Information Transmission in Finance

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Abstract

Because theories in finance rely critically on what agents know, designing powerful tests of these theories requires measuring information transmission. In this review, I characterize the rapidly growing subfield directly analyzing information in financial markets. Its three hallmarks are the examination of (*a*) a wide array of informative events, (*b*) different mechanisms for transmitting information, and (*c*) measures of information content based on nonnumeric information. Recent research directly measures flows of information to shed light on diverse phenomena in asset pricing, such as market reactions to news and nonnews, investors' portfolio choices, and mutual fund flows and returns, and in corporate finance, such as mergers and acquisitions, initial public offering (IPO) underpricing, and executive compensation. Continued improvements in access to data and computing power are likely to propel this line of research for years to come.

1. INTRODUCTION

Prices and allocations in financial markets depend on investors' demand for securities and firms' willingness to supply securities. Information transmission plays a critical role in finance because it shapes investors' and managers' expectations of the future and thus profoundly influences the resulting supply-demand equilibrium. The most well-known studies of information transmission are those analyzing stock market activity around corporate events, such as earnings announcements, and analyst forecasts. The classic example is Fama et al.'s (1969) event study of the evolution of firms' stock prices around publicly announced stock splits. This article surveys studies that build on such analyses by examining (*a*) a wide array of informative events, (*b*) different mechanisms for transmitting information, and (*c*) measures of information content based on nonnumeric information. These are the three hallmarks of the burgeoning literature on information transmission in finance.

Many studies in this vein analyze data on publicly available news stories to obtain a comprehensive sense of how informative events affect financial markets. Examining all newsworthy events simultaneously limits "dredging for anomalies," Fama's (1998, p. 287) phrase for conducting event studies of different event types until one finds an apparent market inefficiency. Only 31% of newswires about firms relate to earnings (22%) or stock analysts (9%); many of these stories include earnings guidance events and analyst news that typical studies of earnings announcements and forecast revisions do not consider.[1] Most news stories about firms do not directly relate to earnings or analysts, including news about revenues (15%), insider ownership (12%), mergers and acquisitions (6%), corporate executives (5%), business contracts (4%), cash distributions (3%), product information (2%), investment and liquidation (2%), credit quality (2%), labor issues (1%), security issuance (1%), and legal issues (1%).

Investors learn about these events through several channels beyond traditional newspapers and newswires. Recent studies analyze data from television shows, disclosure websites, spam emails, Internet searches, and online social networks. Viewers passively receive standardized content from newswires, newspapers, television, and spam emails. In contrast, the website format facilitates visitors' active choices of which items to view, resulting in more customized content. Internet search engines require highly specific user input and generate individualized results, leading to further customization. Online social networks entail dynamic and often repeated interactions between users, resulting in the exchange of information. These platforms are unique in that users provide and receive information. Section 3 discusses how researchers use data from such media in novel tests of models.

To exploit these opportunities, researchers must collect, process, and interpret uncharted data, which can be a significant endeavor. Fortunately, improvements in computing power and online data resources in the past two decades have dramatically lowered the cost of studying information transmission. Now anyone with basic computing skills can write programs to extract data from the Internet. If the format of the data is textual, such as words from newspaper articles, one can employ automated textual analysis to convert the data to numeric format amenable to statistical analysis. One can perform textual analyses using widely accessible software. (Li 2010, Das 2011, and Kearney & Liu 2014 provide reviews of textual analysis in finance and accounting.) The real challenge lies in finding appropriate data, constructing relevant measures of information content, and conducting sensible statistical tests of theories.

[1]Estimates are based on the author's analysis of Ravenpack categories of Dow Jones newswires from 2000 to 2010. Neuhierl, Scherbina & Schlusche (2013) analyze market reactions to firms' press releases by news event category.

There are three central themes in this review. First, media content is a useful measure of the information environment in financial markets. Second, media reporting sometimes exerts a causal influence on the information environment, but such an influence is not necessary for media content to provide insights into market activity. Third, theories of the links between information transmission and market activity can guide empirical research.

Empirical studies employing direct measures of information investigate diverse phenomena in asset pricing, such as market reactions to news and nonnews, investors' portfolio choices, and mutual fund flows and returns, and in corporate finance, such as mergers and acquisitions, initial public offering (IPO) underpricing, and executive compensation. Rather than list all findings, I distill empirical results into representative categories. The main asset pricing findings from this literature are as follows:

- The link between information arrival and price movement in asset markets is weak.
- Underreaction of market prices to information and overreaction to noninformation partly explain the weak link between information arrival and price movement.
- The public release of uninformative media content elicits market overreaction, whereas the release of informative content elicits underreaction. An implication is that the manipulation of content can affect prices.
- Overreaction (underreaction) to content increases (decreases) with investor attention.
- Increases in investor attention are associated with increases in market prices, often followed by partial price reversals. An implication is that the manipulation of attention can affect prices.
- Price movements associated with the release of information are also associated with high trading volume.
- The reporting of news by itself can cause significant increases in trading volume.

Key corporate finance findings are as follows:

- Media coverage can increase firm performance by either attracting customers or reducing the costs of monitoring corrupt and inefficient manager behavior.
- Media coverage, particularly positive coverage, can help firms raise capital by increasing investor awareness or by increasing investor sentiment.
- Textual analysis of media allows researchers to measure key concepts, such as the similarity of firms' products, readability of disclosures, and managerial overconfidence.

Finance research on the media is rapidly growing. **Figure 1** shows the number of articles cited here by year of publication. Although it is an imperfect representation, the figure depicts the finance profession's flourishing interest in the role of media.[2] One impetus is the expansion of media coverage resulting from improved information technology. **Figure 2** shows the growth in the file size of the Dow Jones news archive, consisting of the text and identifying characteristics of all newswires with financial content. The log-scale figure suggests that news coverage increases by orders of magnitude after 1980.[3] The amount of news plateaus in recent years, but data production, storage, and processing capabilities continue to grow.

I organize this article as follows: In Section 2, I briefly review selected theories that feature information transmission. In Section 3, I discuss the large body of studies that measure information

[2]Two limitations of **Figure 1** are that this review is not comprehensive and could be biased toward recent studies and that data for 2013 exclude its last two months but include forthcoming articles that will be published in 2014.

[3]The sudden fluctuations in 1999 and 2001 likely represent gaps in the archive, not genuine changes in coverage. Part of the sudden rise in 1994 occurs because of an increase in the repetition of newswires.

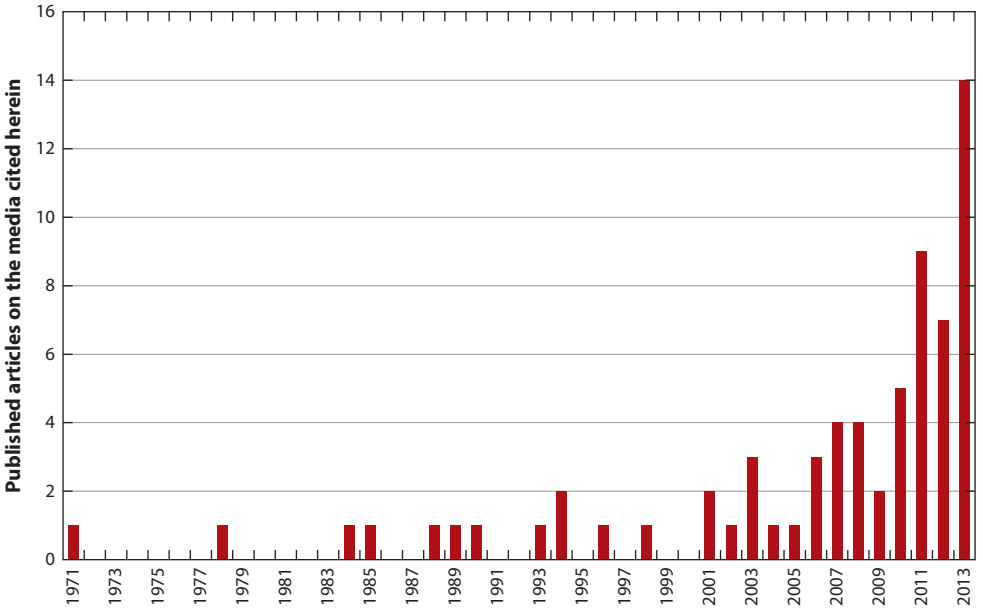

Figure 1

The figure shows the number of published articles cited in this review by year of publication. Data for 2013 exclude the last two months but include forthcoming articles that will be published in 2014.

transmission primarily as a means for testing whether changes in the information environment affect asset market activity. These studies establish key facts about the relation between the release of information and market activity. Section 4 reviews studies evaluating the causal impact of media reporting on market activity. Section 5 provides an overview of studies of information transmission in a corporate finance context. Section 6 concludes and suggests promising directions for future research.

2. THEORETICAL BACKGROUND

Theoretical models provide the framework for understanding the role of information transmission in financial markets. Prices and trading volume in asset markets depend on the impact of information on investors' expectations of firm values. Rational investors cannot disagree about firm values if public information, such as the market price, fully reveals traders' beliefs (Aumann 1976). Milgrom & Stokey (1982) show that this logic implies there will be no trading at all in asset markets inhabited solely by rational agents with purely speculative motives. Grossman & Stiglitz (1980) show that rational agents will only collect information if prices do not fully reveal traders' beliefs, which only happens if factors other than genuine information affect asset prices. Because much trading takes place and many traders collect information in real-world asset markets, these results suggest that factors other than genuine information are important for explaining observed market activity.

The release of information typically causes some investors' beliefs to converge while others diverge for reasons that may or may not be rational. Several models highlight the importance of investor disagreement for understanding asset pricing and trading volume. Most models based on rational disagreement, such as those provided by He & Wang (1995) and Tetlock (2010), predict that public information causes trade only insofar as it resolves information asymmetry and leads to a convergence in traders' beliefs.

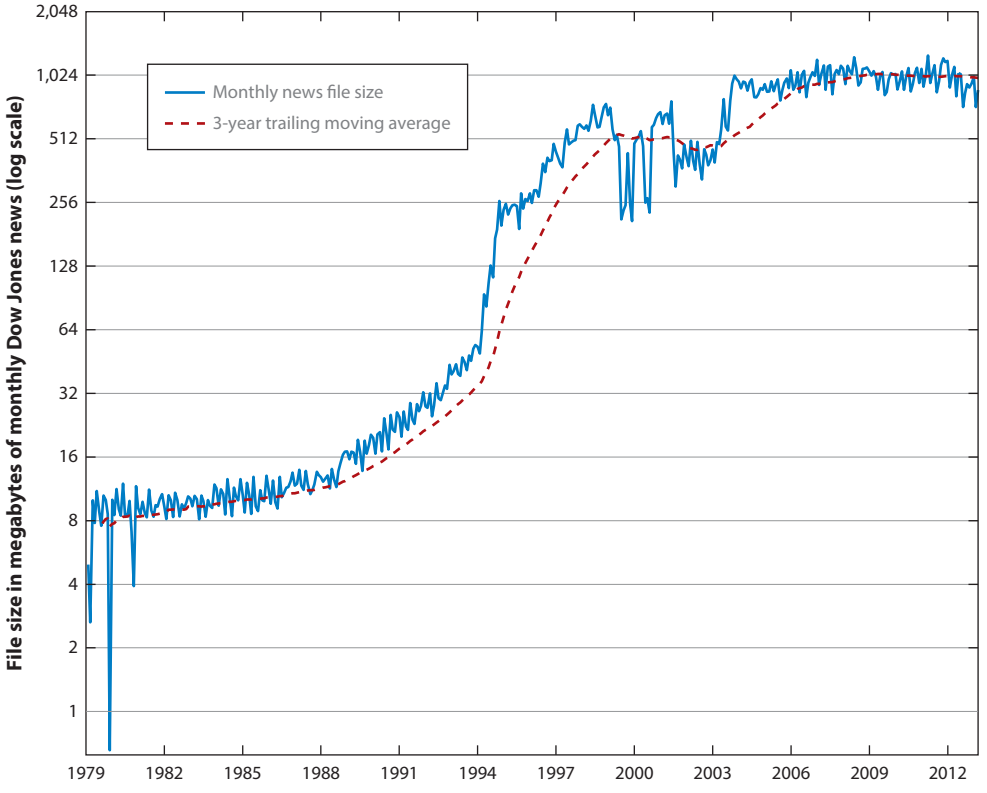

Figure 2

The log-scale figure shows the evolution of file size of the Dow Jones news archive, consisting of text and identifying characteristics from all newswires with financial content. The solid blue line represents monthly news file size; the dashed red line represents the trailing 3-year moving average of news file size.

An alternative modeling approach is to allow investors to hold different prior beliefs and interpret information differently. Early models based on differences in opinion include those by Miller (1977), Harris & Raviv (1993), Kim & Verrecchia (1994), and Kandel & Pearson (1995). Kandel & Pearson (1995) argue that such models can explain evidence on stock analysts' expectations, asset price movements, and trading volume around the release of public information—most notably, the fact that analysts' earnings forecasts often diverge or change rank ordering around earnings announcements. The static model of Miller (1977) and the dynamic models of Scheinkman & Xiong (2003) and Banerjee & Kremer (2010) elucidate the general insights from difference-in-opinion models:

- Differences in investors' trading positions reflect the level of disagreement.
- Trading volume reflects changes in investor disagreement.
- Asset prices represent the average of investors' beliefs about valuation.
- With short-sale constraints, prices equal or exceed optimistic investors' beliefs.[4]

[4]In Scheinkman & Xiong's (2003) model, differences in opinion vary over time. Price bubbles can arise because prices embed an option to resell the asset to other investors who may become optimistic in the future.

Recent models in behavioral finance propose specific belief biases that can cause investor disagreement and in turn affect asset prices and trading volume. If media content reflects or influences investor biases, as suggested by Mullainathan & Shleifer (2005a,b), content and biases should exhibit similar relationships with market activity. De Long et al. (1990) characterize equilibrium in a model with random belief biases—i.e., noise trading driven by investor sentiment—and limits to arbitrage. They show that innovations in sentiment affect asset returns; and absolute sentiment innovations determine trading volume between noise traders and rational agents. These predictions become testable if media content is an empirical proxy for investor sentiment.

Information transmission can also affect market activity by directing investor attention. Merton (1987) analyzes a model of incomplete information in which some investors are unaware of some securities and do not use them in constructing their portfolios. He shows that firms with small investor bases, particularly those with high idiosyncratic volatility, exhibit relatively low stock prices and high expected returns. In his theory, media visibility can increase a firm's investor base, thereby increasing its market value and lowering its expected return. Merton's (1987) static model does not make clear predictions of how a stock's price adjusts to a sudden increase in demand resulting from heightened investor recognition. Duffie (2010) provides a model of slow-moving capital that predicts that prices increase sharply and subsequently reverse over a longer period in response to positive demand shocks. The extent and duration of overshooting depend on trading impediments, such as short-run search frictions and capital constraints.

Studies by Hirshleifer & Teoh (2003) and Peng & Xiong (2006) model the impact of limited investor attention on reactions to information. In these models, investors attend to general information that tends to be salient and widely applicable, and they ignore detailed information that tends to be costly to process. For example, investors attend to summary statistics, such as a firm's total earnings, rather than specific components, such as cash flows and accruals. As a result, asset prices overreact to general information and underreact to detailed information.

Several models consider how the sequential release of information to different investors affects market activity. Hirshleifer, Subrahmanyam & Titman (1994) and Brunnermeier (2005) focus on implications for trading volume and informational efficiency. Both studies show that early informed traders can exploit information before and after public information arrival. Such staggered information release can have detrimental consequences for informational efficiency. Tetlock (2011) proposes that investors may not realize the extent to which others have already traded on the information in a given news story, leading them to confuse fresh and stale news. In a model with limited arbitrage, this bias causes asset prices to underreact initially and overreact eventually to the sequential release of partially redundant information.

Some recent models feature investors who receive similar information within social networks. Colla & Mele (2010) and Ozsoylev & Walden (2011) prove that information linkages among traders increase trading volume by increasing competition and reducing information asymmetry across traders. Traders near each other in the network exhibit positively correlated trades, whereas those far from each other exhibit negatively correlated trades. Han & Hirshleifer (2012) provide a model in which the way investors transmit ideas affects beliefs and market activity. They assume that investors prefer to discuss their investment successes and that others do not fully account for this tendency. This conversational bias increases the popularity of active investing strategies, such as frequently trading stocks with high volatility and skewness.

3. MEDIA AS A REFLECTION OF THE INFORMATION ENVIRONMENT

Early empirical studies provide foundational insights into the relation between the release of public information and asset market activity. Most studies use newspaper articles as measures of public

information and stock price changes and trading volume as measures of market activity because of their importance and wide availability. However, alternative media measures are becoming more common as their importance and availability increase. The standard methodology is to analyze price changes and volume around the time of public information arrival, building on the Fama et al. (1969) study and the ensuing event study literature.

3.1. Public Information Arrival and Market Activity

Roll's (1988) presidential address is an important early attempt to link stock price changes (i.e., returns) to identifiable public information. In a study of 96 large firms from 1982 to 1986, Roll (1988) shows that systematic economic influences, such as the market and other factors, account for only 21% of daily fluctuations in firms' returns. In theory, market reactions to public firm-specific news could explain much of the remaining 79% of return variation. Roll (1988) tests this theory by identifying all events in which firms are featured in either *Dow Jones News Service* (*DJNS*) or the *Wall Street Journal* (*WSJ*), two comprehensive sources. After excluding the 24% of days with such news, the explanatory power (i.e., R^2) of systematic influences for firm stock returns increases by only 2% (to 23%). Roll's (1988) results point to the importance of private information, sentiment-driven trading, or high-frequency changes in risk premiums in explaining stock returns.

Cutler, Poterba & Summers (1989) examine whether major fundamental news is associated with large market-wide stock price movements. They focus on the 50 days with the most extreme stock price movements and the 49 most important world events between 1941 and 1987. Their main finding is that it is difficult to link major market moves to economic or other information. On days with major price moves, "the information that the press cites as the cause of the market move is not particularly important"; and there are no subsequent "convincing accounts of why future profits or discount rates might have changed" (Cutler, Poterba & Summers 1989, p. 9). Cornell (2013) extends the Cutler, Poterba & Summers analysis of major price movements to include the 1988 to 2012 period and reports strikingly similar results.

Mitchell & Mulherin (1994) and Berry & Howe (1994) relate aggregate stock market volume and volatility to broad measures of news about firms and the economy. Mitchell & Mulherin (1994) analyze the number of *DJNS* and *WSJ* stories per day, whereas Berry & Howe (1994) measure hourly news items from *Reuters News Service*. Both studies find weak correlations of less than 0.12 between market volatility and the number of news items. The correlation between the number of news stories and trading volume is considerably higher (e.g., 0.37 at the daily frequency). The higher explanatory power of news for trading volume suggests the presence of noninformational trading linked to news, a theme in later studies.

Market inefficiency could partly explain why stock prices do not react strongly to public information and move even in the absence of such information. Chan (2003) examines whether long-run market reactions to a broad sample of firm-specific news and nonnews events are efficient.[5] Using data on *DJNS* newswires from 1980 to 2000, he defines news as a month in which a firm appears in the headline of a newswire. Chan (2003) analyzes one-month price momentum within groups of firms with and without news by constructing long-short portfolios based on firms' monthly returns—e.g., the news momentum portfolio consists of long (short) positions in

[5]Most earlier studies focus on specific types of events, including Patell & Wolfson (1984) and Jennings & Starks (1985), who analyze earnings news releases, and Pound & Zeckhauser (1990), who analyze takeover rumors in the *WSJ* column "Heard on the Street" (HS). Pound & Zeckhauser (1990) argue that the market reacts efficiently to the 42 takeover rumors in their sample. The two earnings news studies identify modest market underreaction to earnings surprises, measured relative to stock analysts' expectations.

the subset of firms with news that have relatively high (low) monthly returns. His primary result is that the news momentum portfolio outperforms the no-news momentum portfolio by a significant margin of 5% in the year after formation. A key reason is that firms with low returns in news months experience no price reversal, whereas firms with low returns in nonnews months experience large price rebounds.

Studies by Tetlock (2010) and Griffin, Hirschey & Kelly (2011) find qualitatively similar results at the daily frequency in US and international data, respectively. The news-momentum relation is strongest for news stories that coincide with high trading volume and for small and illiquid firms. These findings suggest significant noninformational trading occurs on news days. Such trading could arise because public news resolves information asymmetry, resulting in the accommodation of long-lived liquidity shocks, as proposed by Tetlock (2010). Consistent with reductions in asymmetric information, bid-ask spreads are lower and market depth is higher around earnings announcements that receive press coverage (Bushee et al. 2010).

A complementary explanation for the news-momentum relation is that investors do not adequately attend to firm-specific news arrival, as predicted by models of limited attention. Although few studies directly measure attention to news, some provide evidence that market reactions to information events increase with news about the event. Klibanoff, Lamont & Wizman (1998) assess market reactions to information by comparing closed-end country fund prices to their fundamental values, as measured by net asset value (NAV). They show that fund prices move only 50% as much as NAV in nonnews weeks, but prices react to 80% of NAV changes in weeks with front page *New York Times* (*NYT*) news about the country. Peress (2008) shows that market underreaction to earnings announcements decreases with *WSJ* media coverage of the event, lending further support to theories of limited attention.[6] However, an earlier study by Vega (2006) finds that firms receiving more media coverage in the 40 days prior to earnings announcements experience increases in post-announcement stock price drift, suggesting investor inattention does not fully account for the well-known drift phenomenon.

3.2. Information Content and Market Activity

Several studies measure the content of news to evaluate directional market responses to the information reflected in news. Niederhoffer's (1971) analysis of news and stock prices introduces key methods and previews basic findings. He identifies 432 world events from 1950 to 1966 as days in which the width of an *NYT* front page headline exceeds five columns. Human readers categorize these headlines into 19 groups, such as US war developments, US discoveries, political elections, and changes in foreign leadership, and rate each headline's tone on a seven-point good-bad scale. Niederhoffer (1971) finds positive autocorrelation in news arrival and in headline tone, indicating news occurs in streaks. He also shows that sequences of related world events, such as Korean War events, are contemporaneously associated with extreme stock price movements. He notes that cumulative stock returns in days two to five after the 34 world events categorized as Extremely Bad are +1.14%. This apparent price reversal suggests investor overreaction to bad news, but generalizing from so few data points is difficult.

Tetlock (2007) is one of the first to apply automated content analysis to the text of news articles about the stock market. He hypothesizes that one can measure investor sentiment using textual

[6]Similarly, Rogers, Skinner & Zechman (2013) examine a regime change in *DJNS*' reporting of insider trades, as filed in the Securities and Exchange Commission's Form 4. They find that three-minute stock price increases after events in which insiders purchase stocks are almost twice as large in the regime in which *DJNS* reports insider news.

analysis, enabling direct tests of behavioral finance theories, such as De Long et al.'s (1990). Tetlock's (2007) proposed measure is based on the linguistic tone of a popular daily *WSJ* column called "Abreast of the Market" (AM) from 1984 through 1999. The AM column consists of colorful post hoc depictions of traders' moods and expectations from the previous day. This column could reflect and perhaps influence investor sentiment because the *WSJ* is a respected source with the largest circulation among daily financial publications in the United States.

Tetlock (2007) first computes the relative frequencies of AM words in 77 predetermined categories from the Harvard IV-4 Psychosocial Dictionary, such as Strong, Weak, Active, and Passive words. He considers all categories but ultimately focuses on a composite category of words with a negative outlook, such as "flaw" and "ruin," because it captures a large fraction of common (time-series) variation in the word frequencies across all 77 categories. Intuitively, a low (high) frequency of negative words could represent investor optimism (pessimism). The notion that negative words are more important than positive words is consistent with the psychology literature. Baumeister et al. (2001) and Rozin & Royzman (2001), among others, argue that negative information has more impact and is more thoroughly processed than positive information in many contexts. Many studies now employ similar dictionary-based textual analysis procedures to those used by Tetlock (2007).[7]

If negative words in the AM column represent investor sentiment, their frequent occurrence should be associated with temporarily low stock prices that bounce back when either there is sufficient arbitrage capital or noise traders realize their mistake. However, if negative words in the AM column constitute genuinely unfavorable information about firm values, stock prices should fall and should not reverse their course. A third possibility is that stock prices may not react to negative words if the AM column merely recapitulates information that market participants already know. Empirically, Tetlock (2007) demonstrates that negative words in the AM column are associated with lower same-day stock returns and predict lower returns the following day. Moreover, within a week of an AM story with highly negative tone, stock prices completely recover to their initial level on the day of the column. These results are consistent with the interpretation that negative tone in the AM column represents pessimistic sentiment, which temporarily influences stock prices as in De Long et al. (1990).

García (2013) builds on these results in a study of positive and negative words from two *NYT* columns spanning 1905 to 2005. He also finds that linguistic tone predicts market returns one day in advance and that there is a partial reversal of this price movement within one week. He demonstrates that these patterns vary with the business cycle, becoming stronger in recessions. He argues that this business cycle variation is consistent with the idea that investors are more sensitive to sentiment in downturns.

Bollen, Mao & Zeng (2011) and Karabulut (2013) propose measures of investor sentiment based on content from Internet postings on the social networks Twitter and Facebook, respectively. These studies design their sentiment measures to capture investor moods. Bollen, Mao & Zeng (2011) argue that the Calm and Happiness dimensions of public mood extracted from Twitter have strong predictive power for weekly Dow Jones index returns in 2008. Karabulut (2013) shows

[7]Recent studies propose several improvements beyond the simple word counting methodology, including adapting the dictionary technology to a financial context, as in Loughran & McDonald (2011), inferring word importance from market reactions, as in Jegadeesh & Wu (2013), applying machine learning techniques, as in Antweiler & Frank (2004) and Das & Chen (2007), and using proprietary algorithms, such as Ravenpack's tools used in von Beschwitz, Keim & Massa (2013), Reuters' tools used in Grob-Klubmann & Hautsch (2011), and The Stock Sonar system used in Boudoukh et al. (2013). The application of natural language processing techniques to financial text, such as analyst reports, news feeds, and corporate disclosures, is commonly known as sentiment analysis.

that Facebook's Gross National Happiness index—constructed from textual analysis of status updates—positively predicts next-day stock market returns, followed by a partial price reversal. These results highlight the promise of proxies for sentiment based on social network data.

Whereas researchers typically interpret the linguistic tone of media content about the market as a measure of investor sentiment, most interpret the tone of content about individual firms as an informative measure of a stock's value. Intuitively, reporters must write content about the overall market irrespective of whether a major market-wide event occurs, but most firms appear in the news only when they experience major events. Busse & Green (2002); Antweiler & Frank (2004); and Tetlock, Saar-Tsechansky & Macskassy (2008) conduct early studies of firm content from television, Internet chat rooms, and newspapers, respectively.

Busse & Green (2002) analyze the content from 322 analyst reports about individual stocks aired on CNBC's popular *Morning Call* and *Midday Call* segments from June to October of 2000. The authors subjectively rate the tone of each report as positive (280 cases) or negative (42 cases). They find that positive abnormal stock market returns occur within one minute of a stock's positive mention on CNBC; most predictability in abnormal returns dissipates within five minutes. Prices seem to incorporate most information in negative CNBC reports within 15 minutes, although this inference is less clear because of the small number of such reports. The authors conclude that the market responds quite efficiently to TV reports.

Antweiler & Frank (2004) study the frequency and tone of stock message board posts on *Yahoo! Finance* and *Raging Bull* about 45 large US stocks in the year 2000. Their main finding is that message board posting frequency positively predicts stock return volatility and trading volume, even when controlling for the frequency of *WSJ* stories. The authors use an algorithm called Naïve Bayes to classify posts as bullish, neutral, or bearish based on the pattern of word occurrences. They report only weak relationships between posting tone and market activity. (Das & Chen 2007 compare alternative approaches to classifying text from Internet stock message boards and examine the relations between message tone and stock market activity.)

Tetlock, Saar-Tsechansky & Macskassy (2008) analyze the tone of firm-specific newspaper stories. In contrast to studies of selected columns about the market, the authors analyze a comprehensive sample of *WSJ* and *DJNS* news stories focused on individual firms in the S&P 500 index. On average, these firm-specific stories contain more mundane and detailed information and receive less investor attention than the entertaining and widely read AM column. The researchers use a common metric—the fraction of negative words in firm-specific news—to examine the directional impact of all newsworthy events.

Tetlock, Saar-Tsechansky & Macskassy (2008) show that negative words predict negative information about firm earnings, beyond quantifiable traditional measures of firm performance. The forecasting power of textual information for future earnings is comparable to that of stock returns, which in theory should be a very strong predictor of firm earnings. The study also tests whether stock market prices rationally reflect the effect of negative words on firms' expected earnings. It finds that stock market prices immediately incorporate more than 80% of the information from negative words, although the one-day delayed reaction is also significant. This evidence suggests linguistic media content captures otherwise hard-to-quantify aspects of firms' fundamentals. Market prices respond to this information with a slight delay, consistent with models of limited investor attention such as those of Hirshleifer & Teoh (2003) and Peng & Xiong (2006).

Engelberg (2008) relates the findings in Tetlock, Saar-Tsechansky & Macskassy (2008) to those in the post-earnings announcement drift literature. He measures qualitative earnings information as the fraction of negative words in news about a firm on the day of its earnings announcement. He shows that qualitative earnings information has incremental predictive power for future returns above and beyond quantitative earnings surprises. The predictive power of

qualitative earnings information is particularly strong at long horizons. One interpretation is that investors experience difficulty processing qualitative information.

Another challenge for investors with limited cognitive abilities is distinguishing new information from old information. News stories about stocks typically convey a combination of genuinely novel facts and older well-established facts that provide context. Market prices should already reflect these older facts and thus should only react to new information. Investors with limited attention, however, may not recognize which facts are old and the extent to which other market participants have already traded on previously released information. As a result, such investors could overreact to old or stale information.

Tetlock (2011) uses *DJNS* data from 1996 to 2008 to test the hypothesis that investor overreaction to financial news increases with the staleness of information. He defines the staleness of a news story as its textual similarity to the previous stories about the same firm. The similarity between two texts is a simple [0,1] measure, originally proposed by Jaccard (1901): the number of unique words present in the intersection of the two texts divided by the number of unique words present in the union of the two texts. This measure identifies news stories that contain a greater proportion of textual information that overlaps with previously known facts. The measure of market overreaction is the extent of stock price reversals, as measured by a firm's initial daily return around a news event negatively predicting its return in the week after the event. Tetlock's (2011) main finding is that market reactions to news are better negative predictors of future returns when news is stale. (This result echoes earlier evidence from Davies & Canes 1978 and Barber & Loeffler 1993, who find partial price reversals of market reactions to secondhand analyst recommendations reported in the *WSJ*.) Tetlock's (2011) interpretation is that investors with limited attention overreact to stale information, causing temporary movements in firms' stock prices.

3.3. Information Arrival and Valuation

Many of the above studies support the idea that news releases are associated with increases in investor attention to asset markets. This section reviews studies that relate media attention or spin to market valuations. Merton's (1987) theory predicts that attention can increase market valuations directly by alleviating informational frictions that prevent investors from holding lesser-known assets. Barber & Odean (2008) hypothesize that unsophisticated investors are prone to buying salient stocks because of limits on attention and short sales. They provide direct evidence that individual investors are net buyers of stocks featured in *DJNS* articles. The theories of Merton (1987) and Barber & Odean (2008) both predict increases in valuation and low future returns following positive shocks to investor attention. Short-run price dynamics, such as the extent and duration of any price reversal, should depend on trading frictions (Duffie 2010).

Fang & Peress (2009) test whether investor awareness of stocks increases valuations, using firm-specific media coverage in the *NYT*, *USA Today*, *WSJ*, and *Washington Post* as a proxy for investor attention. They find that stocks without media coverage in the previous month earn 3% higher annualized returns than stocks with above-average media coverage from 1993 to 2002. The return differential is as high as 8–12% among stocks with low market capitalizations, low analyst coverage, high individual investor ownership, and high idiosyncratic volatility. These results are broadly consistent with Merton's (1987) theory in which media coverage can make everyday investors aware of certain relatively obscure stocks.

Da, Engelberg & Gao (2011) provide complementary evidence in an analysis of Internet searches for information about stocks. The authors propose that the frequency of Google searches (Search Volume Index or SVI) for a stock's ticker is a measure of investor attention to the stock—e.g., the SVI of AMZN reflects investor attention to Amazon's stock. Using a sample of US stocks

from 2004 to 2008, they show that SVI positively predicts three empirical proxies for attention: news stories, trading volume, and the absolute value of stock returns. Their main result is that increases in SVI predict increases in stock prices in the next two weeks followed by a partial price reversal within the year.

Several studies use television content to test whether shocks to investor attention predict increases in stock prices, as Merton (1987) hypothesizes. Fehle, Tsyplakov & Zdorovtsov (2005) examine firms featured in Super Bowl commercials; Kim & Meschke (2011) analyze the firms of CEOs interviewed on CNBC; and Engelberg, Sasseville & Williams (2012) study stocks recommended on CNBC's popular *Mad Money* show. These three studies provide large-scale evidence that strongly supports theories in which investor attention increases stock prices. Each study uses direct attention measures, such as Nielsen viewership ratings, and shows that stock price reactions increase with viewership. The studies by Kim & Meschke (2011) and Engelberg, Sasseville & Williams (2012) find evidence of a partial reversal of the initial spike in stock prices, consistent with Duffie's (2010) theory of slow-moving capital.

Media coverage could also affect market valuation by influencing investors' beliefs. Studies by Tumarkin & Whitelaw (2001), Dewally (2003), and Bhattacharya et al. (2009) suggest that media touting of Internet stocks during the boom of the late 1990s increased investor sentiment, but it had a muted impact on stock prices. Several studies examine the relation between email endorsements of stocks, commonly called stock spam, and stock market activity. Stock spam consists of unsolicited emails recommending particular stocks; these messages can reach one million email accounts and cost only hundreds of dollars to send (Böhme & Holz 2006). Studies by Böhme & Holz (2006); Frieder & Zittrain (2007); Hanke & Hauser (2008); and Hu, McInish & Zeng (2010) provide evidence on hundreds of stock spam messages touting small stocks traded on the Pink Sheets from 2004 to 2006. These studies document dramatic increases in daily trading volume on the order of 50% and significant stock price increases up to 2%. The increases in stock prices appear to be temporary, consistent with investor overreaction to noninformation and limits to arbitrage.

4. CAUSAL ROLE OF MEDIA

Although many of the above studies establish Granger causality between media content and market activity, few studies distinguish market reactions to media reporting per se from reactions to the underlying information event reported. Suppose one seeks an estimate of the causal impact of media reporting of earnings announcements on market activity. One could compare market activity around earnings announcements with media coverage to market activity around announcements without media coverage—e.g., as in Peress (2008). The observed difference in average market activity between these events could be a biased estimator of the impact of reporting because the media decision to report on an announcement may depend on the nature of the event—for example, coverage could be more likely for surprising events and for positive events. This section reviews studies that cleverly identify (plausibly) exogenous variation in media reporting, allowing for (plausibly) unbiased estimates of the causal impact of reporting.

4.1. Case Studies

Huberman & Regev (2001) analyze a striking instance in which a news article in the *NYT* about promising new anticancer drugs causes the stock of EntreMed, a small biotechnology firm, to increase by more than 600% within a day. The *NYT* reporting is plausibly exogenous because disclosure of the underlying information event, EntreMed's promising research, occurred five

months earlier in *Nature*. Although EntreMed's stock experiences a partial price reversal, its price remains elevated by more than 150% in the next three weeks. These results are consistent with Merton's (1987) hypothesis in which media reporting increases investor attention. In this interpretation, the magnitude of media-induced attention must be enormous. However, it is difficult to distinguish media's impact on temporary irrational exuberance from its impact on attention.

Another remarkable anecdote studied by Carvalho, Klagge & Moench (2011) and Marshall, Visaltanachoti & Cooper (2014) highlights the influence of media reporting on investor beliefs. In 2008, a six-year-old news story about United Airlines' 2002 bankruptcy mistakenly appears on several websites as news. Within minutes of the article's posting on Bloomberg news, United's stock price falls by 76%. Soon thereafter, United denies the story, exposing the news to be stale and irrelevant. Although the firm's stock price rebounds, it remains down by 11% at the close of trading. This episode demonstrates that reporting influences investor beliefs beyond its effect on attention.

4.2. Media Impact on Volume and Volatility

Although these two anecdotal studies illustrate the potential magnitude of media effects, only large-scale evidence on the causal impact of media indicates the practical importance of media effects. The challenge is that natural experiments in which media reporting varies for exogenous reasons may not produce meaningful variation in reporting. Furthermore, by design, reporting in these cases is uncorrelated with the information being reported. If reporting influences investors most when it reinforces their preexisting prejudices and tendencies, evidence from natural experiments provides a lower bound on the causal impact of media.

Engelberg & Parsons (2011) compare the trading behavior of investors exposed to different local media coverage of the same information event, namely firm earnings announcements. Local newspaper coverage of an earnings announcement increases the daily trading activity of individual investors in nearby zip codes by 48%. Peress (2014) examines the effect of reductions in media coverage caused by newspaper strikes in different countries. Strikes reduce daily trading volume by 14% and return volatility by 9% in a country's stock market. The impact of strikes is largest for small stocks, which have high individual ownership. Both studies provide convincing evidence that reporting causes substantial increases in trading activity. However, neither study distinguishes media impact on attention from its impact on beliefs.

4.3. Media Impact on Stock Prices

Studies of the directional impact of media on stock prices may be able to disentangle attention and belief effects. Dyck & Zingales (2003) analyze how the type of earnings emphasized in newspaper stories—either official accounting earnings or unofficial pro forma earnings—relates to stock price changes around earnings announcements. They show that stock prices react more to the type of earnings reported in newspapers—particularly credible ones, such as the *WSJ*—suggesting newspaper reporting influences beliefs.

An alternative strategy for isolating the impact of media on beliefs is to examine variation in media incentives to report favorable news about an asset. Reuter & Zitzewitz (2006) show that personal finance publications such as *Money Magazine* are more likely to positively recommend mutual funds from companies who pay to advertise in these publications. These positive mentions of funds are associated with fund inflows, consistent with an influence on investor beliefs. Solomon (2012) tests whether stock price reactions to news depend on whether firms hire investor relations (IR) firms, who can spin their clients' news. Firms with IR spin enjoy higher average returns

around nonearnings news events, but they exhibit significantly lower returns around earnings announcements, perhaps because earnings news is more difficult to spin. A natural interpretation is that IR firms exert a temporary impact on investor beliefs. (In a similar vein, Ahern & Sosyura 2013 argue that media coverage of merger rumors unduly influences investors' beliefs about merger likelihood, causing temporary increases in the stock prices of potential target firms.)

Dougal et al. (2012) exploit exogenous rotation of *WSJ* writers of the AM column, who differ in their writing styles. They find that journalist fixed effects have significant predictive power for next-day aggregate stock market returns, increasing the R^2 of a forecasting regression from 2.8% to 3.8%. A positive (negative) fixed effect estimate indicates that a journalist exerts a bullish (bearish) influence on stock prices. On one hand, the impact of writing style is modest; on the other, it is surprising that the writing style of the writer of a single newspaper column about yesterday's market activity has any measurable impact. Presumably, this effect operates through investor beliefs.

A recent study by Schmidt (2013) suggests that the attention channel is also important. He uses Google searches for international sporting events to test Peng & Xiong's (2006) theory in which distracted investors prioritize market news over firm-specific news. (Eisensee & Strömberg 2007 are the first to identify distraction using so-called news pressure from other events.) He shows that a standardized increase in investor attention to sports—implying inattention to stocks—reduces dispersion in firms' stock prices by 13%. In addition, investor attention to sports reduces market volatility by 8% and trading activity by 4%. Although this evidence ostensibly supports the attention mechanism, attention is a prerequisite for media content to influence beliefs.

5. CORPORATE FINANCE APPLICATIONS

The above studies indicate that media coverage exhibits strong correlations and causal relations with asset prices. Given the importance of capital markets for managerial decisions, it is natural to examine whether media coverage is linked to firm behavior and the real economy. This section reviews studies that use media data to analyze the relation between corporate finance and the information environment.

5.1. Media and Firm Performance

Media coverage could improve firm performance in two ways. First, coverage could serve as advertising that increases consumer awareness of the firm and improves attitudes toward its products, thereby increasing firm revenues and profits. As a result, firm decisions that influence media coverage, such as disclosure or financing policies, could affect performance. In this spirit, Demers & Lewellen (2003) argue that IPO events and IPO underpricing attract media attention and generate valuable publicity for firms going public. The authors demonstrate that first-day IPO returns positively predict website traffic growth for Internet firms and media coverage for non-Internet firms, suggesting significant marketing benefits.

Second, coverage could enhance firm performance by reducing the costs of monitoring corrupt or inefficient managerial behavior. Dyck, Volchkova & Zingales (2008) analyze media coverage of corporate governance violations by Russian firms from 1999 to 2002. They show that international media coverage increases the probability that a firm reverses a corporate governance violation, presumably motivated by external social and shareholder pressure. Kuhnen & Niessen (2012) examine media coverage of chief executive officer (CEO) pay in the United States and show that negative coverage predicts reductions in stock option grants. Enikolopov, Petrova & Sonin (2013) investigate the effects of blog postings about corruption in Russian state-controlled firms

and find that postings positively predict management turnover. Collectively, these results are consistent with the theory that media plays an important monitoring role.

5.2. Media and the Cost of Capital

If media coverage influences the price at which firms raise or acquire capital, managers have incentives to take actions that affect coverage. Actions that could improve media coverage include issuing more press releases, hiring an IR firm, or increasing advertising expenditures. Bushee & Miller (2012) demonstrate that hiring an IR firm increases media coverage, analyst following, and institutional investor holdings. Gurun & Butler (2012) find that firms' advertising expenditures in local media outlets positively predict the linguistic tone of local news about the firms.

Media coverage, particularly positive coverage, can help firms raise capital by increasing investor awareness and investor sentiment. Cook, Kieschnick & Van Ness (2006) and Liu, Sherman & Zhang (2014) test this idea in analyses of media coverage prior to firms' IPOs. Cook, Kieschnick & Van Ness (2006) find that a firm's pre-IPO publicity positively predicts its stock return and retail investor trading on the IPO date. Liu, Sherman & Zhang (2014) show that pre-IPO media coverage positively predicts a stock's long-term valuation, liquidity, analyst coverage, and institutional ownership. Both studies conclude that media coverage reduces firms' cost of raising capital.

Media coverage could also affect the cost of acquiring capital. Ahern & Sosyura (2014) analyze mergers in which firms use their stock as currency for acquiring another firm. They show that bidders in stock mergers issue more press releases during merger negotiations and that the temporary run-up in bidder stock price associated with such stories decreases the effective cost of acquiring the target firm's stock.

Just as firms need capital, mutual funds rely on the willingness of investors to provide capital. Solomon, Soltes & Sosyura (2014) analyze whether mutual funds' disclosures of stock holdings affect investors' capital allocation choices. The researchers show that funds holding stocks with high past returns attract inflows of capital only if these stocks are mentioned recently in major newspapers. Such capital inflows give fund managers incentives to hold stocks featured in the news. Consistent with this incentive, Falkenstein (1996) finds that mutual funds tend to hold stocks that appear in the news. Fang, Peress & Zheng (2011) show that fund managers who buy stocks with high media coverage tend to underperform relevant benchmarks by up to 2% per year, suggesting these fund managers behave inefficiently.

5.3. Textual Analysis of Media as a Measurement Tool

The words in media reports and firm disclosures convey information to investors. Econometricians can also analyze these texts to improve their evaluation of firms' information environments, allowing for novel tests of economic theories. Recent studies apply textual analysis to media to test theories of IPOs (Hanley & Hoberg 2010, Jegadeesh & Wu 2013, Loughran & McDonald 2013), mergers (Hoberg & Phillips 2010), product market competition (Hoberg, Phillips & Prabhala 2014), financial constraints (Bodnaruk, Loughran & McDonald 2013), disclosure policy (Li 2008; Loughran & McDonald 2014a,b), and manager behavior (Malmendier, Tate & Yan 2013). (A recent study by Mayew & Venkatachalam 2012 uses voice analysis to measure managers' affective states.) The richness of textual data allows researchers to construct measures of concepts such as similarity of firms' products, readability of disclosures, and managerial overconfidence. (Manela & Moreira 2013 apply textual analysis to estimate the forward-looking volatility of asset returns.)

6. DISCUSSION AND DIRECTIONS FOR FUTURE RESEARCH

Two sets of findings from the literature on media in finance offer especially fertile ground for further study. First, anecdotal studies suggest the impact of media on asset prices could be enormous, with the publication of single articles causing prices to rise or fall by factors of three to six. But the large-scale evidence from studies using instruments for exogenous changes in media reporting reveals impacts that are smaller by an order of magnitude. One can reconcile these facts by arguing either the anecdotes are unusual or the instruments are weak. Future research should determine the merits of these explanations.

Second, one of the most important and unsettling findings in the literature is the weak link between information arrival and asset price movement. The evidence suggests that underreaction of prices to information and overreaction to noninformation partly explain this weak link. A complementary possibility is that high-frequency changes in risk premiums influence prices and volume. However, the properties of measurable firm-level risk and market returns noted by Lewellen & Nagel (2006) cast doubt on the quantitative importance of this risk-based explanation. The importance of the two remaining classes of explanations remains debatable. Private information could be critical for explaining market activity, as suggested by French & Roll (1986). Alternatively, current measures of public information may be inadequate.

The abundance of public data in modern society presents opportunities for testing these competing theories, but it also makes identifying, parsing, and analyzing implications for market activity challenging. Given the potential importance of quasi-public information, such as widely dispersed word-of-mouth communication and Internet chatter, allocating more resources to the collection and analysis of such data seems worthwhile. In this spirit, a flurry of recent studies by Bollen, Mao & Zeng (2011); Giannini, Irvine & Shu (2013); Heimer & Simon (2012); Karabulut (2013); and Chen et al. (2013) undertakes the challenge of analyzing data from social networks of investors, including Facebook, Seeking Alpha, and Twitter.

These data, along with data on individuals' media viewership and search activity, can help researchers understand the role of attention and active information gathering in financial markets. For example, by measuring how many potential investors view specific content at specific times, one could analyze how information diffusion across investors affects trading behavior and asset price adjustment. Then one could test the growing number of theories of information diffusion within investor networks. Continued improvements in access to data and computing power are likely to propel this line of research for years to come.

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