n)$  with sample mean  $\bar{R}$  drawn from an unknown distribution  $F$ . In order to estimate  $p \equiv \text{Prob}(\bar{R} > K)$  for some constant  $K$ , we use the following algorithm:

- (1) Estimate the distribution of  $F$  with the nonparametric empirical distribution  $\hat{F}$  putting probability  $1/n$  on each  $R_i$ .
- (2) Draw a bootstrap sample from  $\hat{F}(R_1^*, R_2^*, \dots, R_n^*)$  where each  $R_i^*$  is drawn randomly with replacement from the observed values  $(R_1, R_2, \dots, R_n)$ , and calculate  $\bar{R}^*$ .
- (3) Independently, repeat step (2) 10,000 times, obtaining  $\bar{R}^{*1}, \bar{R}^{*2}, \dots, \bar{R}^{*10,000}$ , and calculate

$$p \equiv \text{Prob}(\bar{R} > K) = \frac{\text{Number of times } \bar{R}^* > K}{10,000}. \quad (1)$$

The empirical bootstrap  $p$ -value for a one-sided hypothesis test  $H_0: \bar{R} > K$  is computed as  $1 - p$ . We also calculate two-sided  $t$ -tests and find similar results.

To examine the profitability of short-term trading based on the information in the CNBC reports, we identify trades as buyer- or seller-initiated by comparing the trade price to the prevailing bid and ask quotes. Recent research suggests refinements to the widely used Lee and Ready (1991) algorithm for matching transaction prices with quotes. We follow Ellis et al. (2000) and Bessembinder (2001) and compare transaction prices to the prevailing quotes at the time the trade is recorded (i.e., without a lag). We find, however, that the results are very similar when we use the Lee and Ready (1991) algorithm. When a trade occurs within the prevailing bid–ask spread, we rely on the tick rule. The tick rule classifies a trade as buyer-initiated if it occurs on an uptick or a zero-uptick (i.e., no price change on the current trade but the previous trade occurred on an uptick), and as seller-initiated if it occurs on a downtick or a zero-downtick.

To measure the effect of CNBC reports on the direction of submitted market orders, we calculate aggregate order imbalances using a measure similar to Hvidkjaer (2000). Specifically, we measure order imbalance as

$$IMBAL_{it} = \frac{nBuys_{it} - nSells_{it}}{nBuys_{it} + nSells_{it}}, \quad (2)$$

where  $nBuys_{it}$  is the number of buyer-initiated trades during time interval  $t$  around report  $i$ .  $nSells_{it}$  is defined similarly. Thus,  $IMBAL_{it} = 1$  implies all trades are buyer-initiated and  $IMBAL_{it} = -1$  implies all trades are seller-initiated. Although standard in the literature, this measure of order imbalance is more accurately described as trade imbalance because the TAQ database does not indicate whether an executed trade was part of a larger order.

We measure statistical differences in trading intensity and order imbalances with the two-sample Kolmogorov–Smirnov test. The two-sample Kolmogorov–Smirnov test is a test of whether two independent samples are from populations with the same distribution. We use a one-tailed test to determine whether the data from one of the samples are stochastically larger than the data from the other sample. In particular, let  $S_m(X)$  be the observed cumulative distribution for one sample (of size  $m$ ), that is,  $S_m(X) = K/m$ , where  $K$  is the number of data less than or equal to  $X$ . Let  $S_n(X)$  be similarly defined for the second sample of size  $n$ . The Kolmogorov–Smirnov two-sample one-sided test statistic is given by  $D_{m,n} = \max[S_m(X) - S_n(X)]$ . For  $m$  and  $n$  greater than 25, the statistic  $X^2 = 4D_{m,n}^2 [mn/(m+n)]$  is approximated by a chi-squared distribution with two degrees of freedom. See Siegel and Castellan (1988). Two-sample  $t$ -tests give similar results.

### 3. Price response to analyst reports

#### 3.1. Magnitude of price response

Fig. 1 shows the price response of stocks featured on the CNBC call segments. We measure average returns cumulatively beginning 15 minutes before the stock is first mentioned on-air, and we plot returns separately for positive and negative, Morning and Midday Call reports. Overall, the price response is consistent with the sentiment of the news, but marked differences exist in the magnitude of the responses. Positive reports during the Midday Call lead to a significant price increase. The cumulative return from 15 minutes before to one minute after the event is 62 basis points, of which 41 basis points occur during the first minute after the event. Seventy-three percent of the firms discussed positively during the segment have a positive one-minute return, with an average increase of \$109 million in market capitalization.

The one-minute response is followed by a small reversal over the next three minutes, which is consistent with initial overreaction. The average return from one to four minutes after the event is  $-12$  basis points and is statistically significant at the 5% level. Reversals in the initial price response to analyst recommendations are documented at the daily level by Stickel (1985) for *Value Line* ranking changes, and

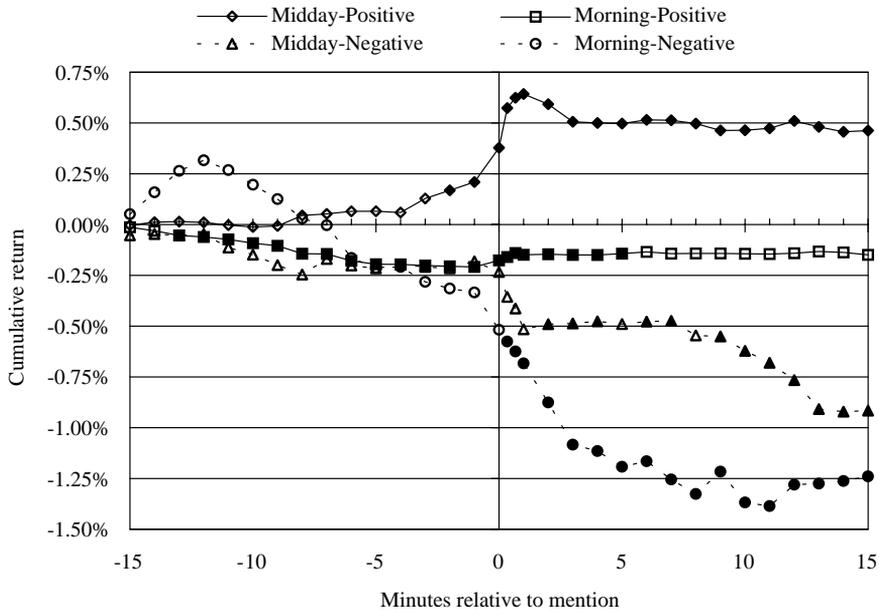


Fig. 1. Stock price reaction to CNBC reports. The figure shows the reaction of stock prices to on-air stock reports during the Morning Call and Midday Call segments on CNBC. The chart plots cumulative returns beginning 15 minutes before the stock report. The plot partitions reports into groups depending on whether the reports are positive or negative. A solid marker denotes that the cumulative average return is significantly different from zero at the five percent level using bootstrap empirical  $p$ -values. The data cover 322 stock reports from June 12, 2000 through October 27, 2000.

by Barber and Loeffler (1993) and Liang (1999) for stock picks in the *Wall Street Journal's* Dartboard column. For instance, Stickel finds positive abnormal returns for two days following publication of the *Value Line* rankings, and then a reversal on day three. Compared to previous research, we find that prices respond more quickly: a positive return in the first two minutes, with a partial reversal in the third minute.

The response of positive reports during the Morning Call is less dramatic. Although the average one-minute return after the event is positive (6.8 basis points), the cumulative half-hour return is negative. The small response to positive reports during the Morning Call suggests that the segment provides information that is either not highly relevant or not new.

Negative reports elicit a larger but more gradual response. The one-minute price change after negative reports during the Morning Call and Midday Call is  $-29$  basis points and  $-23$  basis points, respectively, whereas the 15-minute returns are  $-93$  and  $-75$  basis points. The delayed response could reflect the higher costs of short selling.

Jurgens (2000), by comparison, studies the price response to analysts' upgrades and downgrades distributed through First Call, a real-time PC-based subscriber service used by professional investors. She finds a 0.79% price increase for upgrades and a 0.83% price decrease for downgrades in the half hour surrounding the release on First Call, which are similar in magnitude to the 0.46% and  $-0.92\%$  half hour

returns for the Midday Call in Fig. 1. In contrast, Kim et al. (1997) examine analysts' initiations of coverage with a buy recommendation, as reported through the Dow Jones News Wire, and find no price response to the newswire story. These results suggest that the market considers analysts' views reported during the Midday Call to be informative, similar to semi-private information services such as First Call, rather than redundant like the newswire.

The significant run up in prices before positive Midday Call reports is also interesting. The five-minute average return before positive reports is positive and significant. The run up in prices before the report is consistent with some market participants' awareness of the information before the segment airs. Analysts who share their views with the host of the Midday Call are also likely to share their views with clients, who can trade on the information before it is broadcast.

### 3.2. *Speed of price response*

To measure the speed of price response to the CNBC reports, Table 2 shows stock price changes over short intervals following the report. Prices respond significantly to positive and negative Morning and Midday Call reports in the first 15-second interval following the event. The reaction to positive reports continues for 45–60 seconds. This response pattern is considerably faster than the price response documented in earlier work. For instance, Kim et al. (1997) find a 10- to 15-minute price response to initiations of coverage with a buy recommendation.

The response to negative reports is more gradual. The 15-second intervals following negative events are negative and significant for both the Morning Call and the Midday Call. Prices generally trend downward over the next 15 minutes, and several price changes are significantly negative. Taken together with Fig. 1, these results indicate about a 15-minute response to negative reports. However, we should caution that our relatively small sample size leads to higher standard errors, making it difficult to estimate the precise speed of price adjustment and, in particular, when adjustment ceases.

The extended reaction to negative reports is consistent with the pattern in earlier, lower frequency studies. For example, Womack (1996) finds positive abnormal performance following positive recommendations for a month after the recommendation. On the other hand, Womack finds that negative recommendations exhibit negative abnormal performance for six months. We find that prices reflect positive reports within one minute, whereas prices take 15 minutes to reflect negative information.

Jennings and Starks (1985) find that the speed of response to earnings announcements depends on how informative the release is. To examine whether the speed of response to the CNBC segments varies with the content of the report, we recalculate the results in Table 2, partitioning the reports into two groups. One group contains reports accompanied by price charts, typically shown during longer, more detailed reports. The other group contains reports without the price charts. The speed of the price response is similar regardless of whether or not a price chart is shown.

Table 2

## Speed of price adjustment to CNBC reports

The table reports average percentage price changes following on-air stock reports during the Morning Call and Midday Call segments on CNBC. We calculate price changes over each interval, where the interval begins where the previous interval ends. For example, the interval labeled 0.25 corresponds to the price adjustment from 0 to 0.25 minutes. One and two stars denote significance at the five and one percent level, respectively, using bootstrap empirical  $p$ -values. The data cover 322 stock reports from June 12, 2000 through October 27, 2000.

Minutes relative to report	Morning Call		Midday Call	
	Positive reports	Negative reports	Positive reports	Negative reports
–15 to –10	–0.073%	0.268%	–0.003%	–0.113%
–10 to –5	–0.106**	–0.431**	0.068	–0.090
–5 to 0	–0.030	–0.170	0.143*	0.020
0.25	0.024**	–0.136**	0.108**	–0.044*
0.50	0.014*	–0.072	0.193**	–0.066*
0.75	0.014	–0.045	0.075**	–0.073**
1.00	0.016*	–0.040	0.037*	–0.051**
1.25	–0.007	0.018	0.017	–0.030
1.50	0.002	0.004	0.015	–0.067*
1.75	–0.011	–0.076*	0.007	–0.005
2.00	0.007	–0.005	–0.021	0.001
2.25	0.010	–0.050	–0.021	0.012
2.50	–0.005	–0.025	–0.014	0.006
2.75	–0.001	–0.037*	–0.019	0.003
3.00	–0.002	–0.084*	0.004	0.006
3.25	0.005	–0.040	–0.023	–0.014
3.50	–0.004	–0.065*	–0.021	0.019
3.75	–0.008	–0.025	–0.024	0.014
4.00	0.005	–0.080**	–0.016	–0.016
4.25	–0.006	–0.008	–0.010	–0.002
4.50	–0.006	0.024	0.001	–0.001
4.75	–0.001	0.003	–0.015	–0.009
5.00	0.012	–0.048*	0.018*	0.023*
10.00	0.007	–0.102	–0.036	–0.076
15.00	0.005	–0.047	–0.007	–0.380**
30.00	0.035	–0.067	0.027	0.146

Also of interest is whether the speed of adjustment is best measured in calendar time or by the number of trades. If dealers do not observe the stock reports, they will shift prices in response to order imbalances that arise following the stock reports. We would then expect less liquid stocks to respond more quickly to the reports because their prices would be more sensitive to order flow. On the other hand, if viewers are more likely to trade stocks with which they are familiar, then larger trade imbalances could exist for larger and more liquid stocks. Thus, *ex ante*, the relation between speed of response and trading is ambiguous.

To examine the relation between speed of response and trading activity, we first divide the stocks into two groups based on the median number of post-event trades.

The response pattern as a function of time is very similar for both groups. Second, we group the stocks into quartiles based on the relative increase in trading intensity following the reports compared to trading intensity in the hour before the report. The magnitude of the response varies across the quartiles, but the speed of response is similar. The results suggest that although post-event trading is an important element of the response, the speed of adjustment is adequately captured in calendar time.

### 3.3. Cross-sectional determinants of price impact

We next investigate the cross-sectional determinants of the size of the price response to CNBC reports. We regress price changes on characteristics of the report and the company.

#### 3.3.1. Report characteristics

Following Stickel (1992, 1995), who finds that the forecasts of the more reputable analysts outperform other analysts' forecasts, we first consider whether the reputation of the CNBC segment host influences the price impact. Maria Bartiromo, the host of the Midday Call, receives considerable attention in the media. A search for "Maria Bartiromo" in ABI/Inform (a database of newspapers and periodicals) results in 65 articles. Searching for "Consuelo Mack" results in six articles. Moreover, Kurtz (2000) describes Bartiromo as "the most famous woman in financial news, the reporter whom everyone on Wall Street call[s] by her first name." If Bartiromo's reputation reflects an ability to obtain newsworthy information, then we would expect stock reports during the Midday Call to elicit a larger price impact than reports during the Morning Call. We examine whether the afternoon segment impacts prices more than the morning segment by including a segment dummy variable. MIDDAY is 1 if the report airs during the Midday Call and 0 if the report airs during the Morning Call.

To examine whether more extensive reports lead to a larger price response, we consider two proxies. Price charts typically accompany more detailed reports and show the name of the company, the ticker symbol, and the year-to-date stock price plot. Thus, we include CHART, which is 1 if a historical stock price chart is displayed during the report and 0 otherwise. We also include the number of stocks discussed during the segment (NUMBER OF REPORTS), since each segment lasts approximately two minutes, and more stocks per segment generally equates to less time devoted to each company.

#### 3.3.2. Firm characteristics

The price response to the CNBC reports could also depend on firm characteristics. Our choice of specific firm characteristics is motivated by Amir et al. (1999), who find that analysts add more value for firms that report losses, for technology firms, and for small firms.

TECHNOLOGY and INTERNET are industry variables based on North American Industry Classification System (NAICS) codes, and are 1 if the firm

operates in the industry, 0 otherwise.<sup>2</sup> NEGATIVE EPS is 1 if the firm's most recently reported earnings per share is negative, 0 otherwise. We also create firm-size dummy variables based on CRSP NYSE market capitalization quintiles. Since there are only a small number of reports on small firms, we group the three smallest quintiles together into one category (totaling 10 positive reports and 6 negative reports). The regressions compare the marginal price impact of reports about smaller firms (in size QUINTILE 1–3 and QUINTILE 4) to the benchmark case of reports on large firms (in quintile 5).

### 3.3.3. Results

Based on the speed of adjustment evidence in Fig. 1 and Table 2, we examine one-minute price changes following positive reports and 15-minute price changes following negative reports. Table 3 reports the regression results.

The independent variables explain 40% of the one-minute price changes following positive CNBC call reports. The coefficient MIDDAY is a significant 23.4 basis points, which suggests that reports during the afternoon segment exert a greater impact on prices. The greater price impact following reports during the Midday Call suggests that viewers perceive the hosts as differing in ability to obtain market relevant information.

The regression evidence supports the conjecture that more detailed reports elicit a greater price response. The coefficient on CHART is 19.8 basis points and is statistically significant at the one percent level. Moreover, the coefficient on the number of reports is negative, but only marginally significant ( $p$ -value=0.053). Together, the coefficients suggest a relation between the magnitude of the price response and the amount of information in the report.

The sensitivity of the price response to firm characteristics is consistent with Amir et al.'s (1999) findings on the marginal contribution of analysts' forecasts. The coefficients on the TECHNOLOGY and INTERNET dummy variables are positive and significant, 17.1 and 43.9 basis points, respectively. Although the Nasdaq Index had fallen considerably from its highs prior to the sample period, the price impact remains larger for firms in industries associated with the bull market. This result could reflect analysts' comparative advantage in predicting the future financial prospects of these firms. The same argument applies to firms with negative earnings; the coefficient on NEGATIVE EPS is a significant 55.0 basis points.

Price impact also depends on firm size. Since less information is generally available for smaller firms, the market might rely more heavily on analyst research for these firms. The coefficient on QUINTILE 1–3 is positive and significant, 85.7 basis points, which suggests that prices especially respond to reports on smaller firms. The coefficient on QUINTILE 4 is also positive but not significantly different from zero.

The response to negative reports is less sensitive to the characteristics of the report. The independent variables explain 17% of the cross-sectional variation in price

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<sup>2</sup>The technology variable describes firms with NAICS codes 334, 51121, 51331, and 54152. The internet variable describes firms with NAICS codes 514191 and 45411. Descriptions for the NAICS codes are at [www.naics.com](http://www.naics.com).

Table 3

## Characteristics of price impact of CNBC reports

The table shows results of cross-sectional regressions of percentage returns following on-air stock reports during the Morning Call and Midday Call segments on CNBC. Panel A reports the results for positive reports and uses one-minute returns. Panel B reports the results for negative reports and uses 15-minute returns. MIDDAY is 1 if the stock report is during the Midday Call segment and 0 if the report is during the Morning Call. CHART is 1 if a historical stock price chart is displayed during the report and 0 otherwise. NUMBER OF REPORTS is the number of stocks discussed during that day's segment. TECHNOLOGY and INTERNET are industry dummy variables classified using the North American Industry Classification System, and are 1 if the firm operates in that industry, 0 otherwise. NEGATIVE EPS is 1 if the stock has a negative EPS at the time of the report, 0 otherwise. We construct the SIZE QUINTILE dummy variables from CRSP NYSE market capitalization quintiles, and they are 1 if the market capitalization of the firm falls into the designated quintile, 0 otherwise. We calculate standard errors using White's correction for heteroskedasticity. One and two stars denote significance at the five and one percent level, respectively. The data cover 322 stock reports from June 12, 2000 through October 27, 2000.

<i>Panel A: Positive reports</i>			
Observations	280	276	276
Adjusted $R^2$	0.160	0.248	0.405
Coefficients			
CONSTANT	0.146*	-0.047	-0.026
MIDDAY	0.202**		0.234**
CHART	0.236**		0.198**
NUMBER OF REPORTS	-0.017*		-0.016
TECHNOLOGY		0.178**	0.171**
INTERNET		0.439*	0.439*
NEGATIVE EPS		0.532*	0.550**
SIZE QUINTILE 1-3		0.827**	0.857**
SIZE QUINTILE 4		0.337*	0.226
<i>Panel B: Negative reports</i>			
Observations	42	42	42
Adjusted $R^2$	0.054	0.182	0.172
Coefficients			
CONSTANT	-0.889**	-0.334*	0.037
MIDDAY	0.284		-0.350
CHART	-0.719		-0.371
NUMBER OF REPORTS	-0.022		0.006
TECHNOLOGY		-0.855**	-0.970*
INTERNET		-1.537**	-1.197**
NEGATIVE EPS		-1.068**	-1.168**
SIZE QUINTILE 1-3		0.552	0.462
SIZE QUINTILE 4		0.000	-0.212

change, and the industry and earnings variables are the only variables that have explanatory power. However, the small sample size results in large standard errors, which reduces statistical significance. The slow reaction to the reports and insensitivity to characteristics of the report are also consistent with a price impact that is part of a gradual response to negative public news about a firm or industry, rather than a direct response to the report on CNBC.

### 3.4. Price impact over longer horizons

If stock recommendations lead to abnormal performance, what specifically drives the abnormal returns? Since brokerage firms often invest heavily in collecting and analyzing firm level data, analysts' research could uncover new information. In this case abnormal returns would represent a fundamental revaluation that persists over longer time periods. Alternatively, Barber and Loeffler (1993) argue that recommendations create temporary buying pressure from naïve investors, in which case the abnormal performance would later reverse. The price pressure hypothesis could be particularly relevant for CNBC reports, given its reputation in the popular press for influencing financial markets. See, for example, 'Wall Street's Hype machine,' *Business Week*, April 3, 2000; 'Hype is Hip on CNBC,' *Newsweek*, September 4, 2000; and 'There's No Business Like Business Show Business,' *Fortune*, May 24, 1999.

Although the cumulative returns are largely significant during the 15 minutes following the CNBC airing, they are not likely large enough to be statistically detectable over longer, daily horizons. For instance, 0.46% is large compared to the 15-minute standard error in a stock's return but small compared to a stock's daily volatility. Nevertheless, it is interesting to examine whether the initial impact is part of a larger, long-term reaction or subsequently reverses.

Table 4 provides daily cumulative abnormal returns (CARs) for four weeks following the CNBC airing. Panel A shows the results from defining the abnormal return as the difference between the stock return and the return on an equal-weighted matching portfolio of stocks from the same size decile and four-digit SIC code. Panel B uses the residual from a market model regression of total stock returns on the CRSP NYSE/AMEX/Nasdaq value-weighted market portfolio as the abnormal return.

The size, SIC-adjusted CARs following positive Midday Call reports are positive for the month following the airing, fluctuating around 1.5%. The CARs are significant the day of the report and the day after the report. Market model CARs are smaller and insignificant after the day of the report. The stronger results associated with the size-SIC matching portfolios could reflect that size-SIC portfolios have lower abnormal return variance and higher explanatory power (average  $r$ -squared is 31%) compared to the market model (average  $r$ -squared is 24%). Since the CAR standard errors increase with the measurement interval, the multi-day tests lack power against alternatives that the price response increases or reverses over the following month.

For both measures of abnormal return, negative Midday Call reports lead to negative CARs. The CARs become increasingly negative and increasingly significant during the month after the negative Midday Call reports. This evidence indicates that the initial response following these reports could be the beginning of a larger, long-horizon reaction.

Evidence during the Morning Call is less robust. The daily CARs are positive but insignificant for several days after the airing. The negative abnormal performance following negative reports disappears after the day of the report and is insignificant

Table 4

Daily cumulative abnormal returns following CNBC reports

The table reports daily cumulative abnormal percentage returns following on-air stock reports during the Morning Call and Midday Call segments on CNBC. We calculate cumulative returns by comparing the midquote price 15 minutes before the report to the closing prices on the days following the report. In Panel A, we take as the abnormal return the difference between the total stock return and the return on an equal-weighted portfolio of stocks with the same SIC code and from the same NYSE market capitalization decile. In Panel B, we use the residual from a market model regression as the abnormal return. We base the cumulative abnormal return standard errors on stock residuals over a 250-day estimation period prior to the day of the report. One and two stars denote significance at the five and one percent level, respectively. The data cover 322 stock reports from June 12, 2000 through October 27, 2000.

Days relative to report	Morning Call		Midday Call	
	Positive reports	Negative reports	Positive reports	Negative reports
<i>Panel A: Size, SIC</i>				
0	0.280%	-2.550%	1.174%**	-0.529%
1	0.541	1.568	1.402*	-1.333
2	0.726	1.200	1.254	-2.219
3	1.530*	1.141	1.574	-3.503
4	1.497	1.971	1.655	-2.849
5	1.465	0.506	1.120	-2.520
6	0.984	2.328	1.509	-4.101
7	0.635	0.371	1.410	-4.718
8	0.627	-0.740	1.676	-5.072
9	0.277	-0.425	1.445	-7.435**
10	0.226	-1.594	1.391	-7.535*
15	-0.872	-5.585	2.241	-11.519**
20	-1.113	-6.471	0.408	-11.519**
<i>Panel B: Market model</i>				
0	0.293%	-0.618%	0.794%*	-0.516%
1	0.648	2.708	0.744	-1.096
2	0.408	3.653	0.664	-2.274
3	0.705	3.142	0.122	-3.892**
4	0.549	3.807	0.182	-4.036*
5	0.086	4.526	-0.305	-3.514*
6	0.279	6.485*	0.183	-3.566
7	0.019	6.127	0.374	-5.208**
8	0.321	4.993	0.062	-5.039*
9	0.243	4.179	-0.282	-6.808**
10	0.218	4.559	-0.577	-6.668**
15	-0.768	-2.342	0.924	-5.927*
20	-0.036	-2.272	-1.066	-5.247

for the following month. It is important to note, though, that the Morning Call negative report sample size is small. We observe only 19 reports, occurring on just five separate trading days.

The evidence in Table 4 is thus consistent with the findings of Fig. 1. Compared to the stock prices of similarly sized firms from the same industry, the prices of stocks featured during the Midday Call are significantly impacted, both statistically and

economically. Morning Call reports have a smaller, more transitory impact on prices. Although we find no evidence that the initial response after positive reports increases or decreases within four weeks of the report, our tests are not powerful at detecting these alternatives. We now examine how prices incorporate information from the segments by studying trading activity around the reports.

#### **4. The impact of analyst reports on trading**

If only a subset of market participants are aware of the CNBC information, then viewers might have enough of an informational advantage over dealers and other liquidity providers to trade profitably against them. In this section we examine the profitability of a short-term trading strategy based on the sentiment of the information in the segment and study the impact of CNBC reports on trading activity.

##### *4.1. Trading profitability*

To examine the profitability of a short-term trading strategy, Fig. 2 plots the percentage returns from buying at various times, ranging from five minutes before to 30 seconds after the event and selling between one and two minutes after the event. To account for the bid–ask spread, we determine buy prices using the average price of buyer-initiated transactions during the time interval considered. We determine sell prices using the average price of seller-initiated transactions during the relevant time interval.

Individuals aware of the information before it airs are at a clear advantage. Purchasing the stock between four and five minutes before the airing and selling it between one and two minutes after the event yields an average return of 60 basis points after controlling for trading costs. The average trade size in the five minutes before positive reports during the Midday Call is \$76,923, which would lead to a profit of \$461.53. Although the profitability of the trade is not sensitive to the time at which the stock is sold, it is very sensitive to the time at which it is purchased. Purchasing quickly is critical. The profitability of the trade declines as the report approaches and then steeply declines after the event. Executing a buy order within the first five seconds after the event yields an average return of 40 basis points (or approximately \$300 for the average-sized trade). Executing the buy within 15 seconds after the event results in an average return of 16 basis points (approximately \$123). Beyond 15 seconds, average returns are no longer statistically significant; beyond 25 seconds, average returns are negative.

Our evidence of a profitable trading strategy based on analyst recommendations contrasts with Barber et al. (2001). Although Barber et al. (2001) find evidence of a persistent reaction to changes in analyst consensus forecasts, they find that transaction costs subsume any profits earned from trading strategies based on such forecasts. However, their investment strategies involve transacting at the closing

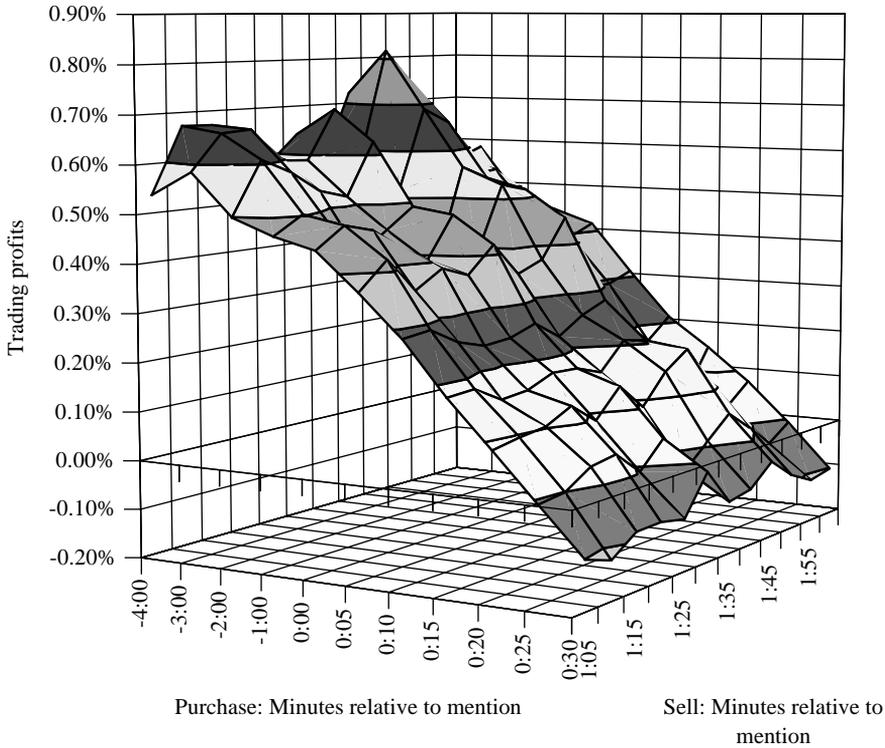


Fig. 2. Trading profits around CNBC reports. The figure shows the percentage price change in average transaction prices surrounding positive on-air stock reports during the Midday Call segment on CNBC. We calculate average purchase prices in intervals from five minutes before the report to 30 seconds after. The interval labeled  $-4:00$  corresponds to the average purchase price from five minutes before the event to four minutes before the event. We calculate average sell prices in intervals from one to two minutes after the event. The data cover 322 stock reports from June 12, 2000 through October 27, 2000.

price on the day of the analyst recommendation rather than within seconds of the news.

As a point of comparison on the magnitude of the profits, Harris and Schultz (1998) study the profitability of day traders who use the Nasdaq Small Order Execution System (SOES). In their sample, which is from one of the largest firms catering to SOES traders, the average trade size is approximately \$60,000, with a mean profit per transaction of \$72.48. They find that fewer than 15% of SOES bandit trades earn profits of \$500 or more. Thus, CNBC could present an opportunity for day traders with access to fast execution, such as SOES traders.

#### 4.2. Trading activity

If profits are available to viewers who respond quickly, do traders act on the CNBC information? To answer this question Table 5 shows the number of trades per

Table 5

## Trading intensity around CNBC reports

The table shows the median number of trades and trading volume per minute around on-air stock reports during the Morning Call and Midday Call segments on CNBC. We partition reports into groups depending on whether the report is positive or negative and whether the stock is listed on the NYSE or Nasdaq. One and two stars denote that the median is different from the –10 to –5 minute period median using the one-tailed Kolmogorov-Smirnov test at the five and one percent level, respectively. The data cover 322 stock reports from June 12, 2000 through October 27, 2000.

Minutes relative to report	Positive reports				Negative reports	
	Morning Call		Midday Call		NYSE	Nasdaq
	NYSE	Nasdaq	NYSE	Nasdaq		
<i>Panel A: Trades per minute</i>						
–10 to –5	3.8	56.0	2.6	27.2	2.2	20.6
–5 to 0	3.8	62.1	2.8	48.6	3.4	22.6
1	6.0*	58.0	11.0**	286.0**	4.0	37.0*
2	6.0**	46.0	10.0**	183.0**	5.0	42.0
3	6.0**	51.0	8.5**	126.0**	4.0	19.0
4	5.0*	47.5	8.0**	85.0**	3.0	51.0
5	5.0	40.0	6.5**	92.0**	3.0	38.0
10	4.2	52.5	6.0**	52.8*	4.4	43.6
15	4.7	52.9	4.9*	49.2*	2.6	38.2
<i>Panel B: Volume per minute</i>						
–10 to –5	5,850	29,560	3,220	12,960	3,860	7,640
–5 to 0	6,470	30,880	4,940	20,840	2,140	11,640
1	4,650	30,950	19,000**	116,800**	7,400	13,600
2	5,400	28,450	16,150**	74,400**	4,800	17,600
3	5,150	23,350	8,850**	67,700**	4,700	14,100
4	5,250	27,650	7,500**	33,300**	1,600	17,100
5	6,650	25,150	5,800	31,300	2,700	13,700
10	6,710	29,440	6,180**	31,600	6,840	15,180
15	6,100	23,460	6,990**	25,500	3,880	11,480

minute and the volume per minute by segment, the sentiment of the information, and the stock listing. A significant increase in trading intensity follows positive reports during the Morning Call and Midday Call. Midday Call Nasdaq-listed stocks experience the largest increase. For instance, trade in Nasdaq stocks more than quadruples from a median of 49 trades in the five minutes before to 286 in the first minute after a positive event during the Midday Call (the average number of trades increases from 84 to 377). The increase in trading activity is also evident in volume (number of shares) per minute.

Although the impact of the report on the number of trades and volume is unambiguous, the impact on trade size is not clear. For instance, the average trade size in the five minutes before positive reports during the Midday Call is 1,682 shares for NYSE stocks and 588 shares for Nasdaq stocks. In the minute following the event, the average sizes are 2,009 and 411, respectively. Neither change in average

Table 6

Order imbalance around CNBC reports

The table shows the median order imbalance, defined as (number of buys–number of sells)/(number of buys + number of sells), around on-air stock reports during the Morning Call and Midday Call segments on CNBC. We partition reports into groups depending on whether the report is positive or negative and whether the stock is listed on the NYSE or Nasdaq. One and two stars denote that the median order imbalance is different from the –10 to –5 minute period median using the one-tailed Kolmogorov-Smirnov test at the five and one percent level, respectively. The data cover 322 stock reports from June 12, 2000 through October 27, 2000.

Minutes relative to report	Positive reports				Negative reports	
	Morning Call		Midday Call		NYSE	Nasdaq
	NYSE	Nasdaq	NYSE	Nasdaq		
–10 to –5	0.000	–0.100	0.143	0.044	–0.083	–0.097
–5 to 0	0.000	–0.064	0.277*	0.067*	0.292*	–0.204
1	0.200**	0.200**	0.500**	0.398**	–0.487*	–0.330*
2	0.077*	0.023*	0.234	0.009	–0.455**	–0.102
3	0.059*	0.000*	0.143	–0.051	–0.333	–0.292
4	0.200**	–0.111	0.000	0.000	–0.053	–0.325**
5	0.100**	0.077**	0.000	–0.072	–0.067	–0.240
10	0.063	0.011**	0.134	0.058	–0.250	–0.165
15	0.148*	0.032*	0.122	0.042	–0.169	–0.013

trade size is statistically significant. Furthermore, quoted depths do not change significantly following the stock reports.

If the increase in trading activity is attributable to viewers trading on the information, more buyer-initiated trades should follow positive reports and conversely for negative reports. To examine the type of orders, Table 6 reports order imbalances in the minutes surrounding the report. In the first minute following the event, order imbalances shift with the sentiment of the report and are significant in all scenarios. The median order imbalance in the minute following positive reports during the Midday Call is 0.50 and 0.40 for NYSE and Nasdaq stocks respectively. This implies that approximately 70 to 75% of the trades in the minute following the event are buyer-initiated. The increase in order imbalances following Morning Call reports is smaller but still significant. By contrast, the order imbalance in the minute following negative events during either segment is negative, –0.49 for NYSE-listed stocks and –0.33 for Nasdaq-listed stocks. The evidence suggests that some viewers place trades based on the information reported in the CNBC segments, especially during the Midday Call.

4.3. *Trading feasibility*

The sensitivity of trading profits to the speed with which the trade executes raises the question of whether it is feasible to trade within the first 15 seconds of the

broadcast. The significant positive order imbalances in Table 6 in the first minute following positive mentions during the Midday Call also hold for the first 15 seconds of the report, which suggests that CNBC viewers impact the market almost immediately. However, we should note that although the measure of order imbalance is based on a standard trade-direction algorithm, the algorithm is less accurate when trades and quote changes occur rapidly because the trades and quotes are not perfectly synchronized.

Since the tick rule is based on observed price moves, it could introduce a spurious relation between price changes and measured order flow. As a robustness check, we modify the algorithm a number of ways: We compare trade prices to lagged quotes, as in Lee and Ready (1991), and to quotes without a lag, as in Ellis et al. (2000) and Bessembinder (2001). We also alter how often we use the tick rule: only for trades at the midquote as in Lee and Ready or for all trades inside the quotes as in Ellis et al. Finally, we compare trade prices to quotes five seconds ahead of the reported trade execution. Regardless of the algorithm, little variation exists in the magnitude or significance of the results.

Bacidore et al. (2001) examine the timing of order reception and execution on the NYSE. Although they cannot determine how long it takes for orders to go from brokers to the NYSE, they estimate that it takes three seconds for orders to arrive at the specialists display book after it arrives at the NYSE, and another two seconds to appear on the book. The latter delay is at least partially due to specialists “freezing” the book while processing existing orders. Trades take an additional 17 seconds on average to execute, but 93% of executed prices match or improve the posted quotes at the time the order is displayed. Consequently, the typical NYSE order executes fast enough for viewers to exploit the CNBC information. It is possible, however, that the type of information event we consider could be one of the rare occasions on the NYSE when executed prices are worse than posted prices at the time the order appears on the book.

Alternatively, viewers trading NYSE-listed securities based on the information in the CNBC reports could forego the price improvement opportunities at the NYSE (by having their orders exposed to the trading crowd) and instead get their orders filled immediately at the National Best Bid or Offer (NBBO) price by trading through another venue. For example, Battalio et al. (2001) find that 90% of the marketable orders of NYSE-listed securities that are routed to Trimark Securities, Inc. and Madoff Investment Securities (two large Nasdaq dealers) execute within two seconds.

Given the importance of transacting quickly, we would expect to see a shift in the number of trades in NYSE stocks that take place off the floor of the exchange, if viewers influence the marginal trading activity in NYSE stocks following the CNBC reports. Table 7 shows the fraction of trades in NYSE-listed securities that execute off the floor of the exchange during the time period surrounding the CNBC reports. The table shows a significant increase in the fraction of trades that take place off the floor of the exchange following the reports. This result is consistent with orders placed by investors who desire fast trade execution.

Table 7

Fraction of trades of NYSE-listed stocks executed off the NYSE

The table shows the median fraction of trades of NYSE-listed stocks that execute off the NYSE around on-air stock reports during the Morning Call and Midday Call segments on CNBC. We partition reports into groups depending on whether the report is positive or negative. One and two stars denote that the median percentage is different from the –10 to –5 minute period median using the one-tailed Kolmogorov-Smirnov test at the five and one percent level, respectively. The data cover 322 stock reports from June 12, 2000 through October 27, 2000.

Minutes relative to report	Positive reports		Negative reports
	Morning Call	Midday Call	
–10 to –5	0.364	0.346	0.344
–5 to 0	0.383	0.289	0.330
1	0.414	0.538**	0.452
2	0.500	0.500**	0.500
3	0.500*	0.600**	0.545
4	0.500*	0.500**	0.605*
5	0.500*	0.545**	0.500
10	0.484*	0.450**	0.367
15	0.396	0.387	0.347

**5. Conclusion**

Prior studies generally support the notion that markets are efficient, insofar as widespread profitable trading opportunities do not persist for long. We shed light on the degree of efficiency (i.e., the speed with which prices incorporate information) in a world of rapid information dissemination and fast, low-cost trade execution. We find that the prices of stocks discussed positively during the Midday Call report on CNBC experience a statistically and economically significant increase beginning seconds after the stock is initially mentioned and lasting approximately one minute. The response to negative reports is larger but more gradual. Prices continue falling for 15 minutes after airing, possibly due to the higher costs of short selling. We find less evidence of a price response for stocks discussed positively during the Morning Call, which suggests that the information is either not highly relevant or is already known by the market. Overall, we find that prices respond similarly to the pattern of abnormal performance found in work on traditional recommendations, such as Stickel (1985) and Womack (1996), only measured in minutes instead of days or months.

Market efficiency relies on vigilant market participants who monitor financial markets and actively trade away price discrepancies. In an equilibrium setting such as Grossman and Stiglitz (1980), low barriers to entry and competition among traders ensure that traders’ profits will be small but positive on average, just compensating them for their efforts in gathering information. Our evidence supports the notion that active traders enhance market efficiency. Although security prices do not fully reflect all available information instantaneously, the market is efficient enough that a trader cannot generate profits based on widely disseminated news unless he acts almost immediately.

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