Trading Volume around Earnings Announcements and Other Financial Reports: Theory, Research Design, Empirical Evidence, and Directions for Future Research

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Abstract

This paper reviews, synthesizes, and critiques the capital market literature examining trading volume around earnings announcements and other financial reports. Our purposes are to assess what we have learned from examining trading volume around these announcements and to suggest directions for future research. We conclude that researchers have yet to realize the potential Beaver (1968) identified for trading volume to yield unique insights regarding the nature of earnings announcements and other financial reports, and the effects of these announcements on market participants. This state of the literature is attributable to a dearth of volume theory early on, and more recently to a disconnect between theoretical development and empirical research. Thus, we begin by briefly summarizing developments in trading volume theory since Beaver (1968). We also discuss unique measurement challenges in trading volume research, including identifying appropriate proxies for abnormal trading volume and for individual investors' beliefs. In light of theory and empirical measurement issues, we interpret the current literature and identify directions for future research. We conclude that extant research just scratches the surface of what trading volume can reveal about the characteristics of financial disclosures and the effects of these disclosures on investors.

Keywords: Trading Volume, Earnings Announcements, Information Asymmetry, Investor Disagreement

JEL Descriptors: D53, D82, G12, M41

1. Introduction

This paper reviews, synthesizes, and critiques the literature examining trading volume around earnings announcements and other financial reports. Our purposes are to assess what we have learned from examining trading volume around these disclosures and to suggest potentially fruitful directions for future research. Most empirical studies of trading volume around financial disclosures appear in the accounting literature, but we include relevant work in economics and finance. We also discuss theoretical and experimental studies. The breadth of our review reflects our belief that advancing this literature will require merging insights from multiple disciplines and research methods. Our ultimate goal is to stimulate further research in an area that has the potential to yield valuable new insights. [1]

In one of the first and most influential capital market studies in accounting, Beaver (1968) identified the potential for trading volume to yield unique insights regarding the nature of earnings announcements and how they affect market participants. Beaver argued that trading volume reactions reflect a lack of consensus regarding the appropriate price of the firm's shares. Further, he asserted that trading volume reactions capture changes in the expectations of individual investors while price reactions reflect changes in the expectations of the market as a whole. Because a given earnings announcement could be neutral in the sense of not changing the expectations of the market as a whole (i.e., leading to no price reaction) and yet greatly alter the expectations of individuals (leading to trading), Beaver (1968, 69-70) concluded that volume reactions may be more sensitive tests of the usefulness of a public disclosure than price reactions.

[1] Our goal is not to provide synopses of an exhaustive set of all empirical studies of trading volume around financial disclosures. Instead, our goal is to provide an integrated discussion of what we think we have learned from examining trading volume reactions to public disclosures over the past forty years. As such, our review encompasses representative studies from important historical and emerging streams of theoretical, archival, and experimental research on trading volume around earnings announcements and other financial disclosures.

Beaver (1968) was not the first to speculate that investor disagreement spurs much of the trading in capital markets. Over 100 years ago, Louis Bachelier (1900) began his seminal thesis on security price fluctuations by linking price changes to investor disagreement and trading:

> *"The influences which determine fluctuations on the Exchange are innumerable; past, present, and even discounted future events are reflected in market price, but often show no apparent relation to price changes…Contradictory opinions concerning these changes diverge so much that at the same instant buyers believe in a price increase and sellers in a price decrease."* (Reprinted in Cootner 1964, p. 17)[2]

Almost 70 years after Bachelier's (1900) treatise, researchers applied advanced data analysis tools to security price formation and fluctuation, spawning an extensive literature in accounting and finance examining price reactions to financial disclosures (Cootner 1964; Ball 1994). Most of this literature, however, focuses on price reactions to earnings announcements and other financial disclosures, and largely overlooks the investor disagreement and trading volume that Bachelier asserted were fundamental characteristics of security markets.

Toward the end of the last century, Stephen Ross (1989) lamented the lack of insight regarding trading volume:

> *"…[S]urely, there can be nothing more embarrassing to an economist than the ability to explain the price in a market while being completely silent on the quantity…[I]n my mind the failure to explain the volume of trade looms as the major dark continent for explorers of this terrain."*

Ross (1989, 94) acknowledged that theorists had largely ignored the role of investor disagreement and trading volume, and he called for theorists to construct a model of trade "that is at one and the same time appealingly rational and yet permits divergent and changing opinions

[2] Similarly, Hong and Stein (2007) argue that early economists such as Adam Smith and John Stuart Mill believed that elevated trading volume (i.e., "overtrading") caused stock prices to vary widely from intrinsic value, perhaps because these economists were influenced by the South Sea Bubble of 1720. (After Britain granted the South Sea Company a monopoly to trade with South America, the Company's share price skyrocketed in a speculative frenzy from just over £100 in January of 1720 to nearly £1,000 in July, before plummeting to just over £100 by December.)

in a fashion that is other than ad hoc."[3]

Since Ross's (1989) discussion, theorists have made significant advances in incorporating divergent and changing opinions to explain trading volume reactions – as well as share price reactions – to public disclosures (See the review in Verrecchia 2001). These theoretical models, coupled with wider availability of trading data, paved the way for capital market research examining trading volume around earnings announcements and other financial disclosures (e.g., Ziebart 1990; Stice 1991; Cready and Mynatt 1991; Lee 1992; Atiase and Bamber 1994; Kross, Ha, and Heflin 1994; Kandel and Pearson 1995; Bamber, Barron, and Stober 1997, 1999; Utama and Cready 1997; Cready and Hurtt 2002; Landsman and Maydew 2002; Ahmed, Schneible, and Stevens 2003; Bailey, Li, Mao, and Zhong 2003; Asthana, Balsam, and Sankaraguruswamy 2004; Barron, Harris, and Stanford 2005; Ball and Shivakumar 2008; Ali, Klasa, and Li 2008). To date, however, there has been no attempt to review this literature, as previous reviews of capital market research reflect the emphasis on the relation between financial reports and share prices (e.g., Fama 1970*;* Lev and Ohlson 1982; Bernard 1989; Kothari 2001). To address this void in the literature, we review, synthesize, and critique capital market studies of trading volume around financial disclosures and offer suggestions for future research.

We believe that a review of research on trading volume responses to earnings announcements and other financial disclosures is warranted for the following reasons. First, trading is a significant economic activity: both daily trading volume and trading volume reactions to earnings announcements have increased since Beaver's (1968) seminal study.

[3] Researchers in financial economics have renewed the call for asset-pricing models that give trading volume a prominent role. For example, Hong and Stein (2007, 111) state:

> "[W]e find it hard to imagine a fully satisfying asset-pricing model—in either the rational or behavioral genres—that does not give a front-and-center role to volume. Trading volume is extremely large across virtually all developed stock markets, and many of the most interesting patterns in prices and returns are tightly linked to movements in volume…"

Landsman and Maydew (2002) find that the average daily turnover of a firm's shares increased tenfold from 0.06% to 0.6% and that abnormal trading volume at quarterly earnings announcements increased significantly over the period 1972–1998.

Second, trading in response to a financial disclosure arguably provides the most direct evidence that the disclosure has affected individual investors' expectations and investment decisions. Recent empirical evidence suggests that trading volume reactions to financial disclosures are more readily detected than price reactions (Cready and Hurtt 2002). Yet, we have limited understanding of different classes of investors and their incentives to trade in announcement and non-announcement periods. This is a significant void because the trading behavior of less sophisticated investors has become more important to regulators since the advent of online trading (Ahmed et al. 2003), and regulators are also increasingly interested in the trading of hedge fund managers and other sophisticated investors (Fung and Hsieh 2006).

Third, trading volume reactions are of interest because of the potential to yield insight into the effects of financial disclosures on (unobservable) disagreement across investors, including disagreement arising from information asymmetry. Growing share turnover, which exceeded 130% on the NYSE in 2008,[4] has led many researchers in economics and finance to conclude that investor disagreement plays a greater role in the capital markets than has previously been acknowledged (e.g., Hong and Stein 2007), and Garfinkel (2009, 1317) concludes that unexpected volume "is the preferred proxy for opinion divergence." There is also a growing belief that the cost of capital increases with opinion divergence if this divergence results from some investors being at an informational disadvantage that causes them to demand a higher return to enter the market (e.g., Verrecchia 2001; Easley, Hvidjkaer, and O'Hara 2002;

[4] From the NYSE website, accessed February 13, 2010:
http://www.nyxdata.com/nysedata/asp/factbook/viewer_edition.asp?mode=table&key=3084&category=3

Botosan and Plumlee 2002; Botosan, Plumlee, and Xie 2004; Barron et al. 2005). Thus, trading volume may also yield insight into firm valuation, underscoring the importance of understanding trading volume in addition to price.

Trading volume is also of interest because of its potential to yield insights regarding information asymmetry and investor disagreement that are of particular interest to accounting researchers and policymakers. A major goal of financial disclosure regulation is to "level the playing field" by reducing the informational disparity among investors (Levitt 1998a, 1998b, 1999). Evidence that some of the trading response to a financial disclosure results from newfound investor disagreement is important because such evidence suggests that the disclosure is not completely effective in leveling the informational playing field. For example, recent evidence that a significant portion of the trading around earnings announcements stems from differential interpretations of the announcement (e.g., Bamber et al. 1999; Barron et al. 2005; Garfinkel and Sokobin 2006) raises questions about the effectiveness of such announcements in reducing information asymmetry and investor disagreement.

We find, similar to Ross' (1989) review of the theoretical literature, that trading volume looms as a relatively unexplored area of capital market research. Although the empirical literature documents many regularities consistent with various theoretical models, and we have gleaned useful insights about the characteristics of financial reports and the effects of financial reports on investors, the literature lacks a unified theoretical framework for interpreting trading volume around financial disclosures. Fundamental measurement and interpretation questions remain unanswered. For example, we still lack precise measures of the proportion of trading around announcements that stems from information asymmetry and investor disagreement vis-à-vis the proportion of trading arising from other factors (such as differences in investors' liquidity

needs, risk preferences, or portfolio rebalancing needs). The lack of a well-accepted measure of the level of background or "liquidity" trading that occurs even absent new information is an important impediment because researchers must subtract liquidity trading to measure announcement-induced trading.

Another obstacle is identifying empirical proxies that closely map into theoretical constructs in models of trading volume around financial disclosures. For example, theory relies on constructs such as the precision of public and private information. Fortunately, there have been significant advances in empirical measurement of theoretical constructs (e.g., Kandel and Pearson 1995; Barron, Kim, Lim and Stevens 1998). Part of our goal is to interpret the empirical evidence in light of recent advances in theory and empirical measurement. By examining what we have learned from research on trading volume around earnings announcements and other financial disclosures, and by identifying directions for future research, we hope to spur interest in this underrepresented area of capital market research.

Our primary target audience is researchers (including Ph.D. students) who are considering investigating trading volume around financial disclosures. In our experience, scholars not actively involved in this line of research are often surprised by the extent to which theory, measurement, and interpretation of trading volume reactions differ from those of price reactions. Thus, it is rarely appropriate to simply substitute trading volume for returns as the dependent variable in a regression of "market reaction" on features of a financial disclosure. Consequently, we begin by discussing fundamental theory and research design. Section 2 summarizes the historical development of theory on trading volume responses to public financial disclosures. In Section 3, we review and critique research designs, including measures of trading volume. Section 4 reviews and critiques empirical research, from the early evidence of trading

volume around financial disclosures to the more recent investigation of disagreement-related determinants of trading volume. Section 5 summarizes what we think we have learned about financial disclosures and the effects of these disclosures on investors from studying trading volume. We conclude that extant research merely scratches the surface of the types of insights that analysis of trading volume can provide. Section 6 identifies directions for future research, and Section 7 concludes.

2. Theoretical underpinnings: Trading volume reactions to public disclosures

This section summarizes the historical development of theoretical models of trading volume around public announcements. The purpose of this summary is to identify the theoretical underpinnings of empirical research on trading volume around public announcements and to explain why trading volume-based research has lagged behind price-based research. We begin by explaining how the assumption of fully-revealing market prices left no role for trading in early models of financial markets, and how adaptive expectations models provided an initial impetus to study trading. We then explain the development of partially-revealing rational expectations models and illustrate their usefulness by discussing Kim and Verrecchia's (1991a) commonly-cited model and related extensions. Finally, we discuss limitations of partially-revealing rational expectations models and the recent development of "disagreement" or "differences of opinion" models of trade that relax the assumption of investor rationality.

Theory: Early models

At the time of Beaver (1968), researchers had little theory to help them structure and interpret tests of trading volume around public announcements. Theorists generally assumed market prices fully reveal all public and private information (Fama 1970), leaving no room for security trading due to informational differences or investor disagreement. The assumption of

fully revealing market prices led to the "no-trade theorem:" Given common knowledge that all investors have rational expectations,[5] new public information cannot induce trade if the initial allocation of shares is Pareto optimal (Aumann 1976; Milgrom and Stokey 1982).[6]

To allow the possibility of trade, theorists first abandoned the rational expectations assumption. Early models of trade assumed investors learn nothing from market price and react adaptively to public information releases (e.g., Epps 1975, 1976; Jennings, Starks, and Fellingham 1981; Karpoff 1986; Jang and Ro 1989). These models formalize Beaver's (1968) intuition that trading volume preserves differences in individual belief revisions that are averaged out in price. These early models identify two determinants of trading volume around a public announcement: (1) heterogeneous prior expectations, and (2) heterogeneous reactions to the announcement (e.g., Karpoff 1986). By assuming that investors learn nothing from market price, however, these models sacrificed realism for the sake of tractability (Karpoff, 1987).

Theory: Partially-revealing (noisy) rational expectations models

Grossman and Stiglitz (1980) showed that theorists can incorporate investor disagreement leading to trade without abandoning the assumption of rational expectations (that investors learn from market price). First, Grossman and Stiglitz demonstrate the practical impossibility of fully-revealing market prices: Competitive markets break down when security prices are fully-revealing because investors are unable to earn a return on their investment in costly information, so information gathering activities grind to a halt. Second, Grossman and Stiglitz demonstrate a

[5] Common knowledge that all investors have rational expectations implies that all investors know that all investors have rational expectations, that all investors know that all investors know that all investors have rational expectations, etc. (Milgrom and Stokey 1982).

[6] The no-trade theorem is based on the adage that investors with rational expectations cannot agree to disagree. Since the initial allocation is Pareto optimal, an investor's only motive to trade after receiving new information is to find an advantageous bet. The willingness of another investor to accept his part of the bet is evidence to the first investor that his own part is *not* advantageous (Milgrom and Stokey 1982).

way to make market price "partially-revealing" so that investors can earn a return on their costly investment in information. Specifically, they add noise to the market by incorporating uncertainty in the per capita supply of the traded asset. This supply noise prevents price from being fully revealing because investors can no longer fully distinguish between: (1) market fluctuations arising from new private information, and (2) market fluctuations arising from supply shocks that are unrelated to information.[7]

After Grossman and Stiglitz (1980), a new stream of rational expectations models assumed investors learn from price, but price reveals private information *with noise* (e.g., Kyle 1985; Grundy and McNichols 1989; Holthausen and Verrecchia 1990; Kim and Verrecchia 1991a, 1991b, 1994, 1997, 2001; Campbell, Grossman, and Wang 1993; Dontoh and Ronen 1993; Blume, Easley and O'Hara 1994; Demski and Feltham 1994; McNichols and Trueman 1994; Wang 1994; He and Wang 1995; Tkac 1999; Chae 2005). These theoretical models are frequently labeled partially-revealing or "noisy" rational expectations models.

To illustrate the intuition behind these models, we rely chiefly on Kim and Verrecchia's (1991a) commonly-cited model and related extensions. Kim and Verrecchia's (1991a) model allows a round of trade before and after an anticipated public announcement. Before the first round of trade, each trader observes a public signal and a private signal regarding the value of a risky asset. The round of trade before the announcement allows traders to achieve a Pareto optimal allocation of shares, which assures that no trading will occur in the subsequent period absent an announcement. After the first round of trade, traders observe the anticipated public announcement and engage in a second round of trade.

[7] Theorists argue that supply noise is realistic, as securities markets are constantly subject to random supply and demand fluctuations arising from investors' changing liquidity needs (Kim and Verrecchia 1991a). While supply noise represents liquidity and/or asset supply shocks (Verrecchia 2001, 119), it is general enough to capture any kind of market noise that keeps market price from being fully revealing.

Kim and Verrecchia (1991a) show that the volume reaction to the announcement is proportional to: (1) the absolute price change at the time of the announcement, and (2) the differential precision of preannouncement private information across traders. Thus, even though the announcement is commonly interpreted (i.e., each trader identically perceives the correct mean and precision of the signal and its realization), the differential precision of private predisclosure information generates *differential belief revision* among traders, which in turn generates trading. This is because traders weight each of their information signals by its precision. Traders with less precise private predisclosure information weight the announcement more heavily, whereas those with more precise private predisclosure information place less weight on the public signal. This differential belief revision causes some traders' expectations (i.e., reservation prices) to cross, which motivates them to change the original allocation of shares through trade. This is why differential prior precision is necessary to generate trade at the time of the commonly-interpreted public announcement in Kim and Verrecchia's (1991a) model.

As with all models, Kim and Verrecchia (1991a) is based on a set of limiting assumptions that sacrifice generality for tractability. One factor absent from the model is a cost of private information.[8] Kim and Verrecchia (1991b) add a cost of private information that is increasing in its precision. They find that a decrease in the cost of private information causes an increase in differential prior precision across investors because investors with more precise information are motivated to increase the precision of their private information more than investors with less precise information (Proposition 4, page 288).

Another factor absent from Kim and Verrecchia's (1991a) model is differential interpretation of the public announcement. Kim and Verrecchia's (1997) model adds differential

[8] The absence of a cost for private information is limiting because, as Grossman and Stiglitz (1980, 404) assert, price systems and competitive markets are important only when some private information is costly.

interpretations arising from event-period private information that can only be used in conjunction with the public announcement (such as information gleaned by studying the annual report). Such event period private information can be considered a specific source of the more general construct of differential interpretations,[9] which in turn lead to trading volume that is unrelated to absolute price change. Thus, a key result of the Kim and Verrecchia (1997) model is that trading volume associated with absolute price change continues to be driven by differential precision of private predisclosure information, whereas differential interpretations lead to trading that is unrelated to the magnitude of the contemporaneous price reaction.

Theory: Limitations of rational expectations models

Because of the well-established body of theory (as summarized in Verrecchia 2001), rational expectations models play a dominant role in the empirical literature (Cready 2007). Rational expectations models are also consistent with Ross's (1989, 94) call for theorists to develop a model of trade "that is at one and the same time appealingly rational and yet permits divergent and changing opinions in a fashion that is other than ad hoc."

These models have limitations, however. Incorporating differential preannouncement information and differential interpretations into the same model poses a challenge (Verrecchia 2001, 121-123). Dontoh and Ronen (1993) were the first to include both sources of differential belief revisions in the same rational expectations model. Their paper focuses on characterizing

[9] Hereafter, we use the broader term *differential interpretations* for Kim and Verrecchia's (1997) event-period private information because as Kim and Verrecchia (1997, 399) point out, it is impossible to distinguish whether differential interpretations of an announcement result from event-period private information or from different likelihood functions arising from other sources (see Kandel and Pearson 1995). There is also debate whether differential interpretations can occur in the absence of private information. One view is that differential interpretations can exist in the absence of new private information because investors have different backgrounds and psychological biases. The other view is that even these differences represent differences in information arising from different experiences or cognitive traits. Whatever the source, intuition and empirical evidence (e.g., Gillette et al. 1999) suggest that investors often differ in their interpretations of commonly observed signals.

information content, and their primary result is that neither price reaction nor volume reaction alone provide a complete characterization of information content. In contrast to Dontoh and Ronen's focus on information content, Kim and Verrecchia (1997) use their model to show that cross-sectional differences in the precision of preannouncement information and differential interpretations manifest themselves as differences in the relation between price changes and trading volume. Neither model, however, yields clear expressions or empirical proxies for the two sources of differential belief revision when both are present in the model. Specifically, Dontoh and Ronen (1993) rely on graphs of numerical simulations for their results and Kim and Verrecchia (1997) rely on corner solutions where only one source of differential belief revision is present at a time. Because of this modeling difficulty, rational expectations models typically include *either* differential preannouncement information *or* differential interpretations to generate trading volume, but not both.

There are other limitations of rational expectations models. For example, modeling pure exchange economies abstracts from any role for production. These models also assume perfectly competitive markets, yet Lambert, Leuz, and Verrecchia (2008) find no direct role for information asymmetry on the cost of capital under perfect competition. Rational expectation models also typically include a single risky asset, which is problematic because investors cannot reduce their investment risk through diversification. Finally, disagreement leading to trade takes a stylized form -- these models typically generate investor disagreement through differences in information, and generally do not allow investors' cognitive limitations to affect trading (Banerjee and Kremer 2009). This limitation has led some theorists to create models that relax strict assumptions of investor rationality.

Theory: Relaxing the assumption of strict investor rationality

The common criticism levied against models allowing investor irrationality is that they potentially explain everything, which, in turn, suggests they explain nothing (Verrecchia 2001, 123-124). However, researchers in behavioral economics and finance find that such models help bridge the gap between traditional market theory and findings in psychology. For example, Kandel and Pearson (1995) develop a model of Bayesian updating that allows investors to use different likelihood functions to interpret a public announcement. Other recent "differences of opinion" models in economics and finance model investor heterogeneity as stemming from differences in information processing or differential preferences. These models incorporate such behavioral constructs as prospect-theory behavior (Barberis and Huang 2001), biased beliefs (Barberis, Shleifer, and Vishny 1998; Daniel, Hirshleifer, and Subrahmanyam 1998), limited attention (Hirschleifer and Teoh 2003; Peng and Xiong 2006), myopic dismissal of other traders' information (Banerjee and Kremer 2009), and overconfidence (Odean 1998; Peng and Xiong 2006). For example, Odean's (1998b) model predicts that a significant portion of investor disagreement arises because overconfident investors tend to overestimate the precision of their own private information relative to the information available to other investors.

The trading volume arising in these disagreement models, however, often resembles the results from rational expectations models that use differential information to generate investor heterogeneity. For example, in Banerjee and Kremer's (2009) model, trading volume arises from: (1) a belief convergence component driven by differences in prior beliefs, and (2) a belief divergence component driven by differential interpretation. Furthermore, rational expectations models can also incorporate noninformation-based idiosyncratic differences among investors. For example, Fischer and Verrecchia (1999) find that public disclosure reduces, but does not necessarily eliminate, the number of heuristic traders who overreact to public information in a

manner consistent with the representativeness heuristic.

Theory: Determinants of trading volume around financial disclosures

We now summarize the primary theoretical determinants of trading volume around earnings announcements and other financial disclosures, grouped into two broad categories: (1) those related to informational differences among investors, and (2) those unrelated to informational differences.

Theoretical determinants of trading: Determinants related to informational differences

A general result common across the early adaptive expectations models, the noisy rational expectations models, and the more recent difference of opinions models is that trading around public announcements stems from differential belief revision caused by differences in: (1) investors' preannouncement beliefs, (2) investors' interpretations of the announcement, or both. To simplify our discussion of these differences, we again return to the rational expectations model of Kim and Verrecchia (1991a). In this model, each investor i receives a signal about an upcoming earnings announcement. These signals are distributed with a zero mean, and precision s_i, and differences in investors' preannouncement beliefs are in part driven by cross-sectional differences in the quality, or precision of their preannouncement information (i.e., the precision of information s_i is unique to each investor). As discussed earlier, trading around a public announcement is a joint function of differential prior precision and the absolute price change at the announcement. Differential precision of predisclosure information spurs trading because investors with more precise predisclosure information place more weight on their prior information and less weight on the announcement than investors who had less precise predisclosure information. The role differential precision of information plays in spurring trading is of special interest to accounting scholars and policymakers, because differential precision

means that some investors are at an informational disadvantage relative to others, and so information asymmetry exists.

But differential *precision* of preannouncement information is not the only possible source of differential prior beliefs. Even if all investors receive preannouncement signals of equal *precision* (i.e., $s_i = s$ for all investors, and so no investor is at an informational disadvantage), this does not mean that that the signals themselves are identical. That is, two signals may be different even if their precision is equal. Although it is not the case in Kim and Verrecchia (1991a), other models suggest that this type of prior period "disagreement" can also lead to subsequent trading around a commonly interpreted public announcement (e.g., Karpoff 1986).[10]

The other major class of information-related differences that spurs trading is different interpretations of the announcement. Theorists have modeled differential interpretation by incorporating idiosyncratic noise in the public announcement (e.g., Holthausen and Verrecchia 1990; Dontoh and Ronen 1993), by introducing a private signal that can only be interpreted in conjunction with the public announcement (e.g., Kim and Verrecchia 1994; 1997), and by allowing investors to use different likelihood functions in interpreting the announcement (Kandel and Pearson 1995).[11] Rational expectation models allowing a differentially interpreted public announcement typically find that this differential interpretation generates trading that is

[10] Verrecchia (2001, 120-121) also suggests that other sources of preannouncement investor heterogeneity (e.g., differences in risk preferences) lead to trading associated with prices changes, in a manner similar to differential prior precision.

[11] Models of trading in general (as distinct from models of trading around public announcements) also rely on informational differences among various classes of investors, but we do not consider these models in detail because they typically do not focus on the trading volume around public announcements that is of most interest to accounting researchers. For example, one group of models includes a market maker who sets the bid-ask spread based on the behavior of investors and information asymmetries that might exist between himself and those investors (e.g., Kyle 1985 Admati and Pfleiderer 1988). These "Kyle-type" models typically focus on the relation between information asymmetry and market liquidity as measured by the bid-ask spread, but they also examine trading volume. Brunnermeier (2001) provides an overview of these Kyle-type models, and he also discusses phenomena such as gradual information flow (some investors learn information before others) which may have implications for future research on the effects of public financial disclosures.

independent of absolute price change.

Theoretical determinants of trading: Determinants unrelated to informational differences

Other factors can magnify or dampen the trading volume around an earnings announcement caused by differences in investors' information. For example, Kim and Verrecchia (1991a; 1991b) show that trading generated by differential prior precision is increasing in the precision of the public announcement, decreasing in the average precision of preannouncement information, increasing in the level of supply (market) noise, and increasing in investors' risk tolerance.[12] Without differential prior precision however, these other factors play no role as there is no differential belief revision leading to trade at the time of the announcement.

Liquidity trading and transaction costs also affect trading volume reactions to public disclosures. Kyle (1985) and Admati and Pfleiderer (1988) suggest that liquidity trading camouflages informational trading.[13] This camouflage spurs informational trading by increasing the returns investors earn from trading on information. Barron and Karpoff (2004) show that investors' transaction processing costs dampen the effects of more precise information on informational trading, and Bhushan (1994) shows that higher transaction costs exacerbate post-earnings announcement drift (presumably by dampening informational trading at the earnings announcement date). Taxes can be viewed as another form of transaction cost. Shackelford and Verrecchia (2002) develop a model predicting that larger differences between short-term and long-term capital gains tax rates attenuate trading at the earnings announcement date (as

[12] Risk tolerance affects trading because investors with greater risk tolerance trade more aggressively on their private information. However, Grossman (1976) and others argue that such differences in trader preferences do not play a major role in explaining the magnitude of trade in speculative markets (Grossman and Stiglitz 1980, 402).

[13] Most extant models of trading around public announcements assume perfectly competitive markets in which investors are price-takers who do not influence security price levels. A possible exception is Kyle (1985), where some trades influence price because less informed traders rationally anticipate that some of the other trading likely reflects other traders' relative information advantage. Our later discussion of directions for future research suggests that theorists can contribute by modeling trading volume reactions to public announcements in an imperfect market, and the relations among this trading, security prices, and firms' cost of capital.

investors are less likely to immediately sell a winning stock given higher short-term tax rates and are more likely to hold the stock until the gain would be taxed at the lower longer-term rate). Collectively, these models suggest a certain level of liquidity trading or limitation on transaction costs may be necessary to support a significant trading reaction to a financial disclosure.[14]

Summary

This section summarized the development of the theoretical underpinnings of empirical research on trading volume reactions to financial disclosures. Trading volume theory developed more slowly than price theory, largely because of assumptions that left no room for investor disagreement that spurs trade. Thus, early empirical researchers had little theory to guide them in designing and interpreting empirical tests of trading volume responses to financial disclosures. Theory developed after Beaver (1968) generally supports his original intuition that price reactions primarily reflect the change in the aggregate market's expectation of firm value, whereas volume reactions also reflect differential belief revision (caused by either differential interpretation of the announcement or differential pre-announcement beliefs).

Before explaining how empirical researchers have examined these models' predictions, we discuss measurement challenges that make it difficult to fully capitalize on trading volume theory. More casual readers who are primarily interested in a summary of what empirical research has concluded from analyses of trading around financial disclosures may wish to proceed directly to Section 4.

[14] Morse (1980, 1130) suggests other noninformational investor differences that are likely to affect trading volume around public announcements: (1) differences in portfolio rebalancing needs, and (2) differences in wealth. In addition, increasing reliance on Black-Scholes option pricing models and the increasing use of financial derivatives are both likely to be associated with higher levels of trading, as investors rebalance their portfolios after financial disclosures spur changes in perceived riskiness or in the prices of securities.

3. Empirical research methods and measures

This section reviews and critiques the methods and measures used in empirical studies of trading around financial disclosures. We raise research design issues and provide a foundation for interpreting the empirical evidence in the following section. We begin by discussing the most fundamental challenge: measuring the trading volume due to public disclosures.

Empirical measures of volume: Number of shares or number of transactions?

Most studies of trading volume around disclosures use daily trading volume data from the Center for Research in Security Prices (CRSP). These summary data are relatively easy to access, but they do not contain information on individual trades. Other studies use data on individual trades available from the Institute for the Study of Security Markets (ISSM) from 1988-1992 and the Trade and Quote (TAQ) database from 1993 onward. The number of transactions captures the number of times investors are motivated to act, whereas trading volume encompasses the magnitude of the action as well as the decision to act (Cready and Ramanan 1995).[15] The appropriate measure of trading volume depends on the purpose of the study and the underlying theory. Other important considerations include the cost of the measure and the power with which it detects trading due to the release of the financial report.

Cready and Ramanan (1995) compare properties of volume-based measures (number of shares traded) with transaction-based measures (number of transactions). Using simulations based on market data, they conclude that a transaction-based design is more powerful in that it detects a given percentage increase in trading more frequently than a comparable volume-based design. This increase in power arises because the number of transactions exhibits less variation

[15] Cready and Ramanan (1995) point out that the number of transactions can be a noisy measure of investor decisions to transact because incoming orders may be batched together and executed as a single transaction, and conversely, a single large order may be broken up into a series of transactions.

than the volume of shares traded. However, the difference in power diminishes rapidly as sample size increases from 20 to 100. Given the relatively high cost of transaction data, Cready and Ramanan recommend that researchers use transaction-based measures rather than volume-based measures when: (1) the specific research question or underlying theory pertains to individual market participants' decisions to trade; (2) the sample size is small (less than 100); (3) the researcher expects any trading response to be small or concentrated among small investors; or (4) the researcher wants to confirm a "nonresponse" result when an initial analysis of summary trading volume data fails to detect a significant trading response.[16]

Empirical researchers typically measure trading volume as the percentage of shares traded relative to the number of shares outstanding, which Lo and Wang (2000, 258) characterize as a "natural measure of trading activity." This share turnover measure controls for firm size and the fact that the number of shares outstanding and the number of shares traded have grown steadily over time As Campbell, Grossman, and Wang (1993) show, this turnover measure still exhibits an upward trend over time, possibly due to elimination of fixed commissions in 1975 (Campbell et al. 1993), technological innovations such as online trading (Ahmed et al. 2003), and the increase in trading activity of institutional investors — especially hedge funds (Fung and Hsieh 2006). In the remainder of this review, references to empirical trading volume tests assume a share turnover measure.

Empirical measures of volume: To adjust or not to adjust?

In the search for an appropriate measure of trading volume, researchers must decide whether to adjust for some expected level of trading to control for trading unrelated to the information event of interest, thereby increasing the power of statistical tests. Whether, and how,

[16] Another approach to confirming a "nonresponse" is to explore the trading around an event over different time frames such as the minutes, hours, and weeks around the event.

to adjust for normal trading volume is problematic. First, theory does not always provide clear guidance whether total trading or abnormal trading is the preferable measure. Second, there is no theoretically or empirically agreed-upon measure of "normal" trading volume that is not due to an announcement, so any adjustment is necessarily *ad hoc*. Third, attempting to adjust for some estimate of this normal trading is likely to eliminate part of the informational trading effect of interest. We discuss each in turn.

Ideally, the decision whether or not to adjust for some expected level of volume should be driven by theory, but theory is not always clear on the issue. Models of trading around a public disclosure generally probe the determinants of the *level* of informed trading around the release and not the *increase* in informed trading or the *abnormal* level of informed trading (e.g., Kim and Verrecchia 1991a), and thus lack an explicit role for noninformational trading. On the other hand, the shocks in the supply of the traded asset – i.e., the events that prevent prices from being fully revealing in rational expectations models – are noninformational trades. Kim and Verrecchia (1991a Proposition 2) predicts that supply shocks will result in more information-based trading around a public announcement. Thus, noninformational trading may cause more information-based trade around a public disclosure.

Kandel and Pearson (1995) argue that the ongoing level of security trading actually observed in nonannouncement periods is too high to be explained by liquidity needs. In particular, these nonannouncement periods appear to contain substantial informed trading spurred by the constant flow of information. This is problematic because most researchers define "nonannouncement" periods simply as periods without the public announcement of interest. Because of the constant information flow to the market, the average firm-specific level of trade

in the nonannouncement period reflects the average trading volume response to the normal flow of information in addition to the normal, noninformational trading. Thus:

1) The "normal" or average level of trading in a "nonannouncement" period exceeds noninformational trading because of the constant flow of information to the market.

2) Because theory suggests informed investors trade more actively when there is more noninformational trading (Kyle 1985; Admati and Pfleiderer 1988; Kim and Verrecchia 1991a), noninformational trading in a firm's stock likely increases informational trade in nonannouncement as well as announcement periods.

3) As a result of (1) and (2), adjusting for the "normal" or average level of trading in the nonannouncement period likely abstracts from part of the informational trading of interest during the announcement period. [17]

In some contexts, theory guides the decision whether or not to adjust for a normal level of nonannouncement trading. For example, Kandel and Pearson (1995) argue that when an announcement spurs insignificant price changes, there is little reason to trade other than as a result of differential interpretations.[18] Consequently, Bamber et al. (1999, 382) do not adjust for "normal" nonannouncement trading in their empirical tests of the effect of differential interpretations on trading around earnings announcements that spur no price changes, because there is little reason *other* than differential interpretations for trading at the earnings announcement date. In contrast, Barron et al. (2005) explore how announcement-related private information creates *additional* disagreement-related trading at the earnings announcement date. In this context, it is necessary to adjust for all other sources of trading.

[17] Adjustments for nonannouncement period trading also abstract from information-based trading in another manner. As mentioned in Section 2, in rational expectations models a round of trade prior to the public announcement allows investors to resolve differences based on their private information in addition to differences in risk preferences, endowments, etc. (Verrecchia 2001, 117). Thus, differential prior precision likely spurs trading in the preannouncement period as well as the announcement period. Consequently, an abnormal volume measure that abstracts from preannouncement trading is likely to underestimate the portion of the trading volume stemming from differential prior precision, reducing the power of the tests.

[18] Kandel and Pearson (1995, 839) argue that absent price changes, there is little reason for information-based trading other than that arising from differential interpretations, and Kyle (1985, 1316) and Admati and Pfleiderer (1988, 5) argue that liquidity trading is likely to be low in periods of minimal price changes and informed trading.

In many contexts, there is no theoretical guidance on whether or not to adjust. Absent a theoretical rationale, we favor examining both adjusted and unadjusted trading volume. This recognizes that adjusting may remove part of the informational effect of interest from trading volume measures, but not adjusting may leave more measurement error and correlated omitted variables in measures of announcement-induced trading.

Empirical measures of volume: How to adjust?

If a researcher decides it is appropriate to adjust for some estimate of "normal" trading volume, the next question is *how* to adjust. Again, theory is silent on the issue. Empiricists have used a number of specifications of abnormal volume, including: (1) median- or mean-adjusting for firm-specific average trading in a nonannouncement period, (2) market-adjusted volume to abstract from the effects of market-wide trading, and (3) residuals from a trading volume counterpart to the familiar market model, which adjusts for firm-specific effects through the intercept and market-wide effects through the coefficient on the market-wide level of trading.

Abnormal volume specifications typically take the following form:

$$(\text{Abnormal Volume})_{it} = (\text{Announcement Period Trading})_{it} - (\text{Expected Trading})_{it} \quad \textbf{(1)}$$

This additive form implies that abnormal volume is independent of (i.e., is additively separable from) the expected level of trading. Some researchers, however, have measured abnormal volume as actual trading *divided by* expected trading (e.g., Ali et al. 2009; Ball and Shivakumar 2008). This ratio form implies that abnormal volume is a multiple of normal trading volume.

As discussed in the next subsection, trading volume (including trading in "nonannouncement" periods) is quite skewed, due to a few days of extremely high trading. Extreme levels of trading in the nonannouncement period reflect the sensitivity of trading to the arrival of other new information during the "nonannouncement" period. For example, Bamber et

al. (1997, 585) argue that information revealed in "nonannouncement" periods induces bursts of trading that have more effect on the mean than the median level of "nonannouncement" trading. This suggests that mean-adjustments abstract from more information-based trading than median-adjustments. Consequently, most estimates of expected trading that are based on firm-specific average levels of trading in "nonannouncement" periods measure expected volume as the median (rather than the mean) nonannouncement level of trading (e.g., Kross et al. 1994; Bamber et al. 1997; Ahmed and Schneible 2007; Chen and Sami 2008).

Citing the lack of theoretical guidance for specifying normal trading volume, Tkac (1999) and Lo and Wang (2000) use capital asset pricing models to support adjusting for market-wide trading. Given strong underlying assumptions, both models predict that expected trading volume (share turnover) will be equal across firms and, therefore, across the market.[19] As these models predict, firm-specific trading is positively correlated with market-wide trading, and Ajinkya and Jain (1989, 334-335) identify four factors that may drive this positive correlation: (1) informational events that affect the entire market (e.g., interest rate changes), (2) firm-specific trading makes up the market-wide trading measure, (3) informed traders may prefer to trade with liquidity traders, and (4) information can be transferred across firms.

Even after adjusting for market-wide trading, Tkac (1999) and Lo and Wang (2000) find that institutional ownership, firm size, and option availability are associated with nonannouncement trading. Thus, a simple adjustment for market-wide trading may not completely adjust for "normal" trading that would occur in the absence of a specific financial

[19] One strong assumption in capital asset pricing models is that there is no asymmetric information in the market. Thus, it is not clear the extent to which results from CAPM-based models such as Tkac (1999) and Lo and Wang (2000) apply to noisy rational expectations or difference of opinion models. For example, Bhattacharya and Galpin (2010) use results from Lo and Wang (2000) to develop a unique measure of value-weighting in investor portfolios (i.e., the value-weighted cross-sectional variance of log turnover). Bhattacharya and Galpin acknowledge that the validity of their measure is based on the strong assumptions that underlie the CAPM, including the assumptions of no asymmetric information and preferences defined over mean and variance in a two-period static model.

announcement. Consequently, Tkac (1999) and Lo and Wang (2000) recommend a trading volume analogue to the market model that incorporates both firm-specific and market adjustments.[20] Ajinkya and Jain (1989) find, however, that market models of expected trading volume provide little improvement in the power of trading volume tests. Given the data and computational cost associated with such models, they conclude that increasing sample size is likely to be a more effective method of increasing the power of trading volume tests than fine-tuning the measure of expected trading volume (Ajinkya and Jain 1989, 350).

Empirical measures of volume: To log or not to log?

Ajinkya and Jain (1989) report that the distributions of daily trading volume for individual NYSE securities, and for relatively small portfolios of securities ($n \leq 50$), are highly skewed to the right. The daily percentage of shares traded remains highly skewed even in large samples (e.g., Bamber et al. 1997). This is problematic in research on the determinants of trading volume because the dependent variable is so highly skewed that residuals of the regressions explaining trading volume typically exhibit significant departures from normality, in terms of both severe skewness and heteroskedasticity. Empiricists usually deal with this by using nonparametric statistical tests, rank regressions, or log transformations of trading volume data.

In some cases, researchers have theoretical reasons to log the trading volume dependent variable. Kim and Verrecchia's (1991a) model predicts trading around an announcement is a multiplicative function of the absolute magnitude of the contemporaneous price change and differential precision of private predisclosure information. In their empirical tests of this prediction, Atiase and Bamber (1994) model the natural log of trading volume as a function of

[20] Garfinkel and Sokobin (2006) take a somewhat different approach and construct a market-adjusted measure of trading volume in the earnings announcement period that also adjusts for firm-specific average trading, without resorting to an OLS market model that is poorly-specified given the highly skewed distribution of trading volume.

the natural log of the absolute price change plus the natural log of a proxy for differential private predisclosure information, thereby preserving the spirit of the theoretical multiplicative relation (adding the logs is equivalent to a multiplicative relation in the underlying raw data).

In most cases, however, researchers use natural log transformations of trading volume (e.g., Richardson, Sefcik, and Thompson 1986; Sivakumar and Waymire 1994; Seida 2001; Blouin, Raedy, and Shackelford 2003; Hope, Thomas, and Winterbotham 2009) to obtain regression residuals that are more normally distributed (Ajinkya and Jain 1989), leading to better-specified statistical tests.[21] Subtracting the natural log of expected volume from the natural log of announcement period volume is equivalent to a ratio-type measure in the underlying raw data, effectively assuming abnormal volume is a multiple of normal volume. Moreover, the log transformation may throw away information regarding the effect of an announcement on trading, because ameliorating the skewness attenuates the elasticity (or responsiveness) of a firm's trading volume to the arrival of news.

In summary, if in a given research setting there is a theoretical basis for specifying a functional form (additive or multiplicative) in modeling the determinants of trading volume, then theory may guide the decision whether or not to log the variables. Given the significant departures from normality in trading volume data, however, we suggest that researchers who choose not to log provide evidence that inferences are not attributable to violations of assumptions underlying the statistical tests, for example, by reporting results based on rank transformations or nonparametric statistical tests (e.g., Sivakumar and Waymire 1994; Landsman and Maydew 2002; Ryan and Taffler 2004; Bailey et al. 2006; Garfinkel and Sokobin 2006).

[21] Campbell and Wasley (1996) report that NASDAQ securities' trading volume measures remain skewed even after log-transformation, so they recommend using both a log transform and nonparametric statistical tests.

Empirical measures of volume: Length of announcement period window

There is no theory regarding the length of time trading occurs in response to a disclosure, and the length of event windows vary widely. Early research used weekly trading volume (e.g., Beaver 1968), whereas other researchers have used windows as short as half an hour (e.g., Lee 1992). Ajinkya and Jain (1989) document that daily trading volume (unlike returns) is serially correlated. Information-induced increases in volume often linger for several days. Morse (1981) finds that while most of the volume reaction to earnings announcements occurs on days –1 and 0 relative to the *Wall Street Journal* announcement date, abnormally high volume persists up to five trading days after the announcement (see also Bamber 1987). The protracted nature of volume reactions suggests researchers may need to include up to seven days (day –1 through day +5) to fully capture the trading response to a disclosure. Most researchers use either daily trading volume (e.g., Morse 1981) or volume across 2-5 day event windows around the announcement (e.g., Kiger 1972; Bamber 1986, 1987; Cready 1988; Bamber et al. 1997; Ahmed et al. 2003; Bailey et al. 2003; Barron et al. 2005; Ahmed and Schneible 2007; Hope et al. 2009).

The serial correlation in daily trading volume also has implications for measuring expected volume. Researchers using a multi-day event window (say a three-day window) should consider measuring expected volume as the median trading volume in contiguous windows of the same (e.g., three-day) length during the nonannouncement period (e.g., Bamber et al. 1997; Ahmed and Schneible 2007).

Empirical measures of volume: Summary

Researchers face difficult choices in measuring trading volume: (1) whether to use volume-based or transaction-based measures, (2) whether to adjust for some "normal" level of trade, and if so, how to adjust (3) whether to use untransformed or logged measures of trading

volume, and (4) the length of the event window. Theory provides guidance in certain contexts, but in many others these design choices necessarily remain arbitrary. Many studies demonstrate robustness to alternative specifications of announcement period trading, but differences in specification can matter. For example, Landsman and Maydew (2002) show that their adaptation of Beaver's measure of announcement-period trading volume (announcement period trading *minus* mean estimation period trading, where the difference is scaled by the standard deviation of estimation period trading) increases over the period 1972-1998. In contrast, Ali et al. (2008, 54) conclude that their measure of announcement period trading (announcement period trading *scaled by* estimation period trading) decreased over the period 1992 to 2001, largely because estimation (i.e., nonannouncement) period trading mushroomed.

Given the current state of the literature, we recommend that empirical researchers justify their measurement choices on these four dimensions. When theory is lacking, we believe the limited improvement in power arising from complex models of expected trading volume, coupled with the extreme skewness in the underlying data, argue for a simple measure of unexpected volume: either market-adjusted or firm-specific median-adjusted trading. When primary results are based on measures of abnormal trading volume, absent strong theoretical justification for this choice, we also recommend discussing results based on unadjusted trading volume as a robustness check.

Theory posits that determinants of trading around financial disclosures center on investors' expectations and changes in those expectations. The Appendix discusses the significant challenges researchers face in measuring investors' expectations.

4. Empirical evidence on trading volume around financial disclosures

After laying the groundwork by reviewing theory and measurement issues, we now

review and critique the growing body of empirical research on trading volume responses to financial disclosures. Table 1 provides a capsule summary of this research.

Empirical evidence: The existence of volume reactions to earnings announcements

Early empirical research concluded that earnings announcements stimulate trading. Beaver's (1968) seminal study examined whether investors consider earnings informative. His sample included annual earnings announcements of 143 firms listed on the New York Stock Exchange (NYSE) that had non-12/31 fiscal year-ends. Beaver found that in earnings announcement weeks, squared price fluctuations were 67 percent higher and *mean* trading was 33 percent larger than in a non-report period (eight weeks before and after the announcement). He concluded earnings announcements have information content that spurs investors to trade.

Kiger (1972) and Morse (1981) extended Beaver's study. Kiger (1972) investigated volume and price reactions in 3-day and 5-day windows centered on quarterly earnings announcements of 87 NYSE firms. He found that the *mean* daily trading volume over 3-day and 5-day windows was about 50% higher than that during a control period (a five-day period beginning eight days before the announcement). Morse (1981) used daily volume and price data to examine *when* the market reacts to quarterly and annual earnings announcements in the *Wall Street Journal.* His sample included 20 NYSE firms, five AMEX firms, and 25 firms whose shares sold over the counter. He reported a significant increase in trading (and price fluctuations) the day before the *WSJ* announcement, extending up to the third day after the announcement for volume and the second day after for price fluctuations.[22]

[22] Morse (1981) acknowledged that the strong market reaction the day before the *WSJ* announcement could arise because the Broad Tape reported many firms' earnings announcements the day before the *WSJ* published the earnings report. In a study using more recent data from 1988-1989, Amin and Lee (1997) report that earnings announcement-induced trading peaks on the day of and the day after the quarterly earnings announcement, but trading remains elevated for over a week.

Beaver (1968, 72) recommended that future research relax the sample selection criteria to assess the generalizability of his findings. However, this did not occur for many years. Meanwhile, researchers failed to fully appreciate that restricting the sample to non-12/31 NYSE firms with less than 20 news items in the *Wall Street Journal* led to a sample of smaller-than-average firms (representing approximately 5% of the period's total market value of NYSE firms, per Bamber, Christensen, and Gaver 2000, 105). With the benefit of forty years of research hindsight, we now know that earnings announcements constitute a larger portion of the public information for smaller firms. And like most of the subsequent research, Beaver (1968) used cross-sectional mean measures of volume and returns that are sensitive to extreme values.

Bamber, Christensen, and Gaver (1994, 2000) show that these research design choices increased the likelihood of finding a significant reaction to earnings announcements, and they go on to show that earnings announcements are much less likely to spur significant price and volume reactions than originally thought. Bamber et al. replicate Beaver's analysis on a similar set of non-12/31 firms. They find significantly elevated trading in just 15% of the announcement weeks, and significant price movements in just 7% of the announcement weeks. In comparison, for the Fortune 200 firms of that era (which comprised 67% of the NYSE's market value), the volume reaction is driven by about 16% of the earnings announcement weeks, while the price reaction is driven by just 3% of these weeks. Thus, Bamber et al. conclude that most earnings announcements did *not* stimulate unusual trading volume or price variability (when measured on a weekly basis), although their results suggest that earnings announcements may be more likely to spur detectable trading than detectable price reactions. Cready and Hurtt's (2002) simulation results confirm that trading volume reactions are more readily detected than price reactions.

In summary, early evidence in Beaver (1968), Kiger (1972), and Morse (1981) suggested

that earnings announcements spur abnormally large trading volume and price movements.[23] In hindsight, however, these studies' research designs and market reaction measure choices increase the likelihood of finding significant reactions to earnings announcements. Bamber et al. (1994; 2000) suggest the incidence of significant market reactions to earnings announcements in the 1960's was smaller than originally thought.[24]

Recent evidence suggests the magnitude of price and volume reactions to earnings announcements is increasing over time, however. Landsman and Maydew (2002) find the over-time increase in trading volume reactions to earnings announcements is driven by large firms. This is an interesting result, given larger firms' earnings announcements typically constitute a smaller piece of the informational pie, and thus spur smaller market reactions, on average (e.g., Atiase 1985; Bamber 1986; Bamber et al. 2000). The literature suggests a number of possible explanations for this over-time increase in trading volume to earnings announcements. First, Francis, Schipper, and Vincent (2002) conclude that the over-time increase in the magnitude of (price) reactions to earnings announcements is attributable to an increase in the number of concurrent disclosures contained in earnings announcement press releases. Consistent with this argument, Barron, Byard, and Yu (2010) show that abnormal trading not explained by price changes is increasing in the number of disclosures made in the earnings announcements. Larger firms typically provide more detailed disclosures, so this could explain Landsman and Maydew's (2002) evidence that the increasingly pronounced reactions to earnings announcements are attributable to the largest firms. Second, Barron, Schneible, and Stevens (2009) find that Landsman and Maydew's (2002) over-time increase in trading volume reactions is driven by the

[23] Anthony (1987) finds that earnings announcements also spur trading in options.

[24] Similarly, Ball and Shivakumar (2008) conclude that the trading volume response to earnings announcements is statistically significant, albeit modest in magnitude, and that trading volume reactions to earnings announcements increased over the period 1972 to 2006.

portion of trading volume associated with absolute price change, which theory suggests reflects an increase in preannouncement information asymmetry over time. Third, Ahmed, Schneible, and Stevens (2003) conclude that the advent of online trading spurred trading by less sophisticated investors, which increased price and volume reactions to earnings announcements. Finally, Bailey et al. (2003) find that (even after controlling for contemporaneous price reactions) the trading volume reaction to earnings announcements increases after Regulation Fair Disclosure (Reg FD hereafter) prohibited selective disclosure. They conclude that this elevated trading reflects differential interpretations of earnings announcements, and further support this interpretation with evidence that analyst disagreement, including Kandel and Pearson's (1995) measure of differential interpretations, likewise increases after Reg FD.

Empirical evidence: Studies comparing volume and price reactions to financial disclosures

Karpoff (1987) reviews an extensive literature in financial economics showing that *in general* (i.e., without regard to the issuance of financial disclosures) trading volume is positively associated with the absolute magnitude of returns. Empirical research confirms that trading is positively related to the magnitude of returns around disclosures such as earnings announcements, as Kim and Verrecchia's (1991a) theory predicts (Atiase and Bamber 1994; Bamber and Cheon 1995; Bhattacharya 2001; Bailey et al. 2003; Hope et al. 2009).

But the relation between trading and the magnitude of returns is not strong – Bamber and Cheon (1995) conclude it is closer to independence than to a strong positive relation. They show that nearly a quarter of earnings announcements generate (1) very high trading but almost no price change, or (2) large price changes but little trading. Consistent with the intuition that trading volume preserves differences among individuals that cancel out in the averaging process that determines equilibrium prices, Kandel and Pearson (1995) find abnormally high trading

even around earnings announcements that do not cause significant price reactions, and Bamber and Cheon (1995) show that trading is high relative to the magnitude of the price reaction when analysts' forecasts are divergent. Bailey et al. (2003) show that after Reg FD, a larger proportion of earnings announcements spur large trading reactions despite small price reactions, and interpret this as evidence that differential interpretations increase after Reg FD.

Not only do the magnitudes of price and volume reactions often differ, but Cready and Hurtt (2002) also provide simulation-based evidence suggesting that volume reactions are more powerful indicators of market response than price reactions. They further show that supplementing return-based analyses with volume-based tests increases the likelihood of correctly rejecting the null hypothesis of no market response to earnings announcements, while the converse is not true. Their results provide further motivation for researchers to use both volume and price measures to test for the information content of financial disclosures. This is especially important where returns-based analyses yield insignificant or mixed results, and statistical power is a concern, such as in small samples.

Empirical evidence: Determinants of volume reactions

Determinants of volume reactions: Early evidence

Bamber (1986; 1987) provided early empirical evidence on determinants of trading volume reactions to earnings announcements. She shows that trading around earnings announcements increases with the absolute magnitude of the surprise in the earnings announcement, consistent with Kim and Verrecchia's (1991a) subsequent model. Bamber (1986) finds that trading around firms' annual earnings announcements is more strongly associated with random-walk-based earnings surprise than with analysts' forecast-based earnings surprise,

consistent with the notion that trading volume reflects actions of all investors, including less-informed investors whose actions may not affect share prices.

Drawing on Atiase's (1985) prediction that earnings announcements constitute a larger portion of the total information set for smaller firms than larger firms, Bamber (1986; 1987) also predicts and finds that small firms' earnings announcements are more surprising and spur heavier trading than larger firms' announcements. Bamber (1987) further finds that more surprising earnings announcements and those of smaller firms lead to more protracted (longer duration) trading reactions. However, Barron, Schneible, and Stevens (2009) find that the relation between firm size and trading volume reactions to earnings announcement has reversed and become a positive relation in recent years. Evidence of such over-time changes suggests that researchers need to be careful not to over-generalize Bamber's (1986; 1987) early results.

These early studies preceded most of the trading volume theory discussed in Section 2, and thus had little alternative but to draw on determinants of price reactions (earnings surprise and firm size) in an ad hoc manner. We now examine empirical research that draws on theory to posit two types of determinants of trading around public announcements: determinants related to informational differences, and determinants not related to informational differences.

Determinants of volume reactions: Determinants related to informational differences

Section 2 explains that theory attributes trading around earnings announcements primarily to differential belief revisions caused by either differential predisclosure information or differential interpretations. Ziebart (1990) was the first to test for an association between trading volume and differential belief revision. He examines the degree to which changes in trading volume reflect: (1) the absolute change in aggregate beliefs (i.e., earnings "surprise"), (2) the change in dispersion in analysts' forecasts, and (3) the level of predisclosure information (as

proxied by firm size). Ziebart finds that the change in abnormal volume is positively related to both: (1) absolute changes in the mean forecast, and (2) changes in forecast dispersion (i.e., trading is higher for earnings announcements that increase rather than decrease forecast dispersion). Ziebart's (1990) hypothesis that increases in the dispersion of investor beliefs spur trading at earnings announcements reflects the intuition in Beaver (1968) and Karpoff (1986). In a subsequent model, Barron, Kim, Lim, and Stevens (1998, BKLS hereafter) show that dispersion in analysts' forecasts is a function of not only Holthausen and Verrecchia's (1990) lack of consensus construct, but also overall uncertainty. Although Barron, Stanford, and Yu (2009) conclude that *levels* of forecast dispersion reflect analysts' uncertainty more than their lack of consensus, the authors also conclude that *changes* in forecast dispersion (which Ziebart examines) are more likely to reflect changes in consensus than changes in uncertainty. Thus, evidence on the relation between *changes* in dispersion in analysts' forecasts and trading volume become easier to interpret.[25]

Atiase and Bamber (1994) test Kim and Verrecchia's (1991a) proposition that trading volume reactions to earnings announcements increase in: (1) the magnitude of the contemporaneous price change, and (2) differential precision of investors' private predisclosure information. Atiase and Bamber (1994) use the dispersion and range in analysts' predisclosure forecasts to proxy for differential prior precision. They acknowledge their proxies suffer from two limitations: (1) they reflect divergent expectations of analysts and not investors, and (2) they

[25] Ziebart (1990) conjectured that his findings might reflect the consensus effect Holthausen and Verrecchia (1990) predict. At the time of Ziebart's study, detailed individual analyst forecast data were generally not available to researchers, and it was common practice to use the monthly average forecast data that included stale forecasts. However, Brown and Han (1992) show that stale forecasts can significantly affect the dispersion in analysts' forecasts. Barron, Harris, and Stanford (2005) revisit Ziebart's prediction after: (1) measuring analyst consensus directly using the BKLS (1998) measure of consensus, and (2) including only firms with at least five analysts' forecasts (of upcoming annual earnings) that were updated within 45 days before the quarterly announcement and revised again within 30 days after the quarterly announcement. Their evidence supports Ziebart's (1990) conjecture and Holthausen and Verrecchia's (1990) prediction.

reflect divergent expectations whereas the theoretical construct is differential precision of predisclosure information. After demonstrating theoretically that forecast dispersion also reflects the average precision of preannouncement information, or preannouncement uncertainty, Atiase and Bamber (1994) control for this uncertainty by including the magnitude of price change and firm size in their empirical tests. Atiase and Bamber find that both the dispersion and range in analysts' forecasts are positively related to trading volume around the announcement, even after controlling for preannouncement uncertainty. Consequently, their results suggest that trading around earnings announcements is positively related to that part of dispersion that does not reflect uncertainty. Stated more directly, Atiase and Bamber's (1994) results suggest that low preannouncement consensus among analysts spurs earnings announcement period trading. Barron, Stanford, and Yu (2009) later argue that lower levels of analysts' consensus reflect larger disparities between the information possessed by informed versus uninformed investors. If so, then Atiase and Bamber's (1994) reported residual effect from preannouncement forecast dispersion captures the effect of differences in the prior precision of information between informed and uninformed groups of market participants.

Utama and Cready (1997) simplify Kim and Verrecchia's (1991a) differential prior precision construct by assuming one group of informed traders has information of equally high precision, whereas the remaining group of traders has information of equally low precision. They argue that the differential precision of private predisclosure information peaks when there is an equal mix of the two types of investors. Utama and Cready (1997) consider institutions representative of the better-informed traders. Utama and Cready find support for their predictions: when institutional ownership is low, trading volume reaction to annual earnings announcements increases with institutional ownership, but when institutional ownership is high

(i.e., over 50%) trading volume reaction decreases with institutional ownership, creating an inverted U-shaped relation between trading volume and institutional ownership. Utama and Cready (1997) conclude that since the level of cross-investor variation in precision peaks around 50% institutional ownership, their evidence supports Kim and Verrecchia's (1991a) prediction that trading volume around earnings announcements increases with differential prior precision.

Ali et al. (2008) refine Utama and Cready's (1997) measure of differential private predisclosure information by focusing on institutions with medium stockholdings. Ali et al. reason that institutions with small stockholdings cannot justify the fixed costs of developing private information, whereas institutions with large stakeholdings are dedicated investors that do not trade around earnings announcements. Consistent with expectations, they find that the predicted inverted U-shaped relation between trading volume and institutional ownership holds for institutions with medium stakeholdings, but not those with small or large stakeholdings.

Bamber et al. (1997) test the incremental role of three measures of disagreement in explaining trading volume around earnings announcements: (1) the *level* of prior dispersion in analysts' forecasts, (2) the *change* in dispersion, and (3) the extent of differential belief revision proxied by the complement of the correlation between analysts' prior and posterior forecasts. Bamber et al. argue that their third measure of disagreement captures belief "jumbling" resulting from announcements that: (1) fail to remove the informational disadvantage some investors possess prior to the announcement, or (2) convey private information to a subset of investors who possess advantages in processing the information. All three measures of disagreement play an incremental role in explaining trading volume around earnings announcements, even after controlling for the magnitude of the contemporaneous price change. They conclude that trading around an earnings announcement is attributable to both forecast dispersion prior to the

announcement (which Barron, Stanford, and Yu 2009 conclude primarily reflects pre-announcement uncertainty) and newfound disagreement spurred by the announcement.

Noting that a commonly interpreted earnings announcement implies there can be no trading in the absence of price changes, Kandel and Pearson (1995) directly test this assumption. They find that even earnings announcements that lead to no discernable price change nonetheless spur abnormal volume. Then they develop a model where investors' differential likelihood functions lead them to interpret the public signal differently (which can spur trading even in the absence of price reactions). Kandel and Pearson use their model to derive an empirical measure of differential interpretations of earnings announcements – the proportion of pairs of analysts' forecasts that (a) move in opposite directions *and* (b) either flip or diverge in response to a given announcement.[26] Kandel and Pearson report that the mean proportion of pairs that either flip or diverge is four to five times greater in the announcement period than in the nonannouncement period, suggesting that many earnings announcements are differentially interpreted.

Bamber et al. (1999) test the relation between Kandel and Pearson's (1995) measure of differential interpretations and trading volume around earnings announcements. Bamber et al. (1999) hypothesize that trading around earnings announcements increases with differential interpretations, given sufficient liquidity trading to help camouflage informed investors' trades. After controlling for earnings surprise, market-wide trading volume, and firm size, they report that trading increases in Kandel and Pearson's (1995) measure of differential interpretations. However, this relation holds only: (1) when price changes are minimal (where theory suggests

[26] Two analysts' forecasts "flip" if the rank ordering of their forecasts reverses as a result of the announcement (i.e., the analyst with the higher forecast before the announcement has the lower forecast after the announcement). Kandel and Pearson's (1995) proxy is a conservative measure of differential interpretations, because pairs of analysts' forecasts that move in the same direction and flip could also be caused by differential interpretation of the announcement.

trading can only be attributable to differential interpretations), or (2) when trading is above the average level of nonannouncement period trading, suggesting that informed investors are more active when there is enough liquidity trading to camouflage their trades.

Collectively, this evidence suggests that differential belief revisions spur trading around earnings announcements. Empirical evidence supports the theoretical prediction that these differential belief revisions are driven by either differential precision of preannouncement information (Atiase and Bamber 1994; Utama and Cready 1997; Ali et al. 2008) or differential interpretations of the announcement (Kandel and Pearson 1995; Bamber et al. 1999).

Recent empirical studies capitalize on Kim and Verrecchia's (1997) argument that the portion of volume related to absolute price change is a proxy for differential precision of predisclosure information, whereas the portion of volume that is unrelated to the absolute price change reflects differential interpretations of the announcement. Ahmed et al. (2003) study how online trading affects reactions to earnings announcements, hypothesizing that online traders reduce differential prior precision (as they access similar information via the Internet) and increase differential interpretations, relative to an earlier period without online trading. As predicted, they find that in a regression of trading volume on absolute price change, the slope coefficient on absolute price change decreases while the intercept increases in the online period.

To explore the effectiveness of Regulation Fair Disclosure (Reg FD) in leveling the informational playing field, Ahmed and Schneible (2007) examine the portion of volume reaction related to absolute price change. After observing that the strength of the volume-absolute return relation declines after Reg FD,[27] Ahmed and Schneible (2007) conclude that the regulation reduced differences in the precision of private predisclosure information, consistent

[27] Bailey et al. (2003) observe a similar decline in the trading volume-absolute return relation after Reg FD, although Barron, Schneible, and Stevens (2009) find that this decline was a temporary effect lasting five years.

with regulators' intention. This effect appears largely attributable to a leveling of the informational playing field for small firms and high tech firms.

Hope et al. (2009) investigate the effect of Statement of Financial Accounting Standards No. 131, which eliminates the requirement to disclose earnings by geographic segment unless the firm defines operating segments along geographic lines. The authors investigate the effect of FAS 131 on proxies for differential precision of private predisclosure information and differential interpretations derived based on Kim and Verrecchia (1997). The authors conclude that ceasing geographic disclosures *decreases* differential interpretations. Although this result may seem paradoxical, the authors conclude that their evidence that segment disclosures are differentially interpreted is consistent with recent evidence that complex *public* information spurs investor disagreement (Sarkar and Schwartz 2009; Barron, Byard, and Yu. 2010).

One concern with these studies is that operationalizing differential interpretations as the *intercept* of a regression of trading volume on the absolute price change and other variables is complicated by the fact that the intercept impounds effects of model misspecification such as omitted variables and nonlinearities. Researchers may wish to confirm such inferences by demonstrating that results are robust using other proxies such as Kandel and Pearson's (1995) proxy for differential interpretations, as in Bailey et al. (2003).

Determinants of volume reactions: Determinants unrelated to informational differences

As discussed in Section 2, theory suggests several other determinants of trading volume reactions to public announcements aside from informational differences. Kim and Verrecchia (1991a) identify two of these determinants -- the magnitude of the earnings surprise and the level of preannouncement uncertainty. As explained previously, prior empirical research confirms that both determinants play a significant incremental role in explaining trading volume

reactions to earnings anouncements (e.g., Bamber 1986; Atiase and Bamber 1994; Bamber et al. 1997). To date, however, most of the other determinants have not been studied in depth.

One notable exception is Kross, Ha, and Heflin (1994). They argue that changes in firm risk that become apparent at the earnings announcement date spur investors to trade to realign their portfolios with their differential risk preferences. They find that trading volume is an increasing function of the change in the firm's risk, as proxied by the absolute change in CAPM beta. The relation persists even after controlling for the information content of the announcement (abnormal returns and earnings surprise) and preannouncement forecast dispersion, although the effect of risk shifts is small relative to the effect of the information content of the announcement.

With respect to transaction costs, Utama and Cready (1997) provide evidence consistent with Barron and Karpoff's (2004) prediction that higher transaction costs dampen trading. Specifically, Utama and Cready (1997) show that the closing stock price two days prior to the earnings announcement (an inverse proxy for commission and bid/ask spread-related trading costs) is positively related to trading volume around annual earnings. Taxes can be viewed as another form of transaction cost. For example, Shackelford and Verrecchia (2002) model the effect of intertemporal tax discontinuities (i.e., higher tax rates for short-term capital gains than for long-term capital gains) on trading volume response to good news earnings announcements. Their model predicts that the greater the disparity in tax rates, the greater the attenuation of earnings announcement period trading. The idea is that investors will be less likely to sell a winning stock immediately (because of the higher short-term tax rate) and will be more likely to hold the stock until the gain would be taxed at the lower longer-term rate. Using data on aggregate trading throughout the market, Blouin et al. (2003) provide evidence consistent with this prediction. Hurtt and Seida (2004) provide sharper evidence supporting Shackelford and

Verrecchia's (2002) prediction by showing that the greater the disparity in tax rates, the less likely the traders subject to differential capital gains tax rates (individual investors) are to sell their shares of appreciated stocks around earnings announcement dates. However, tax effects are likely to be at best second-order conditions: "capital gains tax effects, if they matter at all, are not dominant determinants of equity trading" (Blouin et al. 2003, 613).

Empirical evidence: Insights from intradaily trading at earnings announcement dates

Analysis of intradaily (i.e., transaction-by-transaction) trading yields insight into who trades on earnings announcements and other financial disclosures. Cready (1988) provides early empirical evidence on large versus small investors' trading around earnings announcements. His results suggest that more sophisticated, larger traders are more active around earnings announcements, and they react more quickly than smaller traders to the earnings announcement information. Lee (1992) investigates the number of small versus large trades (using a $10,000 threshold) in half-hour intervals around quarterly earnings and dividend change announcements. Lee (1992) confirms Cready's (1988) evidence that large traders react more strongly and quickly than small traders. Lee (1992) further shows that large trades concentrate around the Broad Tape release time, whereas small trades are more dispersed across the following three trading days.

Bhattacharya (2001) hypothesizes that small investors anchor on seasonal random-walk expectations despite the public availability of more accurate analysts' forecasts. Consistent with this hypothesis, he finds that small investors' trades around earnings announcements increase with earnings surprises from seasonal random-walk expectations, but are *unrelated* to earnings surprises relative to publicly available analysts' forecasts. His results are largely confined to small firms with light to moderate analyst following. Similarly, Battalio and Mendenhall (2005) compare small versus large traders' reactions to Nasdaq firms' earnings announcements, using a

measure of excess net buying to infer the direction of the trade (i.e., whether it was spurred by a buy or a sell). They conclude that around earnings announcement dates, small traders trade in the direction of seasonal random-walk forecast errors, whereas large traders trade in the direction of analyst forecast errors, consistent with small investors anchoring on seasonal random-walk earnings expectations, and large investors anchoring on analysts' forecasts.

Bhattacharya, Black, Christensen, and Mergenthaler (2007) investigate how different investor groups respond to pro forma earnings announcements. Using a measure of excess net buying, they find that small traders trade in the direction of the difference between pro forma EPS and actual EPS, consistent with small traders anchoring on pro forma earnings numbers. In contrast, medium and large traders do not appear to trade based on pro forma earnings.

Sarkar and Schwartz (2009) develop a measure of "market sidedness," which is the correlation between the number of buyer-initiated trades and seller-initiated trades in short time intervals. The authors argue that two-sided trading (i.e., trading spurred by both buyers and sellers) reflects differential beliefs, whereas one-sided trading is more likely to reflect information asymmetry. The study shows that earnings announcements of a sample of Nasdaq firms spur a post-announcement increase in two-sided trading, especially when news surprises are large. The authors interpret this evidence as indicating that investors acquire or develop diverse information to better interpret the news in the earnings announcement, consistent with Kim and Verrecchia's (1997) theoretical prediction.

Recent research suggests a concern with using trade size to distinguish unsophisticated individual investors from larger and more sophisticated investors: as transaction costs have declined, institutions are increasingly engaging in order-splitting to mask their trades. For example, based on a comparison of changes in institutional holdings and trades of various sizes

over the period 1993-2000, Campbell, Ramadorai, and Schwartz (2007) conclude that trades under $2,000 are more likely attributable to institutions than to individuals. Hvidkjaer (2008) similarly concludes that while the volume of small trades was negatively related to changes in institutional holdings up to 2002, thereafter the relation turns positive, while concurrently the number of small trades has mushroomed. These patterns are consistent with increased splitting of institutional orders. This noise in attributing small trades to individuals has spurred recent research in finance to use datasets that identify whether the trader is an individual or an institution (e.g., Kaniel, Saar, and Titman 2008; Kaniel, Liu, Saar, and Titman 2008).

Empirical evidence: Effect of earnings announcement period trading on post-earnings announcement returns

Financial economists are showing more interest in trading volume as it relates to asset pricing (e.g., Varian 1985; Ofek and Richardson 2003; Kindleberger and Aliber 2005; Hong and Stein 2007; Frazzini and Lamont 2007). Recent research in the accounting literature suggests that trading at the earnings announcement date is related to subsequent share prices, in particular, post-earnings announcement returns.

Garfinkel and Sokobin (2006) attempt to isolate the portion of earnings announcement date trading that reflects divergence of opinion. They control for the portion of trading that likely reflects liquidity trading (by controlling for firm-specific average nonannouncement trading),[28] and the portion of trading that likely reflects investors' reaction to the information content of the earnings announcement (by controlling for trading associated with earnings announcement date returns). Theory suggests the remaining trading reflects divergence of opinion. Garfinkel and

[28] Bhushan (1994) concludes that the magnitude of post-earnings announcement drift increases with the costs of trading. He uses the firm-specific average annual trading volume (and share price) as inverse proxies for transaction costs. Like Bhushan (1994), Garfinkel and Sokobin (2006) also find that higher firm-specific average trading volume attenuates post-earnings announcement drift.

Sokobin (2006) find that this portion of earnings announcement trading that reflects opinion divergence is associated with more positive post-earnings announcement abnormal returns. They interpret this evidence as consistent with Varian's (1985) theoretical prediction that opinion divergence is an additional risk factor for which investors require compensation. In other words, they conclude that at least part of the drift subsequent to good news earnings announcements may be compensation for a risk premium associated with divergent opinions.

Ayers, Li, and Yeung (2009) find that more intense trading at the earnings announcement date attenuates post-earnings announcement drift. Using a measure of excess net buying to infer the direction of the trade, the authors show that small traders (but not large traders) continue to trade in the direction of the seasonal random-walk earnings surprise after the earnings announcement.[29] In contrast, large traders (but not small traders) continue to trade in the direction of the analyst forecast-based earnings surprise. When small (large) traders trade more intensively at the earnings announcement date, this attenuates the seasonal random-walk-based (analyst forecast-based) post-earnings announcement drift. The authors interpret their results as suggesting the random-walk-based and analyst forecast-based post-earnings announcement drifts are attributable to two distinct sets of investors (small vis-à-vis large traders) who use different earnings expectation models (seasonal random-walk-based vis-à-vis analyst forecast-based), but who both underreact to the earnings surprise relative to their respective expectations models.

Despite evidence that trading activity by individual investors is negatively associated with future returns (Odean 1999; Barber and Odean 2000), a recent working paper suggests that

[29] Hirshleifer, Myers, Myers, and Teoh (2008) are unable to find evidence that individual investors cause seasonal random-walk drift. However: (1) their analysis does not control for the analyst forecast-based post-earnings announcement drift, (2) their analysis is based on proprietary data from a single broker (with an average of 10 individual trades per earnings announcement), and (3) their design investigates the main effect of individual trades on the total post earnings-announcement return, whereas Ayers et al. (2009) investigate how small trades affect a finer measure of seasonal random-walk-based post-earnings announcement drift – the slope coefficient on the seasonal random walk-based earnings surprise.

some individuals are able to make profitable trades around earnings announcements. Kaniel, Liu, Saar, and Titman (2008) find that intense individual buying (selling) prior to the announcement is associated with significant positive (negative) abnormal returns in the three months following the announcement. They conclude that part of this profitable trading arises due to superior private information or skill. Their evidence suggests that a category of individual traders discover profitable private information prior to an earnings announcement, trade aggressively on that information initially, and then partially reverse their trades.

Empirical evidence: Trading volume reactions to financial disclosures other than earnings announcements

Nichols, Tsay, and Larkin (1979) show that voluntary management forecasts of changes in earnings of at least 40% are informative, because these forecasts spur trading that is about 40% higher than the average level of nonannouncement trading.

Cready and Mynatt (1991) find the release of corporate annual reports (as distinct from earnings announcements) does not spur price or trading reactions, except among the smallest traders. They conclude that large investors rely on earnings announcements released on the Broad Tape, whereas smaller investors rely more on the corporate annual reports. An important strength of their study is the elegant empirical support for their "no price reaction" conclusion. Specifically, after failing to reject the null hypothesis that there is no price reaction to the release of annual reports, Cready and Mynatt (1991) provide simulation evidence demonstrating that if such a price reaction does exist, it is too small to be economically consequential, because their methods would identify a reaction of any meaningful magnitude.

Stice (1991) investigates market reactions when firms file 10-K or 10-Q reports several days before issuing a press release announcing earnings. He concludes there is no significant trading (or price) reaction on the 10-K/10-Q filing date – the market does not react until the firm

issues a press release. Stice's sample period (1976-1985) precedes electronic SEC filings, however. Asthana and Balsam (2001) show that once filings are available on EDGAR, there are both trading and price reaction to the filings. Asthana et al. (2004) show that these reactions are largely attributable to small traders, and they further conclude that EDGAR likely improved small investors' trading outcomes.

Chen and Sami (2008) study trading volume reactions to Form 20-F reconciliations between International Accounting Standards (IAS) and U.S. GAAP earnings. Prior research on the information content of these reconciliations based on price reactions yields mixed evidence. Chen and Sami (2008) point out that investigating the trading volume reaction to these reconciliations provides an important complement because trading volume-based measures are more powerful indicators of whether a public disclosure conveys new information, especially in contexts such as these reconciliations which are necessarily based on small samples (Cready and Mynatt 1991; Cready and Hurtt 2002). Chen and Sami (2008) find that the difference between IAS and U.S. GAAP earnings is positively associated with abnormal trading at the reconciliation announcement date, suggesting that investors find the reconciliations informative.

Richardson, Sefcik, and Thompson (1986; 1988), Bajaj and Vijh (1995), and Gosnell, Keown, and Pinkerton (1996) conclude that dividend announcements spur increased trading. In a study of 51 companies during the 1905 to 1910 pre-SEC era characterized by virtually no disclosure regulation, Sivakumar and Waymire (1993) find that announcements of changes in dividends spur more trading than do announcements of changes in earnings, consistent with dividends providing a more credible signal when earnings disclosures are unregulated.

Researchers have also examined whether audit characteristics are associated with trading. Keller and Davidson (1983) find that trading increases around the announcement of a qualified

audit opinion, but Hagigi, Kluger, and Shields (1993) find that trading declines significantly upon the announcement of auditor changes. Jang and Lin (1993) conclude that IPOs audited by the Big 8 firms spur a heavier but briefer trading reaction than do IPOs audited by smaller firms.

Empirical evidence: Experimental studies of trading volume reactions to financial disclosures

Experimental studies have the potential to provide incremental insights into the determinants of announcement period trading. While experiments necessarily sacrifice some external validity, their key advantages are that researchers can implement strong controls for extraneous factors that might affect trading but are unrelated to the determinant of interest. In many cases, it is also possible to directly measure theoretically-motivated constructs such as investor expectations, which are not accurately measurable in archival data. Despite these advantages, at present there are few behavioral studies of determinants of trading in response to financial disclosures such as earnings announcements.

A notable exception, Gillette, Stevens, Watts, and Williams (1999) explore determinants of trading using an experimental market where the value of the traded asset can shift in response to a public signal. They measure traders' expectations of intrinsic firm value as the trader's forecast of the firm's liquidating dividend. The authors find that even though all information is public and traders have cash incentives to accurately forecast their expectations of firm value, expectations are quite heterogeneous. Because participants received extensive training before the market opened, this heterogeneity can only be explained by differential interpretations of the public signal. Gillette et al. (1999) also find that approximately 10 percent of outstanding shares are traded in each round. This level of trading is inconsistent with the "no-trade" theorem (Milgrom and Stokey 1982), which suggests that trade will not occur when all traders have the same information. Gillette et al. also find that trading volume increases in the mean of traders'

absolute forecast revision, consistent with Kim and Verrecchia's (1991) intuition that trading around announcements increases in the magnitude of the announcement's news. Surprisingly, forty-three percent of trades are inconsistent with traders' forecasts of intrinsic value, suggesting that speculative trading for short-term gain is a significant determinant of trading.

We are unaware of other experimental studies of trading volume around financial disclosures. Several factors have likely hindered this type of research. First, as Berg, Dickhaut, and McCabe (1995, 104) point out, influential early research such as Gonedes and Dopuch (1974, 106) questioned the ability of research on individual behavior to yield insights relevant to aggregate market behavior. However, the persistence of certain market anomalies has shaken the prior confidence that markets are unaffected by non-Bayesian individual behavior. Second, experimental markets are costly. In addition to the cost of an experimental lab, 50 participants yield only 5 statistically independent observations if grouped into experimental markets of 10 participants each. On the other hand, the increasing availability of networked computer facilities and market software may facilitate the development of this research. Moreover, it is possible to glean insights about trading from individual decision-making experiments that do not require a market. For example, Nelson, Krische, and Bloomfield (2003) show that investors' reliance on a general (i.e., nonannouncement-related) trading strategy depends on their relative confidence in that strategy vis-à-vis (over)confidence in their stock-picking abilities.

5. What have we learned about the nature of financial disclosures and the effects of these disclosures on investors?

This section synthesizes what we think we have learned about the nature of earnings announcements and other financial disclosures, as well as the effects of these disclosures on investors, from studying trading volume reactions. Table 2 provides a capsule summary.

What have we learned about the nature of financial disclosures?

Research concludes that financial disclosures, such as earnings announcements, are important enough to cause investors to take action by trading (Beaver 1968; Kiger 1972; Morse 1981; Bamber 1986; 1987). But Bamber et al. (1994; 2000) show that this "on average" result is driven by a small minority of announcements that spur very large market reactions, and Ball and Shivakumar (2008, 975) conclude that earnings announcements provide only modest incremental new information.

The primary unique insights from examining trading volume as compared to price reactions stem from the fact that trading volume sums the actions taken by investors, whereas price reactions yield insights about average revaluations. Many earnings announcements that do not cause significant price reactions are nevertheless useful in that they spur investors to trade (Kandel and Pearson 1995; Bamber and Cheon 1995). Because Cready and Hurtt (2002) show that trading volume reactions are more detectable than price reactions, confining analyses solely to price reactions would understate the informativeness of financial disclosures. Cready and Hurtt's results also mean that investigation of trading volume reactions is especially valuable when statistical power is a concern due to small sample size or small magnitude effects. For example, from analysis of trading volume reactions we have learned that infrequent disclosures such as early SEC filings (that precede earnings announcement press releases), qualified audit opinions, and Form 20-F reconciliations are informative to investors despite their failure to spur significant price reactions (e.g., Stice 1991; Keller and Davidson 1983; Chen and Sami 2008).

Trading volume research has taught us that many earnings announcements have different effects on different investors, and that these effects are complex. Mounting evidence suggests many earnings announcements spur differences of opinion. Recall Garfinkel (2009) concludes that abnormal volume (volume that is unexplained by prior volume or price changes) reflects the

divergence of investors' opinions about firm value. Many earnings announcements spur a significant amount of this "unexplained" trading volume, so we infer that these announcements lead investors to change their perceptions of firm value in different ways. This is often referred to as *differential belief revision*, but it is also sometimes characterized as *differential interpretations* about firm value.

Differential belief revision/interpretation is a broad concept, and there are a number of different paths to, or sources of, differential belief revisions/interpretations. One source arises because investors differ in the quality of the predisclosure information they possess. As predicted in Kim and Verrecchia's (1991) theoretical model, predisclosure information asymmetry spurs differential belief revisions, and in turn, trading at a public announcement because investors with imprecise predisclosure information find the announcement more informative than those privy to more precise predisclosure information (Atiase and Bamber 1994; Utama and Cready 1997; and Ali et al. 2008). Relatedly, Bhattacharya's (2002) evidence that small investors' trades increase with the earnings surprises from the (less precise) seasonal random-walk expectation model, but are *unrelated* to surprises relative to (on average more precise) publicly available analysts' forecasts suggests that small investors trade upon a relatively small portion of available predisclosure information. Bamber (1986), Battalio and Mendenhall (2005), Bhattacharya et al. (2007), Kaniel et al. (2008), and Ayers et al. (2009) provide similar evidence, which collectively suggests that differences in the quality of investors' predisclosure information are sufficiently material to spur significant trading when earnings are finally announced. This source of differential belief revision reflects a leveling of an informational playing field that was not level before the earnings announcements.

The literature also suggests that at least some earnings announcements have the characteristic of spurring differential interpretations (e.g., Kandel and Pearson 1995; Bamber et al. 1999; Gillette et al. 1999) because the announcements themselves convey different things to different investors (in contrast to differential belief revisions stemming from differences in *predisclosure* information). This does not necessarily imply that some investors extract a "better" meaning in the sense that their interpretation is more informed or precise than the interpretations of others. This form of differential interpretation may be relatively benign in that it does not necessarily suggest that the announcement itself "unleveled" the informational playing field.

The third source of differential interpretation may not be so benign, however, because it suggests that some (sophisticated) investors make better use of the information in earnings announcements than are other (less sophisticated) investors. Due to superior ability to analyze financial information and/or to private information that is only useful in conjunction with an earnings announcement, evidence suggests that certain individuals extract or develop private information as a result of earnings announcements (Barron et al. 2002), consistent with Kim and Verrecchia's (1997) theoretical prediction. This private information in turn spurs trading (Barron et al. 2005). This evidence suggests that public information spurs or complements private information (see also Sarkar and Schwartz 2009; Hope et al. 2009). This form of differential interpretation may be of concern to regulators because it suggests that at least some announcements render the informational playing field less level than it was before the announcement.

While Bamber et al, (1994; 2000) and Ball and Shivakumar (2008) suggest that earnings announcements convey limited new information, the over-time increase in trading volume reactions (Landsman and Maydew 2002; Ball and Shivakumar 2008) suggests investors are

perceiving earnings announcements as increasingly useful. There are likely several causes of this over-time increase. First, earnings announcements contain more information with increasingly detailed disclosures (Francis et al. 2002; Barron et al. 2010). But other possible reasons for the over-time increase in trading are not necessarily good news: both predisclosure information asymmetry and differential interpretations are increasing (e.g., Barron, Schneible, and Stevens 2009; Ahmed et al. 2003; Bailey et al. 2003).

What have we learned about who assimilates information in financial disclosures, and when?

The trading volume literature suggests that regulators' concerns about protecting the interests of small investors are well-founded. Evidence suggests small investors are less sophisticated. For example, DeFranco, Lu, and Vasvari (2007) investigate small and large traders' responses to the misleadingly overoptimistic public analyst recommendations that led to the *Global Research Analyst Settlement*. They show that small traders are more likely (than institutions) to follow the *public* misleading analyst recommendations, resulting in an estimated $2.2 billion wealth transfer from individuals to institutions. Research also shows that small traders respond more slowly to earnings announcements (Cready 1988; Lee 1992). Unlike large traders, small traders appear to rely on questionable disclosures such as ad hoc pro forma earnings (Bhattacharya et al. 2007) and simplistic seasonal random-walk expectations of earnings (Bhattacharya 2001; Battalio and Mendenhall 2005; Ayers et al. 2009). Empirical evidence also suggests that small investors trade too intensely, perhaps due to overconfidence, and earn lower returns as a result (Odean 1999, and Barber and Odean 2000). Concern about small investors' informational disadvantage is exacerbated by evidence of over-time increases in both predisclosure information asymmetry (Barron, Schneible, and Stevens 2009) and differential interpretations of financial disclosures (Ahmed et al. 2003; Bailey et al. 2003).

What have we learned about the effects of changes in regulations and accounting standards?

Trading volume-based research has also provided insight into the effects of regulations and of changes in accounting standards. For example, dividend announcements not only spur abnormal trading (Richardson, Sefcik, and Thompson 1986; Bajaj and Vijh 1995; Gosnell, Keown, and Pinkerton 1996), but they spur more trading than earning announcements in early capital markets where earnings are unregulated (Sivakumar and Waymire 1993). This evidence suggests dividends provide a more credible signal when earnings disclosures are unregulated.

Other trading volume-based research suggests that Reg FD reduced predisclosure information asymmetry as regulators intended (Ahmed and Schneible 2007), but also had the unintended consequence of leading to more differential interpretation of the earnings announcement itself (Bailey et al. 2003). With respect to changes in accounting standards, Hope et al. (2009) suggest that by relaxing the requirement to disclose earnings of geographic segments, FAS 131 attenuated differential interpretations.

6. Directions for future research

We draw on our review of the literature to identify directions for future research.

Future research: Capitalizing on the distinction between volume and price reactions to obtain new insights about the characteristics and consequences of financial disclosures

Instead of using trading volume to proxy for broad constructs such as "disagreement," a recent stream of literature has capitalized on Kim and Verrecchia's (1997) theory by using the slope coefficient from a regression of trading volume on the magnitude of price changes as a proxy for differential precision of preannouncement information (e.g., Ahmed et al. 2003; Ahmed and Schneible 2007; Hope et al. 2009). We would benefit from further research validating this proxy. Differential precision of predisclosure information is an important construct because it reflects information asymmetry – i.e., an unequal informational playing field

– that is of particular concern to regulators (Morse 1980, 1129; Levitt 1998a, 1998b, 1999). The literature would benefit from more evidence on how elements of firms' disclosure policies affect information asymmetry. While conventional wisdom suggests public disclosures reduce information asymmetry, recent evidence suggests it may exacerbate information asymmetry by spurring production of private information (e.g., Barron et al. 2002; Sarkar and Schwartz 2009). What characteristics of public disclosures exacerbate or ameliorate information asymmetry? What specific classes of traders are advantaged or disadvantaged by various features of public disclosures? Are traders who are disadvantaged aware of their informational disadvantage?

Similarly, researchers have begun to draw on Kim and Verrecchia's (1997) theory to interpret the intercept of a regression of trading volume on contemporaneous price change as a proxy for differential interpretations. Because these intercepts impound effects of model misspecification, we would benefit from evidence on the extent to which such intercepts actually capture differential interpretations. Validation of a reliable proxy for differential interpretations would enable researchers to address many interesting questions. What specific characteristics of earnings announcements generate differential interpretations?[30] To what extent are differential interpretations the result of differences in investors' private information versus differences in their ability to process financial disclosures? Do certain characteristics of earnings announcements spur more private information? Can characteristics of disclosures exacerbate or ameliorate the effects of differences in investors' mental processing abilities, or their heuristics such as overconfidence? Answers to these kinds of questions would clearly be of interest to policymakers and practitioners as well as academics.

[30] Barron et al. (2010) find that earnings announcements with more accounting disclosures generate more differential interpretations, as evidenced by both trading volume unexplained by price changes, and differential interpretations by analysts.

Future research: Opportunities to better understand firms' cost of capital

Prior research suggests private information leads to information asymmetry that increases the firm's cost of capital (e.g., Botosan et al. 2004). To the extent that trading around an announcement reflects differences in the quality of investors' private preannouncement or announcement period information, such trading may be associated with an increase in a firm's cost of capital. Evidence in Barron et al. (2002) suggests earnings announcements spur more private information, which Barron et al. (2005) show leads investors to trade, concluding that "if a significant amount of trade on private information occurs when public disclosure peaks, then some unsophisticated traders are likely at a greater disadvantage" and that "this uneven informational playing field may increase a firm's cost of capital" (p. 405), if unsophisticated traders demand a premium to trade because they are informationally disadvantaged.

The conjecture that some trading around earnings announcements reflects private information (i.e., information asymmetry) that in turn spurs an increase in firms' cost of capital is largely based on indirect evidence that: (1) private information increases firms' cost of capital *in general* (Botosan et al. 2004), and (2) private information around earnings announcements spurs more trading around the announcements *in particular* (Barron et al. 2002). To date there is little theoretical support for this conjecture, however, because most theory assumes perfectly competitive security markets in which investors are price-takers who do not influence security prices. Theory investigating trading reactions to public announcements in imperfectly competitive markets – where a portion of trading reflects informational asymmetries that could affect share prices and thus the firm's cost of capital – would be very valuable.

Thus, more rigorous theoretical and empirical evidence documenting direct links from private information around financial disclosures, to trading, and firms' cost of capital could make a significant contribution. Exploration of how disclosure characteristics affect these linkages has

the potential to increase our understanding of how financial disclosures affect investor behavior and security pricing. In this sense, accounting researchers have the potential to help financial economists understand the "dark continent" of how and why trading occurs and how it is related to security pricing.

Future research: Low R^2s, the need for closer partnering between theorists and empiricists, and the triangulation of evidence

We still lack an understanding of the primary determinants of trading volume reactions to earnings announcements. Research examining determinants of volume reactions to earnings announcements is characterized by low explanatory power (low R^2s). This could be attributable to poor measures of volume (e.g., measures of volume versus transactions), noisy measures of the determinants (e.g., outdated analysts' forecasts), inadequate controls for noninformation-based trading, nonlinear relations between trading volume and the modeled determinants, or incomplete theory of the determinants of trading. Collaboration between theorists and empiricists will likely be required to materially increase the explanatory power of these models. Communication between theorists and empiricists can be facilitated by use of more precise language. For example, instead of broad terms such as "disagreement," it would be helpful to use more precise terms such as "differential precision of preannouncement information" to refer to more specific forms of disagreement, when possible.

As discussed earlier, disconnects between theoretical constructs and empirically observable phenomena make it difficult for empiricists to cleanly test theoretical predictions. Empiricists can benefit from making the investment required to understand theories of announcement-induced trading, and as mentioned above, empiricists will also benefit from refining empirical proxies to map more closely into unobservable theoretical constructs.

Theorists can spur significant advances by specifying theories in terms of (more nearly)

empirically observable phenomena, and by being aware of empirical regularities so that they can attempt to relax key simplifying assumptions that are likely not descriptive. For example, Kim and Verrecchia (1997) find that upon relaxing their 1991 model's assumption of homogeneous interpretations, differential interpretations are an important driver of announcement period trading. As another example, theory could explore the effects of economically plausible transaction costs on announcement period trading.

As the Appendix explains in more detail, errors in measuring the informational determinants of trading volume are likely a major cause of empirical models' low explanatory power. *Investors'* uncertainty about future firm value, differential precision of preannouncement information, differential interpretations, and consequently differential belief revisions are proxied using measures based on *analysts'* beliefs. Analyst-based measures are noisy proxies for investor-based constructs: (1) the proxies are based on beliefs of a relatively well-informed subset of market participants,[31] (2) the proxies measure analysts' beliefs about (usually near-term) earnings, as distinct from their beliefs about intrinsic firm value, and (3) theoretical information-related constructs like uncertainty and differential precision of private predisclosure information are unobservable, so any empirical proxies measure the underlying constructs with error. As another example, Garfinkel's (2009) empirical evidence casts doubt on the validity of stock price volatility, bid-ask spread, and dispersion in analysts' forecasts as proxies for investor disagreement. Thus, empirical research would also benefit from better measures of investors' earnings expectations and other proxies for the nature of investors' information (and differences in information).

Imperfect controls for noninformational sources of trading (e.g., liquidity trading) further

[31] Indeed, Bamber and Cheon (1995) use the difference between the mean analyst forecast and a naive seasonal random-walk earnings expectation as a proxy for disagreement between sophisticated and unsophisticated investors .

garble the estimated relation. Simulations confirm that measurement error significantly dampens the measured relation between information variables and trading volume around earnings announcements. Even in a (simulated) world where differential interpretations is the *sole* source of trading, Bamber et al. (1999) report that a regression of trading volume on Kandel and Pearson's (1995) proxy for differential interpretations yields an average R^2 of only 10%. Barring a major breakthrough, even phenomena that are the primary determinants of trading in response to earnings announcements are unlikely to provide substantial explanatory power.

Such evidence suggests we should be wary of expecting high R^2s. Instead, researchers will have to be creative in identifying the primary determinants of trading volume around financial disclosures. Researchers might examine more closely the estimated coefficients (perhaps in reverse regressions of information-based determinants on trading volume) and consider what the magnitude of these coefficients suggests about the economic significance of various determinants of announcement-period trading. Another path is ruling out other possible determinants of announcement period trading. For example, after finding abnormally high trading around earnings announcements even in the absence of a price reaction (a context where theory suggests differential interpretations is the only driver of trading), Kandel and Pearson (1995) go on to demonstrate that a number of factors *unrelated* to disagreement do *not* help explain this trading.[32] This additional analysis strengthens their conclusion that abnormal trading around earnings announcements that do not spur price reactions arises primarily because investors interpret the earnings announcements differently

[32] Specifically, they show that: (1) "life cycle"/liquidity trading is not concentrated around earnings announcements, (2) increased trading is not due to arrival of other information at earnings announcement dates, and (3) earnings announcements are not associated with a switch from partially to fully revealing rational expectations equilibria. They also find no evidence that abnormal volume around earnings announcements is explained by patterns in the arrival or production of private information, trade due to wealth changes, or trade due to risk shifts around the earnings announcement.

Progress in eliminating otherwise plausible determinants of trading (so future studies can rely on prior research to rule these out) will require appreciation of research that uses powerful designs yet fails to reject the null hypothesis. That is, progress in ruling out otherwise plausible determinants will require reviewers and editors to guard against the well-documented bias against publishing papers that fail to reject the null hypothesis (Greenwald 1975; Lindsay 1994). Greenwald (1975) points out that such bias against the null delays the acquisition of knowledge by fostering the publication of studies whose results (rejecting the null hypothesis) are true, but of limited generalizability. Bamber and Bamber (2009) argue that bias against the null also impedes science by giving researchers dysfunctional incentives to continue mining the data until some relation yields the desired *p*-value.[33] That said, it is of course *incumbent on authors to demonstrate that the study's empirical tests are powerful enough to detect an economically material effect, should one exist*.[34] In sum, research that uses a powerful design, yet finds that a well-motivated proposed determinant does not play a significant role in explaining announcement period trading, can make a valuable contribution.

Future research: Opportunities for experimental studies

Experimental studies can also contribute to the triangulation of evidence. While experiments necessarily sacrifice some external validity, they have several advantages: (1) researchers can implement strong controls for factors that might affect trading but are unrelated to the determinant of interest, (2) researchers can often obtain more direct measures of theoretical determinants of trading than is possible with archival data (e.g., differential precision

[33] Bamber et al. (2000, 124) further argue that in combination with the bias against publishing replications (which is more extreme in accounting than in hard sciences where replication is the norm), editorial bias against the null "can lead to a situation where the first published studies are more likely to reject the null, and these initial studies have a disproportionate effect on subsequent research due to the bias against publishing replications."

[34] See Greenwald (1975) for suggestions on gracefully failing to reject the null, and Cready and Mynatt (1991) for an excellent illustration in an accounting context.

of preannouncement information), and (3) researchers can explore reactions to proposed new financial disclosures or new regulatory environments before such changes are implemented in the real world.

Given the theoretical focus on differences across individual investors' preannouncement information, their interpretations of public information, and their risk preferences, behavioral research may prove useful. Although some question the ability of research on individual behavior to yield insights relevant to aggregate markets, archival evidence that at least some investors fail to fully assimilate all available public information (e.g., DeBondt and Thaler 1985; Bernard and Thomas 1990; Battalio and Mendenhall 2005; Ayers et al. 2009) suggests that markets are affected by non-Bayesian individual behavior.

Recent research in finance illustrates how archival researchers can benefit from exploring behavioral theories of non-Bayesian individual investor behavior. Odean (1998a) draws on Kahneman and Tversky's (1979) prospect theory to hypothesize a "disposition effect" in which investors, in order to avoid a feeling of regret, hold their losing stocks too long and sell their winning stocks too soon. Using data on 10,000 individual accounts at a discount brokerage, he finds evidence consistent with this hypothesis. Then, based on Odean's (1998b) theoretical model predicting that significant investor disagreement arises because of investor overconfidence, Odean (1999) and Barber and Odean (2002) provide archival evidence suggesting that overconfidence-related disagreement significantly increases trading in general.[35] Future research could ask whether certain features of financial disclosures exacerbate or

[35] Odean (1999) and Barber and Odean (2000) present evidence suggesting that overconfident investors trade too intensely, and earn lower returns partly because of transaction costs. In a review of early market-based empirical research in accounting, Lev and Ohlson (1982) also argue that trading volume yields insights into social welfare, drawing on Beaver's (1968 and 1972, pp. 414-15) argument that trading volume reflects "the extent to which accounting data induces heterogeneous expectations among investors and, hence, an exchange of shares without changing the equilibrium price of a security, [an issue that Beaver suggests is] important because non-zero costs are incurred as a result of exchange of shares."

ameliorate investor overconfidence? Can we identify educational interventions that would help users better calibrate the appropriate level of confidence?

Similarly, experimental research finds that less-informed traders are overconfident and engage in overly aggressive trading that transfers wealth to more-informed traders (e.g., Bloomfield, Libby, and Nelson 1999). In another recent experimental markets study, Hales (2009) finds that investors tend to construct myopic models of fundamental firm value that overweight their own information and underweight the information of other traders, prompting them to trade excessively to their financial detriment. However, these studies do not explore how behavioral characteristics such as the disposition effect and investor overconfidence affect trading around financial disclosures such as earnings announcements.

7. Closing

We have synthesized and critiqued the empirical literature examining trading volume around earnings announcements and other financial reports. Subsequent research confirms Beaver's (1968) early intuition that trading volume reactions reflect a lack of consensus regarding firm value, and that trading volume captures changes in the expectations of individual investors whereas price reactions reflect changes in the expectations of the market as a whole. That is, while returns reflect the average change in investors' beliefs, volume reflects the sum of differences in traders' reactions to an announcement, whether those differences arise from differential interpretation or differential preannouncement beliefs.

Accounting researchers should be interested in trading volume because it reflects differences across investors. For example, recent evidence suggesting that a significant portion of the trading around earnings announcements stems from differential interpretations of the announcement raises questions about earnings announcements' effectiveness in leveling the

informational playing field (e.g., Bamber et al. 1999; Barron et al. 2005). And studies of intradaily trading have the potential to tell us who is reacting to disclosures such as pro forma earnings announcements and electronic SEC filings (e.g., Bhattacharya et al. 2007; Asthana et al. 2004). Another nascent stream of research suggests that trading around earnings announcements is of interest because it is systematically associated with post-announcement returns (e.g., Garfinkel and Sokobin 2006; Ayers et al. 2009).

Despite trading volume's potential to yield new insights on questions of interest to accounting researchers, regulators, and policymakers, most capital market studies focus on *price* reactions to earnings announcements and other financial reports. We suspect the relative underrepresentation of trading volume analyses arose because a relative paucity of both data and theory early on led a generation of researchers to largely overlook the potential for trading volume to yield interesting new insights incremental to those available from price-based studies. Our ultimate goal in this review is to stimulate further research by summarizing what we think we know about trading volume around financial disclosures, highlighting the kinds of questions for which trading volume analyses have the potential to yield valuable new insights, while also warning would-be researchers about some of the unique research design challenges in this area.

To this end, we summarize the historical development of trading volume theory, from the early models of financial markets that allowed no room for investor disagreement that spurs trade, to the early adaptive expectations models, to the noisy rational expectations and differences of opinion models that underlie contemporary empirical research on determinants of trading volume around public announcements. A key conclusion from the theoretical literature is that trading around public announcements increases with disagreement arising from both: (1) differences in investors' prior beliefs, and (2) differential interpretation of the announcement.

We then turn to unique research design challenges, such as how to measure trading volume, how to deal with the extreme skewness in trading volume data, and the pros and cons of various empirical proxies for disagreement-related determinants of trading. We illustrate specific contexts where it is possible to rely on theory to guide the choice, but point out that in many cases these research design choices necessarily remain rather ad hoc.

After setting the stage with theory and research design challenges, we discuss empirical evidence on trading volume reactions to earnings announcements and other financial disclosures. In addition to evidence that trading is abnormally high around financial disclosures, we review evidence on the determinants of this elevated trading, and highlight research on the relation between price and volume reactions to financial disclosures. Not only do the magnitudes of price and volume reactions generally differ (e.g., Bamber and Cheon 1995), but Cready and Hurtt (2002) suggest that volume provides more powerful tests of investors' reliance on a disclosure.

Consistent with theory, various proxies for differential investor belief revision (stemming from differences in preannouncement information or differential interpretations of the announcement) play an important role in explaining announcement-period trading (e.g., Ziebart 1990; Bamber et al. 1999; Ali et al. 2008). More specifically, a recent stream of research capitalizes on Kim and Verrecchia's (1997) argument that the portion of volume reaction related to absolute price change reflects differential precision of predisclosure information, whereas the portion of the volume reaction that is unrelated to the absolute price change reflects differential interpretations of the announcement, in order to explore the effect of financial disclosures on investor disagreement (e.g., Ahmed et al 2003; Hope et al. 2009). Digging beyond aggregate trading, intradaily trading allows us to investigate who is trading on various disclosures (e.g., Cready and Mynatt 1991; Asthana et al. 2004; Bhattacharya et al. 2007), and to explore how

earnings expectations differ across small versus large traders (e.g., Bhattacharya 2001; Battalio and Mendenhall 2005).

Building on our analysis of the theoretical and empirical literature, we suggest directions for future research. Despite a significant increase in research effort over the past few decades, we have just scratched the surface of the insights trading volume can provide about the characteristics of financial disclosures and their effects on investors. For example, we still lack an understanding of the primary determinants of trading volume reactions to earnings announcements. Also, we have little theory or empirical evidence concerning how these volume reactions impact security pricing and the cost of firms' capital. Thus, we still agree with Ross' (1989) observation that the volume of trade (especially that around financial disclosures) remains a major dark continent for explorers of financial accounting and securities markets. In addition to archival research, theorists can contribute by specifying models in terms of (more nearly) observable phenomena, and by relaxing key assumptions that are not likely to be descriptive. Laboratory experiments can contribute by more directly measuring theoretical determinants of trading responses to public announcements that are impossible to measure accurately in an archival context (e.g., differential precision of preannouncement information).

Research that capitalizes on fundamental differences in the implications of price versus volume reactions has the potential to yield new insights on issues of importance to practice as well as to researchers. For example, who is reacting to financial disclosures? Does the quality of preannouncement information appear to differ systematically across different types of disclosures or different types of investors? What specific characteristics of disclosures cause differential interpretations? Do different types of investors differ in their interpretation of financial disclosure, and if so, how and why? To what extent are differential interpretations due

to differences in investors' private information or differences in their ability to process financial information? Analysis of trading volume around financial disclosures has great potential to yield important new insights into these kinds of questions that are clearly relevant to policymakers as well as academics.

TABLE 1
Major Published Archival Studies of Trading Volume at Earnings Announcement Dates

Study	*Major Volume Findings*
Beaver (1968)	Mean trading volume in the week of annual earnings announcements is 33% larger than the mean volume during the 8 weeks before and after the announcement week. Volume is below normal in the 8 weeks prior to the announcement week and slightly above normal for the 4 weeks just after the announcement week.
Kiger (1972)	Average trading volume for 3- or 5-day periods centered around 2nd and 3rd quarter earnings announcements, adjusted for market fluctuations, is greater than a 5-day control period beginning 8 days prior to the announcement of interim earnings.
Morse (1981)	Daily trading volume is abnormally large from 1 day prior to quarterly earnings announcements up to 3 days after the announcements.
Bamber (1986)	Trading volume around annual earnings announcements is positively related to the magnitude of unexpected earnings and negatively related to firm size. Non-12/31-year-end firms and non-NYSE firms have a stronger trading reaction to annual earnings announcements than 12/31-year-end and NYSE firms.
Bamber (1987)	Both the magnitude and duration of the trading volume reaction to quarterly earnings announcements are positively related to unexpected earnings and negatively related to firm size.
Cready (1988)	Average transaction size is above average in time periods surrounding annual and quarterly earnings announcements. Larger size transactions occur sooner after the announcements than smaller size transactions.
Ziebart (1990)	The change in trading volume the week of quarterly and annual earnings announcements is positively related to both the change in analysts' forecast dispersion (coefficient of variation) and the absolute value of the percentage change in the mean forecast.
Lee (1992)	Both small and large trades increase abruptly in the half hour of quarterly earnings announcements. The small trade reaction is slower than the large trade reaction, extending across the following three days.
Sivakumar and Waymire (1993)	In early capital markets where earnings disclosures were effectively unregulated, dividend announcement spur more trading than earnings announcement.
Atiase and Bamber (1994)	The magnitude of the trading volume reaction to annual earnings announcements is positively related to the magnitude of the contemporaneous price reaction and the dispersion of analysts' forecasts in the prior month.
Kross, Ha, and Heflin (1994)	Trading volume around annual earnings announcements is positively related to the absolute change in beta between the year prior to and the year following the announcements.
Sivakumar and Waymire (1994)	In early capital markets where earnings disclosures were unregulated, disclosures of interim earnings spur abnormal trading in the subset of firms that infrequently disclose interim earnings.
Bamber and Cheon (1995)	While the magnitudes of price and volume reactions to quarterly earnings announcements are positively related overall, nearly a quarter of the announcements generate either (1) very high trading but little price change, or (2) large price change but little trading.
Kandel and Pearson (1995)	Abnormal trading volume around quarterly earnings announcements exists regardless of the magnitude of the price reaction, including zero price reaction.

Amin and Lee (1997)	Document abnormally high trading around quarterly earnings announcements, concentrated largely on the day of and the day after the earnings announcement, but trading remains elevated for over a week after the earnings announcement.
Bamber, Barron and Stober (1997)	Trading volume around quarterly earnings announcements is positively related to (1) prior dispersion in analysts' forecasts, (2) jumbling of analysts' forecasts, and (3) the change in forecast dispersion.
Utama and Cready (1997)	When institutional ownership is low the trading volume reaction to annual earnings announcements increases with institutional ownership, but when it is high (i.e., over 50%) the trading volume reaction decreases with institutional ownership.
Bamber, Barron and Stober (1999)	Kandel and Pearson's (1995) measure of differential interpretations is significantly related to trading volume around quarterly earnings announcements, but only when trading is above the average level of non-announcement period trading.
Bhattacharya (2001)	Small trades around earnings announcements are increasing in the magnitude of seasonal random-walk forecast errors, even after controlling for analyst-forecast-based earnings surprises and contemporaneous price changes.
Landsman and Maydew (2002)	The trading volume reaction to quarterly earnings announcements has increased over the period 1972 to 1998.
Ahmed, Schneible, Stevens (2003)	The advent of online trading has increased price and volume reactions to earnings announcements. They conclude that the availability of online trading has increased less sophisticated investors' trading.
Bailey, Li, Mao, and Zhong (2003)	Even after controlling for the magnitude of the contemporaneous price reaction, the trading volume reaction to earnings announcements increases after Regulation Fair Disclosure. The authors conclude that this elevated trading reflects greater disagreement about earnings announcements, and differential interpretations in particular.
Hurtt and Seida (2004)	The greater the difference between short-term and long-term capital gain tax rates, the less likely individual investors are to sell shares of appreciated stocks around earnings announcement dates.
Barron, Harris, and Stanford (2005)	Announcements that increase analysts' private information (as measured by BKLS empirical proxies) are associated with abnormally high trading volume.
Battalio and Mendenhall (2005)	Around earnings announcement dates, small traders trade in the direction of seasonal random-walk forecast errors, whereas large traders trade in the direction of analyst forecast errors.
Garfinkel and Sokobin (2006)	Isolates a portion of announcement period trading volume that likely reflects divergence of opinion, and shows that this is associated with more positive post-earnings announcement returns. The authors interpret this evidence as consistent with Varian's (1985) theoretical prediction that opinion divergence is an additional risk factor for which investors require compensation.
Ahmed and Schneible (2007)	The portion of earnings announcement period volume related to the contemporaneous price change declines after Regulation Fair Disclosure. The authors conclude that Reg FD successfully decreased differential precision of predisclosure information.
Bhattacharya, Black, Christensen, and Mergenthaler (2007)	Small traders (but not medium or large traders) trade in the direction of the difference between pro forma EPS and actual EPS, consistent with small traders anchoring on pro forma earnings.

Ali, Klasa, and Li (2008)	Refine Utama and Cready's measure of differential precision of private predisclosure information (total institutional ownership) by focusing on institutions with medium stockholdings. They find that when ownership by institutions with medium stakes is low, the trading volume reaction to earnings announcements increases with institutional ownership, but when it is high, the trading volume reaction decreases with institutional ownership. This pattern holds only for institutions with medium stockholdings and not for those with high or low stockholdings.
Sarkar and Schwartz (2009)	Earnings announcements spur an increase in two-sided trading (i.e., trading spurred by a balance of buyers and sellers), especially when the news is large. The authors interpret this as suggesting that earnings announcements spur differential interpretations and/or investors acquire diverse information to better interpret the earnings announcement.
Hope, Thomas, and Winterbotham (2009)	The portion of earnings announcement period volume reaction related to the contemporaneous price change declines after SFAS 131 eliminates the requirement to disclose earnings by geographic segment. The portion of earnings announcement period trading that is unrelated to the price change also declines after SFAS 131, but only for firms that cease geographic disclosures.

Table 2
What we think we have learned about financial disclosures and their effects on investors from studying trading volume

On average, earnings announcements convey enough new information to prompt investors to take action by trading (Beaver 1968; Kiger 1972, Morse 1981), and earnings announcements are having an increasing effect on investors over time (Landsman and Maydew 2002; Ball and Shivakumar 2008)
This "on average" result is driven by a small minority of announcements; most earnings announcements provide only modest incremental information (Bamber et al. 1994; 2000; Ball and Shivakumar 2008).
Earnings announcements that are associated with heavy trading despite minimal price changes are associated with proxies for investor disagreement (Bamber and Cheon 1995; Bamber et al. 1999)
Many earnings announcements spur differences of opinion (Garfinkel 2009), leading investors to change their perceptions about firm value in different ways. This is often referred to as differential belief revision, which can arise from either differential predisclosure information or differential interpretations of the announcement (Karpoff 1986; Kim and Verrecchia 1991a; Banerjee and Kremer 2009).
Some of the trading around earnings announcements is associated with proxies for differential quality of predisclosure information (Kim and Verrecchia 1991a; Atiase and Bamber 1994; Utama and Cready 1997; Ali et al. 2008), and differences in the quality of predisclosure information appear to be increasing over time (Barron et al. 2009). Such information asymmetry (i.e., "unlevel" informational playing field) is of interest to policymakers.
Small investors appear to be at an informational disadvantage relative to large investors (DeFranco et al. 2007). Unlike large traders, small traders react more slowly (Cready 1988; Lee 1992), they rely on ad hoc pro forma earnings (Bhattacharya et al. 2007), and on simple seasonal random-walk earnings expectations whereas large investors appear to trade based on analysts' forecasts (Bhattacharya 2001; Battalio and Mendenhall 2005; Ayers et al. 2009).
Evidence suggests that some earnings announcements are interpreted differently by different investors (Kandel and Pearson 1995; Bamber et al. 1999; Gillette et al. 1999; Barron et al. 2002; Sarkar and Schwartz 2009), and differential interpretations appear to be increasing over time (Bailey et al. 2003; Ahmed et al. 2003). Evidence that differential interpretations appear to be increasing over time should be of interest to policymakers.
Technology appears to have changed investors' reactions to SEC filings. After EDGAR, investors, especially small investors, appear to be using the SEC filings, and this has improved their trading outcomes (Asthana and Balsam 2001; Asthana et al. 2004).
Reg FD appears to have ameliorated predisclosure information asymmetry as regulators intended (Asthana and Schneible 2007), but also appears to have had the unintended consequence of leading to more differential interpretations of the earnings announcement itself (Bailey et al. 2003)
On average, earnings announcements provide enough information about changes in firms risk to prompt investors to trade (Kross et al. 1994)
In an unregulated environment, dividend announcements are a more credible signal than earnings announcements (Sivakumar and Waymire 1993)
Other financial disclosures, such as corporate annual reports, qualified audit opinions, and Form 20-F reconciliations, that do not routinely spur significant price reactions nonetheless are useful to investors in the sense of prompting them to trade (Cready and Mynatt 1991; Keller and Davidson 1983; Chen and Sami 2008)

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Appendix

Challenges in empirical measurement: Measuring investors' expectation-based determinants of trading volume reactions to financial disclosures

Theory posits that determinants of trading volume around financial disclosures involve investor expectations and changes in those expectations. Because investor expectations are not observable, researchers must form proxies using time-series models or analysts' forecasts of earnings. The increasing availability of analysts' forecasts from sources such as First Call, plus the greater accuracy of analysts' forecasts relative to time-series-based forecasts, led to increased use of analysts' forecasts as proxies for investor expectations (Kothari 2001).[36] We highlight two issues regarding the use of analysts' forecasts to measure investor expectations. First, how well do analysts' forecasts of upcoming earnings proxy for investors' beliefs about firm value? Second, even if we accept analysts' forecasts as reasonable proxies for investors' expectations about firm value, what is the relation between properties of analysts' forecasts and theoretical determinants of trading volume reactions to financial disclosures?

Analysts' earnings forecasts are a noisy proxy for investors' expectations of firm value. First, information relevant for forecasting upcoming earnings is not identical to information relevant for assessing firm value. A change in accounting methods may affect analysts' forecasts of upcoming earnings without changing investors' expectations about the underlying value of the firm. Conversely, news that the firm has signed a lucrative long-term contract effective next period may affect investors' expectations about firm value without changing analysts' forecasts of this period's earnings. Second, analysts are not representative of the full population of investors. Analysts have unique economic incentives and training (Schipper 1991), so their

[36] Schipper (1991), Brown (1993; 1996), and Ramnath, Rock, and Shane (2008) review the voluminous analyst forecast literature.

forecasts likely reflect the expectations of sophisticated investors who have better information or better information processing capability than the average investor.

Researchers have used differences between analysts and less-informed investors to yield useful insights regarding market reactions to earnings announcements. Price reactions to earnings announcements track more closely earnings surprises measured relative to analysts' forecasts (e.g., Brown et al. 1987), whereas (total) trading volume reactions track more closely earnings surprises from an unsophisticated seasonal random-walk expectation model (Bamber 1986; 1987). Bamber and Cheon (1995) conjecture that this difference arises because the price effects of any investors trading on (outdated) seasonal random-walk expectations are largely cancelled out by better-informed investors trading on analyst-forecast-based expectations, whereas trading volume reflects the trades of all investors.

Even though analysts' forecasts primarily reflect the expectations of more sophisticated investors, researchers have used analysts' forecasts as proxies for investor expectations in general. For example, researchers have used dispersion in analysts' forecasts to proxy for differential precision of private predisclosure information across all investors. But theory suggests it is problematic to use dispersion in analysts' forecasts as a proxy for differential precision of private information. Abarbanell, Lanen, and Verrecchia (1995, hereafter ALV) analyze how analysts' forecasts relate to investor expectations and trading volume by adding analysts' forecasts to Kim and Verrecchia's (1991a) model. They are unable to link forecast dispersion to trading volume through differential precision of private predisclosure information, and they conclude that the relation between forecast dispersion and trading volume is a matter of conjecture (see ALV, 49). In ALV's model, analysts' forecasts are exogenous information signals similar to other public signals available to investors. Barron, Kim, Lim and Stevens

(1998) extend ALV by modeling analysts' forecasts as endogenously determined by the common and private information available to analysts. BKLS combine observable elements of analysts' forecasts (the error in the mean forecast, dispersion in forecasts, and the number of forecasts) to develop proxies for theoretical constructs such as the precision of common and private information. Similar to ALV, BKLS do not find a direct link between forecast dispersion and differential precision of private information.

Recent empirical research also suggests that forecast dispersion is not likely to be a good proxy for investor heterogeneity. Barron, Stanford, and Yu (2009) show that forecast dispersion reflects the degree of firm-specific uncertainty more than lack of consensus as characterized by Holthausen and Verrecchia (1990). Also, Garfinkel (2009) finds that a measure of opinion divergence constructed from microstructure data is not associated with forecast dispersion, but is associated with unexplained (abnormal) trading volume, and he concludes that unexplained volume is a better proxy for opinion divergence.

In summary, empirical studies of trading volume reactions frequently use properties of analysts' forecasts to form proxies for unobservable theoretical constructs such as differential interpretation and differential prior precision. Historically, these proxies have been rather *ad hoc.* To narrow the gap between trading volume theory and empirical evidence, researchers are beginning to identify more theoretically defensible proxies, such as Kandel and Pearson's (1995) proxy for differential interpretations, and the proxies for uncertainty and precision of private and public pre-disclosure information in BKLS (1998).