"What moves the market? Individual firms' earnings announcements as drivers of index returns"

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Abstract

In this paper, we document aggregate market reaction to firms' news releases. We leverage the S&P500 index futures data and use narrow intraday and overnight windows to isolate the market-wide reactions to earnings announcements. We find that earnings announcements of individual large firms represent an economically significant source of market-wide news, on par with macroeconomic releases. These results highlight the existence of information spillovers associated with earnings announcements. However, we also find that the magnitude of the aggregate market reaction to earnings announcements has declined over our sample period, 2004 – 2021. This decline contrasts with the increasing firm-level informativeness of earnings announcements documented in prior research. We find a similar decrease in the informativeness of the official macroeconomic releases, which raises the possibility of some common factors driving the decline in price responses to both sets of announcements.

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1. Introduction

A voluminous literature focuses on the price discovery around corporate earnings announcements (e.g., Beaver 1968). In addition to serving as one of the most important information releases for the announcing firms, these events produce significant information spillovers. Investors can use the announced information to update their expectations about aggregate cash flows of other firms in the market and the economy at large.[1] The simultaneous update of individual firms' and aggregate expectations is one of the proposed explanations for the existence of an earnings announcement premium, i.e. a higher realized return over the earnings announcement periods (e.g., Ball and Kothari 1991; Patton and Verdado 2012; Savor and Wilson 2016).[2] In this paper, we provide novel evidence on the extent of spillovers by measuring the broad index reaction to individual firms' announcements.

Prior research has inferred the aggregate-level information spillovers indirectly, for example, by measuring the ability of announcement returns to predict future aggregate earnings (e.g., Savor and Wilson 2016). Our evidence is more direct: we isolate an immediate market reaction to the firms' announcements at the intra-hour frequency. A substantial portion of earnings announcements falls outside the regular stock exchange trading hours, when the stock markets are relatively illiquid. To overcome this limitation, our empirical tests use the return and volume information from the S&P 500 e-mini futures. The S&P 500 e-mini (ticker ES) is one of the most liquid products traded on the

[1] Information spillovers also occur more narrowly among the related firms, e.g. within industry (Foster 1981), through customer-supplier networks (Pandit, Wasley and Zach 2011), etc. We focus on the aggregate-level spillovers since they are the source of systematic risk and risk premia.

[2] Ball end Kothari (1991) find that beta increases cannot fully explain the announcement premia. Patton and Verdado (2012) document a significant increase in betas based on intraday returns around announcement days; they do not test whether these beta increases explain announcement premia. Savor and Wilson (2016) suggest earnings announcements lead to increases in cash-flow-news betas that command a higher premium than the discount-rate-news betas, which explains why CAPM betas that utilize total realized returns cannot explain the announcement premia.

Chicago Mercantile Exchange (CME).[3] Most important in our setting, the e-mini futures contracts are traded round the clock, providing an ideal setting for gauging the arrival of the news around earnings announcements. [4]

Our sample consists of 12,917 earnings-announcement windows for the 100 firms with the largest market capitalization between 2004 and 2021.[5,6] Each announcement window consists of the 15-minute interval that the announcement falls into (time t) and the two adjacent 15-minute intervals (t-1, t+1) to account for the pre- or post-announcement drifts (e.g., Bernile et al. 2016; Kurov et al. 2019). We infer the presence of index-wide information associated with the announcements by measuring the abnormal market activity for the S&P 500 e-mini contracts within the announcement windows.[7] These tests, in the spirit of Beaver (1968), measure new information release and allow us to extract the market-wide reaction to individual firm's earnings announcements.

In particular, we estimate the time-series regressions of either the return volatility or the trading volume measured over the 15-minute intervals on the EA window indicators.[8] The time-series regressions include fixed effects that account for the time interval, day of the week, year, and calendar quarter, and control for the announcement timing within the monthly news calendar, as well as

[3] Prior research has relied on the S&P 500 e-mini futures to document information release and price discovery around various macroeconomic announcements (Lucca and Moench 2015; Bernile, Hu, and Tang 2016; Cieslak, Morse, Vissing-Jorgensen 2019, Hu, Pan, and Wang 2017 , and Kurov, Sancetta, Strasser and Wolfe 2019).

[4] The majority of price discovery for the S&P 500 index occurs in the futures market, with futures prices typically leading the spot prices (Hasbrouck 2003). Since its introduction in September 1997, the S&P 500 e-minis have been the fastest growing product in CME's history (Kurov and Lasser 2004). The size of the e-mini contract is one-fifth of the regular S&P 500 futures contract traded on the floor of CME, which makes them more accessible for traders with limited amount of capital.

[5] Although the S&P 500 e-mini contracts have been introduced in 1997, the initial trading hours had an overnight gap. Round-the-clock trading started in 2004 (e.g., Bondarenko and Muravyev 2020). Section 2 provides more details on the futures contract and the institutional features of the futures market.

[6] The futures prices and trading volume measured at 15-minute intervals are obtained from Pi Trading Inc. The earnings announcement information, including the date and time of the release, actual earnings and consensus analyst expectations, is from I/B/E/S. We check I/B/E/S timestamps against the news wire times in Ravenpack and use the earlier of the two in our tests (e.g., Bradley, Clarke, Lee, and Ornthanalai 2014). Additional accounting data are from Compustat. The macroeconomic indicator information, including the date and time of the release is from Haver Analytics. Section 3 provides the full list of macroeconomic announcements examined.

[7] In this paper, we use index-wide and market-wide interchangeably.

[8] The volatility measure is the absolute value of continuously compounded return (e.g., Andersen and Bollerslev 1997).

microstructure effects (e.g., volume or volatility autocorrelation and futures contract rollover periods). We also control for the release of macroeconomic information by including indicators for the times of macroeconomic announcements.

Our results suggest that individual firms' EA intervals are associated with significant index-level abnormal volatility and trading volume. The absolute returns (volume) around EAs are on average 0.5 basis points (7%) higher than in the non-announcement intervals. The magnitude of abnormal volatility (volume) associated with EAs is also economically significant, representing 25% (47%) of average abnormal volatility (volume) associated with MAs. When compared to macro releases that exclude the major announcements (unemployment, FOMC, inflation, and GDP advance releases), the magnitude of abnormal volatility (volume) associated with EAs is even more pronounced at 44% (75%) of the respective MA magnitudes.[9] The results are qualitatively similar when we exclude recessionary periods. Additional tests indicate that prices continue to drift in the direction of the initial market reaction for the next seven hours, so these magnitudes represent a lower bound on the amount of spillover from the earnings announcing firm to the market. Overall, our results suggest that the information released during the largest firms' EAs exert significant influence on index prices, indicating the presence of macro-information spillovers.

We perform several additional tests to provide a more in-depth characterization for the information spillovers. First, we account for the timing of the announcements. Prior research has identified significant differences in the information content of the overnight and daytime returns both

[9] The relatively high magnitudes of the abnormal market reactions over the EA intervals suggest that our results are unlikely to be entirely driven by the idiosyncratic returns of the largest S&P 500 index constituents having a mechanical association with index returns. For comparison, Frankel, Johnson, and Skinner (1999) document that firms in their sample experience an average absolute return of 1.77% over the 75-minute window surrounding the earnings announcement, compared to 0.8% average absolute return over the control period, i.e. the earnings announcements are associated with a 0.97% abnormal absolute return. As regular returns do not differ significantly from continuously compounded returns over short intervals, this is equivalent to 0.97% / 5 = 0.19% 15-minutes abnormal absolute return. The average weight (by market capitalization) of the largest 100 firms in the S&P500 index is 0.75%. Thus, when a large firm announces earnings, the mechanical change in the index return should be 19 basis points * 0.75% = 0.14 basis points, which is significantly lower than the average abnormal absolute return of 0.5 basis points that we observe in our sample.

in the stock market (Lou, Polk, and Skouros 2019; Hendershott, Livdan, and Rosch 2020) and in the futures market (Bondarenko and Muravyev 2020; Boyarchenko, Larsen, and Whelan 2020). The overwhelming share of EAs occurs outside regular stock exchange hours. We split the announcements into those that fall within and outside the regular trading hours (we refer to these announcements as daytime and overnight, respectively). We find that only the overnight EAs are associated with a statistically significant amount of abnormal volatility. In addition, as prior research finds that the stock market processes post-close and pre-open EAs differently (Lyle, Stephan and Yohn 2021), we further split the overnight announcements into post-close and pre-open and find that the futures market reacts more strongly to post-close EAs than those announced before market open.

Second, we explore if the informativeness of the EA depends on its timing within the earnings announcement cycle. Designating announcements that fall in the first month of the calendar quarter (i.e., Jan., Apr., Jul., and Oct.) as the "early" announcements and those in the rest of the quarter "late" announcements, we find that the abnormal volatility around EA windows is only present for the early EAs, while MAs elicit abnormal volatilities over the entire quarter regardless of announcement timing. Similar observations can be made when we split the announcements into post-close, pre-open and daytime — both post-close and pre-open EAs generate higher abnormal volatility when they are announced early in the season, however, daytime EAs has little impact on market activities regardless of announcement timing. These findings echo the evidence in intra-industry information transfer that early announcers generate stronger spillover effects to their industry peers (e.g., Ramnath 2002).

Our next set of tests documents the intertemporal variation in the market-wide reaction to earnings announcements. In general, we find a significant downward trend in the abnormal volatility associated with EAs over our sample period and a similar decrease associated with MAs. These results differ from the previously documented increase in the informativeness of EAs for the individual stock returns (Beaver, McNichols, and Wang 2018, 2020; Shao, Stoumbos, Zhang 2021). We also find

evidence of elevated aggregate abnormal volatility around EAs during the recessionary periods, which is consistent with a greater demand for financial information during periods of high aggregate uncertainty (Bonsall, Green, Muller 2020). Using the 90-day trailing-average implied volatility index (VIX) as an uncertainty measure, we confirm that the abnormal volatility over both the EA and MA intervals increases with VIX. Controlling for VIX subsumes a significant coefficient on the recession indicator for the EAs, but it does not fully subsume a downward trend in either the EA or MA abnormal volatility. Additional analysis suggests that the downward slopping trend in the informativeness of EAs is mainly driven by the decreasing importance of pre-open EAs. Interestingly, there seems to be a shift in the informativeness between pre-open/daytime EAs and post-close EAs, with the former gaining importance as aggregate uncertainty increases while the latter becoming less important.

Overall, we find little evidence of a pronounced upward trend in the ability of individual large firms' announcements to influence index prices, which is inconsistent with the argument in recent research and the financial media that extremely large firms are gaining in their market-wide influence due to lack of market diversification (e.g., Byun and Schmidt 2020, Schlingemann and Stulz 2020). Combined with a waning effect of macro releases on the stock index prices, these results suggest investors' decreasing reliance on the two primary sources of fundamental news relevant for index prices identified in prior research (e.g., Baker, Bloom, Davis, Sammon 2021).

Our paper makes several contributions. First, we contribute to the research on the market-wide information content of accounting earnings. Although prior research has documented significant market reactions to firms' earnings and guidance surprises, a statistically significant aggregate earnings response coefficient (ERC) per se does not allow us to gauge the relative importance of earnings disclosures as a source of market-wide news when other sources of macroeconomic information are in abundant supply. By benchmarking the abnormal market activity within narrow EA windows

against MAs, we provide novel evidence on the economic significance of accounting disclosures as a source of timely market-wide news.

Second, this paper is related to an emerging line of research that examines the effects of individual firms on aggregate outcomes. This literature argues that the law of large numbers can be violated when the firms' size distribution is highly skewed, resulting in firm-level shocks being reflected in aggregate output (e.g., Gabaix 2011) or market returns (e.g., Byun and Schmidt 2020) rather than diversified away. Our finding that individual large firms' EAs can generate index-level price movements that are qualitatively similar to those induced by MAs highlights the importance of firm-level disclosures even for well-diversified investors (e.g., Ball and Sadka 2015). However, we do not find evidence supporting an increasing trend in the largest firms' ability to move index returns, contrary to the recent outcry among the financial community that that market returns are increasingly driven by a handful of large firms.

Third, our paper contributes to the adjacent literature on the earnings announcement premiums. Heitz, Narayanamoorthy, and Zekhnini (2022) document a decrease in the firm-level earnings announcements premiums. They find no corresponding decrease in the ability of announcement-week returns to predict future aggregate earnings and no significant decrease in the announcement week betas. Our results suggest that the diminished investors' reliance on earnings announcements as a source of market-wide news may have contributed to the disappearance of the premiums.

Finally, our paper provides a methodological contribution. By leveraging the round-the-clock intra-hour futures data, we can measure the aggregate-level abnormal market activity surrounding individual firms' disclosures using the event-study research design commonly used in the firm-level research since Beaver (1968), which allows us to compare and contrast the aggregate-level and firm-level findings on the information content of accounting disclosures (e.g., Cready and Gurun 2010;

Anilowski et al. 2007; Bonsall et al. 2013). Furthermore, our high-resolution intraday data has the advantage of measuring the immediate reaction to an information event in a liquid market even if the event falls outside regular trading hours. The precision with which we can pinpoint the market reaction over the narrow event window improves identification and allows us to differentiate between the information content of earnings announcements and confounding concurrent events. The intraday frequency thus obviates the need to rely on the magnitude of earnings surprises to infer the market-wide information content; the latter complicates inferences because the sign of the market reactions to aggregate earnings surprises varies over time (Gallo, Li, and Hann 2016) and with the surprise measure specification (Ogneva 2013). Hence our paper adds to the arsenal of research design options available to researchers interested in the market-wide implications of accounting disclosures (e.g., Ball, Gallo, Ghysels 2019; Kim, Schonberger, Wasely and Yang 2021).

2. Prior literature and institutional background

2.1 Prior literature

The stock prices are determined by the market through aggregation of vast quantities of information that arrives almost continuously. Arguably, the two primary sources of fundamental news relevant at the aggregate market level are the macroeconomic releases prepared by government agencies (e.g., GDP growth released by the Bureau of Economic Analysis or unemployment statistics released by the Bureau of Labor Statistics), professional organizations (e.g., PMI index compiled by the Institute for Supply Management) or research institutions (e.g., the Michigan Consumer Survey) and the disclosures made by public companies.

The significance of macroeconomic announcements as a source of market-wide news is well established in prior work (e.g., Flannery and Protopapadakis 2002; Savor and Wilson 2014; Lucca and Moench 2015; Bernile, Hu, and Tang 2016; Cieslak, Morse, Vissing-Jorgensen 2019; Hu, Pan, and

Wang 2017; Kurov, Sancetta, Strasser and Wolfe 2019; Baker, Bloom, Davis, Sammon 2021). However, recent research identifies a growing disconnect between the stock market and the economy at large, attributing it in part to the rise of extremely large firms (as measured by market capitalization) whose firm-level shocks are not fully diversified away in aggregate when the distribution of firms' size is fat-tailed. Specifically, firms with extremely high market capitalization may account for a disproportionate amount of aggregate output or the price movement of a broad market portfolio, yet they may not be representative of all U.S. firms as a whole (which includes both private and public firms) in terms of industry composition and may not contribute as much to the economy in terms of the number of workers hired as one would expect based on their sheer size (e.g., Gabaix 2011; Bessembinder 2018; Flynn and Ghent 2020; Schlingemann and Stulz 2020; Byun and Schmidt 2020). These trends raise the possibility of a significant shift in the relative importance of different information sources relevant for a broad stock market index. In particular, the importance of macroeconomic announcements as a source of market-wide news may be waning, while the individual large firms' disclosures may be gaining in economic significance.

Prior research on the market-level information content of accounting disclosures has mostly focused on the long-window co-movements between stock market returns and aggregate earnings (Kothari, Lewellen and Warner 2006. 2006; Sadka and Sadka 2009; Ball, Sadka, and Sadka 2009; Patatoukas 2014; Anilowski et al. 2007). These papers suggest that aggregated firm disclosures contain information that is reflected in aggregate market returns, but they do not provide direct evidence that the stock market extracts market-wide news from accounting disclosures.[10] A handful of studies target

[10] There is also evidence that, when aggregated across a wide cross-section of public firms, accounting disclosures (e.g. GAAP earnings) contain a significant amount of non-diversifiable information about the broader macroeconomy, such as future GDP growth (Konchitchi and Patatoukas 2014a,b; Abdalla and Carrabias 2021), monetary policy (Gallo et al. 2016), inflation (Shivakumar and Urcan 2017), and unemployment (Hann, Li, and Ogneva 2021). However, the extent to which equity investors rely on firms' earnings disclosures as a source of market-wide news in the presence of a plethora of macroeconomic announcements from regulatory bodies and research institutions has received less attention.

short-window reactions to firms' disclosures, including earnings announcements (Cready and Gurun 2010; Kim et al. 2021) and managers' forecasts (Bonsal et al. 2013). The former provide somewhat contradictory evidence. Cready and Gurun (2010) identify a significant negative association between market-wide returns and earnings announced in the surrounding three-day window, which they attribute to the discount-rate news conveyed through the non-diversifiable component of earnings. By contrast, Kim et al. (2021) find no evidence of a significant association between the same-day market returns and aggregate earnings surprises, although they do find that aggregate volatility increases with the magnitude of average earnings surprises. The latter association is more pronounced for negative earnings surprises and for the announcements made in the first 30 days of the quarter. Our paper complements Kim et al. (2020) in several ways. First, our tests capture all information released around earnings announcements rather than focusing on a particular accounting measure, which is particularly important given the documented trends towards bundled disclosures in firms' earnings releases. Second, our event-window design allows us to evaluate economic significance of individual firms' earnings announcements as a source of market-wide information by benchmarking them against macroeconomic announcements releases that are arguably the primary source of market-wide fundamental news. Third, our unique setting with highly liquid round-the-clock trading permits us to have a more granular picture of the immediate market reactions to earnings announcements and macro releases, which frequently occur outside the regular stock exchange trading hours. By incorporating the timing of the announcement in our design, we can account for the possible mismatched timing between the uncertainty resolution and information releases (Hu, Pan, Wang, and Zhu 2022).

2.2 Futures market

Our empirical tests rely on the price and volume information from the S&P 500 e-mini futures market. The futures contracts trade on the Globex electronic market of the Chicago Mercantile Exchange (CME) that is open almost round-the-clock.[11] The contracts expire quarterly (March, June, September, and December). At each point in time listed futures include contracts that expire over five consecutive quarters. The contract for the closest quarter is typically the most liquid (except for the rollover period) and it is called a lead (or front) month contract. Our data consists of the lead-month contract prices and trading volume; we control for the rollover between the contracts, as explained below. Over our sample period, the S&P 500 e-mini futures have been the most liquid futures contract on the CME with an average daily trading volume of over $100 billion, far exceeding not only the standard S&P 500 futures but also the volume of trading in the underlying S&P 500 index securities.[12,13]

Generally, a futures contract is an agreement to buy or sell an underlying asset at a pre-determined price at a particular time. For example, an investor buying an S&P 500 e-mini futures is, in theory, committing to purchase the S&P 500 index at that price at the expiration date. In practice, the index-based futures on CME are settled financially. Unlike stock exchanges, where cash payments occur only when securities are bought or sold, the futures market has a daily settlement procedure, where funds are added to (subtracted from) an account if the contract has earned a profit (loss) on

[11] Section 3 describes in detail the trading hours of the S&P 500 e-mini futures.

[12] CME Group (https://www.cmegroup.com/market-data/volume-open-interest/equity-volume.html) and NYSE (https://www.nyse.com/data-insights/market-volume-and-off-exchange-trading).

[13] E-mini S&P 500 futures are based on the underlying Standard & Poor's 500 stock index. For example, the price of the March 2021 contract at the end of the trading session (17:41 ET) for the S&P 500 e-mini was $3,899.25 on 19 Feb. 2021. The contract unit is $50 x S&P 500 Index, which is one fifth the size of standard S&P futures. So, the notional value that one would need to pay to open an S&P 500 e-mini futures position was $194,962. In May 2019, CME has launched a new product—the S&P 500 micro e-mini futures (ticker MES)—with a lower contract unit equal to $1/10^{th}$ of the e-mini futures. The micro e-mini contract has since overcome the e-mini S&P 500 as the most-traded futures contract on the CME (in terms of the number of contracts traded).

that day.[14] On the expiration day, the investor ends up with an accumulated cash profit in their account or a paid-out loss and, because at that time a futures price is exactly the same as the underlying spot price, the final settlement involves simply closing an open position.

An important feature of the futures market is contract rollover. Contracts expire on the third Friday of the last month of the calendar quarter and they cease trading on CME Globex eight days prior to the expiration. For example, the expiration date for the March 2021 contract is 3/19/21, it rolls over on 3/11/21 when the June 2021 contract becomes the lead month and the March 2021 contract is no longer available for trading on Globex. Most contracts, however, are not held until expiration and are instead rolled over to the next-month contract. The rollover needs to be initiated by the investor and it is typically associated with a small transaction cost that investors try to minimize by timing the rollover.[15] Most traders switch to the next-month contract a few days prior to the official rollover day (e.g., Huang and Locke 2009). In our empirical tests, we control for the rollover periods defined conservatively as an 11-day period prior to and including the expiration day.

The main purpose of taking a position in the futures market is to get exposure to the underlying index or to hedge market risk. The price of the S&P 500 e-mini is linked to the spot price for the S&P 500 index, but does not equal it exactly.[16] However, within short intraday intervals, the

[14] In practice, the funds need to be transferred to cover losses only when the daily loss results in net equity falling below the exchange-established maintenance margin levels.

[15] The rollover is accomplished by selling the expiring contract and buying the deferred contracts (i.e., contracts that settle in quarters beyond the current trading quarter). A choice of a time to "buy the roll" (i.e., sell the expiring contract and buy the deferred contracts) depends in part on the difference between the prices of the expiring and deferred contracts that, in turn, is affected by the implicit financing rate and the prevailing short-term rates such as LIBOR.

[16] The difference between the futures and spot prices is called "basis." Basis increases in financing costs and decreases with expected dividends. At a given point in time, the futures price is given by the spot price plus the financing costs minus dividend income. Intuitively, an investor can recreate the return on the future contract by purchasing the underlying index and holding it until the futures expiration date. The return earned in that case would be (a) lower by the amount of financing costs—the interest on the funds an investor would have to borrow to buy an underlying index and hold it until the futures expiration, and (b) higher by the amount of dividends received before the expiration date that a futures holder is not entitled to. Specifically, if we assume that one finances the portfolio at prevailing short-term rates such as LIBOR rates (R) and benefits from the accrual of dividend income measured in index points (Div) over so many days (days) until futures maturity, the futures price is given by [spot price * (1 + R * days/365) – Div]. For example, assume that the spot S&P 500 price is 1,176.80, short-term LIBOR rate is 0.39%, there are 112 days until expiration and we expect 7.90 index points of dividend accrual until futures contract expiration. The fair value of a futures contract is then equal to 1,170.22.

futures price movement approximates the change in the price of the underlying index. Thus, intraday returns of the S&P 500 e-mini futures have been extensively used in prior literature to infer the stock market reactions to various events that tend to occur outside of the normal trading hours. For example, the S&P 500 e-mini futures have been used to measure the stock market reaction and liquidity changes related to information released around the FOMC meetings (Lucca and Moench 2015; Bernile, Hu, and Tang 2016; Cieslak, Morse, Vissing-Jorgensen 2019), Michigan Index of Consumer Sentiment announcements (Hu, Pan, and Wang 2017), and a broad set of macroeconomic releases (Kurovet al. 2019). The jump in the S&P 500 e-mini futures' prices has been used to identify the macroeconomic-level events that affects a significant number of stocks simultaneously (Bradley, Clarke, Lee, and Ornthanalai 2014). To our knowledge, our paper is the first to use the S&P 500 e-mini futures to measure an immediate market reaction to accounting disclosures.

3. Sample and research design

3.1. Sample and data

Futures data

We obtain the futures market data through Pi Trading Inc., which aggregates raw intraday data from the CME for the continuous E-mini S&P 500 contracts.[17] Our sample covers 2004 to 2021, a period over which the futures have been traded round-the-clock on Globex (e.g., Bondarenko and Muravyev 2020).

The futures market is open from Sunday 6:00pm till Friday 5:00pm ET. The trade is halted over the 4:15 – 4:30pm ET interval for the daily settlement, followed by a half-hour trading session, and a

[17] Pi Trading Inc. (https://pitrading.com/) provides data on the active front month contract and switches to the next quarterly contract eight calendar days before the contract expires following the rollover convention of CME to form a continuous time series.

non-trading daily maintenance period between 5:00 and 6:00pm ET.[18] We rely on fifteen-minutes intervals to accommodate the fifteen-minutes trading halt between 4:15 and 4:30pm. Each 24-hour calendar day is divided into 96 fifteen-minutes intervals, and after excluding the intervals when the trading in the futures market is closed, each Sunday (weekday) has 20 (91) trading intervals.

We use the minute-by-minute trading data to calculate the return volatility and trading volume for each fifteen-minute interval. Return volatility is the absolute value of the continuously compounded return over each interval (e.g., Anderson and Bollerslev 1997); trading volume is the logarithm of one plus the number of contracts traded during each interval.[19] The return is calculated as a difference between the logarithm of the close price for the last minute in an interval and the logarithm of the open price of the first minute in that interval.

Earnings announcements

We identify earnings announcements of the 100 largest firms with the highest market capitalization at the end of the previous month. These firms have been frequently used in prior research as "bellwether" firms whose earnings, when aggregated, convey a significant amount of macroeconomic news (e.g., Konchitchki and Patatoukas 2014b; Anilowski et al. 2007). The earnings announcement timestamps are obtained from I/B/E/S and Ravenpack. Ravenpack is a major real-time news analytics service that retrieves firms' press releases directly from Dow Jones Newswire. Although I/B/E/S is our primary source of data pertaining to earnings announcements, the timestamps provided by I/B/E/S can be delayed (e.g., Bradley, Clarke, Lee and Ornthanalai 2014). When we compare firms with timestamps available in both I/B/E/S and RavenPack, I/B/E/S timestamp is delayed for 22.4%

[18] https://www.cmegroup.com/trading/why-futures/welcome-to-e-mini-s-and-p-500-futures.html
[19] At the firm level, a difference in absolute returns between the event and non-event widows has been used to infer the arrival of news during the conference call (Frankel, Johnson, and Skinner 1999).

observations, with a mean (median) delay of 1.59 (0.30) hours. Accordingly, we use the I/B/E/S timestamp only when it precedes the RavenPack and rely on the RavenPack timestamp otherwise.

Macroeconomic announcements

We rely on Haver Analytics and Investing.com to obtain the time stamps for a comprehensive sample of macroeconomic announcements. The announcements include inflation (CPI, PPI), GDP (Advance, Preliminary, and Final), Unemployment, Personal Income, Balance of Payment, Government Deficit, Consumer Credit, Durable Goods, Business Inventories, New Orders, Construction Spending, Capacity Utilization, Industrial Production, Chicago PMI, ISM PMI, Michigan Consumer Sentiment Index (Preliminary and Final), Housing Starts, New Home Sales, and Retail Sales. In addition, we collect the publication date and time of the FOMC press releases from the FOMC website.[20]

3.2. Research design

Event windows

We denote a 15-minute trading interval as having a macro announcement (MA=1) if there is at least one macro announcement released either during that interval or over the preceding (i.e., lag one) or following (i.e., lead one) interval. If there are no macro announcements over the 45 minutes surrounding an interval, MA is set to 0. We include the preceding interval to account for any pre-announcement drift and the following interval to accommodate a prolonged market reaction beyond 15 minutes as prior literature documents both the pre- and post-announcement drift around certain macroeconomic releases (e.g., Lucca and Moench 2015; Bernile, Hu and Tang 2016; Hu, Pan and Wang 2017; Kurov et al. 2019).

[20] https://www.federalreserve.gov/newsevents/pressreleases.htm

Similar to macro announcements, we define a 15-minute interval as having an earnings announcement (EA=1) if a large firm announces earnings either during that interval or over the preceding (i.e., lag one) or following (i.e., lead one) interval. If there is no large firm announcement over the 45-minutes surrounding an interval, EA is set to 0.

Abnormal market reaction

Our first research design relies on a time-series regression using day-interval observations to gauge the abnormal market activity over earnings and macro announcement intervals. Specifically, we estimate the following regression (subscript t identifies the day-interval):

$$MKTACT_t = \beta_0 + \beta_1 * EA_t + \beta_2 * MA_t + Controls + \text{FE} + \varepsilon_t, \quad (1)$$

where $MKTACT_t$ is the level of market activity over day-interval t. MKTACT is either return volatility (ABSRET) or log trading volume (LOG_VOLUME). EA_t is an indicator equal to 1 if a large firm announced earnings over one of the three 15-minutes intervals surrounding the current interval t, and 0 otherwise. $MA_{t,a}$ is an indicator variable that is equal to 1 if there is at least one macro announcements over one of the three 15-minutes intervals surrounding the current interval t and 0 otherwise.[21] The regressions include fixed effects (FE) for the trading interval, weekday, month, and year-quarter. The coefficient β_1 (β_2) measures the average abnormal market activity over the earnings (macro)

[21] In certain specifications, we designate two separate indicator variables for major and non-major macro announcements. Specifically, *MA_MAJOR* is an indicator variable that is equal to one if there is at least one major macroeconomic announcement (i.e., CPI, PPI, FOMC, Advance GDP, and Unemployment) during the 45 minutes surrounding the interval, and 0 otherwise. *MA_OTHER* is an indicator variable that is equal to one if there is at least one non-major macroeconomic announcement (i.e., Balance of Payment, Business Inventories, Capacity Utilization, Chicago PMI, Construction Spending, Consumer Credit, Durable Goods, Preliminary GDP, Final GDP, Government Deficit, Housing Starts, Industrial Production, ISM PMI, Preliminary Michigan Consumer Sentiment Index, Final Michigan Consumer Sentiment Index, New Home Sales, New Orders, Personal Income, Retail Sales) during the 45 minutes surrounding the interval, and 0 otherwise.

announcement interval compared to intervals with no large firm (macro) announcements, after controlling for other determinants of market reactions.

We include several control variables (Controls) to account for the institutional features and microstructure effects in the futures market. Rollover is an indicator variable equal to 1 if a day belongs to the rollover window, which starts 10 days prior to the contract expiration date and ends on the date of contract expiration, and 0 otherwise. Days is the logarithm of one plus the number of days since the beginning of the month; it controls for the timing of the announcements within a month, which can significantly affect the market activity (e.g., Ernst, Gilbert and Hrdlicka 2019). We also control for the intraday autocorrelations in volatility and volume by including the lags of dependent variables (e.g., Andersen and Bollerslev 1997; Kurov et al. 2019). Specifically, *LAGn_LOG_VOLUME* (*LAGn_ABSRET*) (where n = 1, 2, 3) is *LOG_VOLUME* (*ABSRET*) in the *t-n* interval. We include three lags since after controlling for the institutional features and time fixed effects, the partial autocorrelation for both trading volume and volatility are statistically significant only up to the first three lags.[22]

4. Empirical results

4.1 Descriptive statistics

Figure 1 plots the frequencies of large firm earnings announcements and macroeconomic announcements over the calendar year. Specifically, we group trading intervals by the day since the beginning of the year and calculate the announcement frequency as the percentage of intervals with EA (MA) equal to 1 for each day. Earnings announcements follow a strong seasonal pattern, with four

[22] Specifically, we first regress *LOG_VOLUME* (*ABSRET*) on *ROLLOVER*, *DAYS*, and interval, weekday, month and contract period fixed effects and take the residuals *RES_LOG_VOLUME* (*RES_ABSRET*). We then test the autocorrelation of *RES_LOG_VOLUME* (*RES_ABSRET*) and find positive autocorrelation in these two variables within 3 lags.

peaks at the end of January, April, July and October, while macro announcements are distributed more uniformly, with the highest frequencies at the beginning of each month.

Panel A of Table 1 provides more details on the overlap between the intervals that contain the large firm earnings announcements (EA) and macroeconomic announcements (MA). Of the 12,917 intervals with large firm announcements, 11,419 (88.4%) fall over the overnight window while 1,498 (11.6%) are during trading hours. 56.3% of the MAs are released overnight while 43.7% are during trading hours. Figure 2 plots the frequencies of large firm earnings announcements and macroeconomic announcements by the intra-hour intervals during the day. Each trading day has a maximum of 91 fifteen-minute intervals from 6pm ET to 5pm ET the next day, excluding the trading halt over the 4:15 – 4:30pm ET interval. The frequencies are measured as the percentage of intervals with EA (MA) equal to 1 for each interval category. The EAs are concentrated over 6:00 – 9:00 and 16:00 – 17:00, while the MAs are concentrated over 8:00 – 10:00 and 13:30 – 15:30.

Table 1, Panel B provides summary statistics on the market activity variables measured over the 15-minutes intervals. The mean (median) signed interval return RET is 0.037 (0) basis points with a standard deviation of 14.374, which is comparable with the statistics on hourly S&P e-mini futures returns in Boyarchenko et al. (2020). The mean (median) ABSRET is 7.320 (3.813) basis points with a standard deviation of 12.371. VOLUME has a mean (median) of 16,506.9 (3,333) contracts with a standard deviation of 29,584, and LOG_VOLUME has a mean (median) of 8.025 (8.112) with a standard deviation of 2.336.

4.2 Abnormal market reaction around earnings announcements

In this section, we document the index-wide reaction to the earnings announcements of the largest firms by estimating the abnormal return volatility and trading volume in the intervals surrounding the announcements.

We first provide a graphical depiction of the changes in volatility and volume over the intervals surrounding the EA and MA intervals. Specifically, we plot the abnormal volatility and volume over the 21 fifteen-minute intervals surrounding the interval containing the announcement. For this purpose, we estimate the following regression that includes the time fixed effects and microstructure controls:

$$MKTACT_t = \beta_0 + \sum_{k=-10}^{10} \delta_k * EA_t^k + \sum_{k=-10}^{10} \gamma_k * MA_t^k + Controls + \text{FE} + \varepsilon_t, \quad (3)$$

where *MKTACT* is either the absolute value of the continuously compounded return (*ABSRET*) or the log of trading volume (*LOG_VOLUME*); EA_t^0 (MA_t^0) is an indicator variable that is equal to 1 if there is at least one large firm announcing earnings (at least one macroeconomic announcement) in a 15-minute interval *t*, and 0 otherwise; EA_t^k (MA_t^k) ($k \sim= 0$) is an indicator variable that is equal to 1 if an interval is *k* interval(s) before (after) an EA (MA) interval for $k < 0$ ($k > 0$); controls and fixed effects (FE) are the same as in regression (1).

The coefficients on EA_t^k (MA_t^k) dummies represent the average abnormal market activity for the event-time intervals relative to the earnings (macroeconomic) announcements. For example, the coefficient on EA_t^0 represents average abnormal market activity during the earnings announcement window, whereas the coefficient on EA_t^{-5} represents the abnormal activity within the 15-minutes lagged by five intervals relative to the earnings announcement window (i.e., during the [*j*-75 minutes; *j*-60 minutes] relative to the earnings announcement window *j*).

Figure 3 plots the estimated abnormal volatility and volume. The upper two graphs contain the abnormal volatility in event time. For both earnings announcements and macro announcements, the increase in volatility is concentrated over the event window (k = 0). The lower two graphs plot abnormal volume. For earnings announcements, abnormal volume spikes over the -1 and 0 windows. For macro announcements, the increase in volume is also statistically significant and is concentrated

within the announcement window. After the announcements, market activities (both volume and volatility) revert to their pre-announcement levels. Overall, Figure 3 shows a market-wide reaction associated with the large firms' earnings announcements; the reactions are of comparable magnitude to the reactions generated by the macroeconomic releases.

Next, we formally measure the magnitude of abnormal market reactions over the EA and MA windows by estimating regression (1) and report the results in Table 2. As explained in Section 3, the coefficients on the indicators for the EA and MA intervals measure the abnormal volatility or volume associated with the three 15-minute intervals surrounding each type of the announcement. We measure the abnormal market activity over the entire sample period and excluding the recessionary periods.

The left side of Table 2 presents the abnormal volatility results. The slope magnitudes represent basis-point difference in absolute return between the event and non-event intervals. The baseline regression suggests that absolute returns around earnings announcements are 0.505 basis points higher than the non-announcement returns over the full sample (column 1) and 0.392 basis points higher when excluding the recession (column 3). These abnormal return magnitudes amount to around 6.9% (5.4%) of the average absolute return in our sample, which is equal to 7.32 basis points (reported in Table 1).

The right side of Table 2 presents the abnormal volume results. The slope magnitudes represent differences in the log volume between the event and non-event intervals and can be interpreted as percentage increases in volume during the announcement windows. The baseline regression suggests that volume of trading increases by 7.8% around earnings announcements over the full sample (column 5) and by 7.9% when excluding the recessionary period (column 7).

To gauge the economic significance of the abnormal volatility and volume associated with earnings announcement periods, we rely on a benchmark provided by the macroeconomic

announcements—arguably, the primary source of macroeconomic information. Both the abnormal volatility and abnormal volume associated with EAs are of the same order of magnitude as those associated with MAs. In particular, the 0.51 basis points (7.8%) increase in volatility (volume) around EAs equals 25% (47%) of the increase in volatility (volume) associated with MAs. When excluding recessionary period, the 0.39 basis points (7.9%) increase in volatility (volume) around EAs represents 19% (46%) of the increase in volatility (volume) around MA intervals. Overall, the immediate market-wide reaction to large firms' earnings announcements is both statistically and economically significant.

The MAs are heterogeneous in terms of their informativeness, which allows us to benchmark the index-moving ability of EAs against MAs with varying importance. Prior research differentiates between the major macroeconomic announcements that are most closely followed by the investors and other macroeconomic releases (e.g., Savor and Wilson 2014). Following this research, we separate out the major macro releases—unemployment, FOMC meetings, CPI and PPI inflation, and GDP advance announcements—and refer to the rest of the MAs as "other" macro releases. The regressions in columns (2), (4), (6), and (8) in Table 2 include two separate dummies for the major (MA_major) and other macro announcements (MA_other). As expected, the amount of new information impounded into index prices around the major MAs exceeds the "other" MAs—the coefficient magnitudes for MA_major are approximately six (five) times of the coefficient magnitudes for MA_other in the abnormal volatility (volume) regressions when estimated using either the full sample or excluding recessions. The market-wide news conveyed around earnings announcements is more comparable to the "other" macro releases. In particular, when estimated using the full sample, the abnormal volatility around EA intervals is about 44% of the abnormal volatility associated with the "other" macro releases. Likewise, the abnormal volume around EA intervals is about 75% of the abnormal volume associated with the "other" macro releases. When estimated within expansionary periods, the abnormal volatility (volume) around EA intervals is about 31% (74%) of the abnormal

volatility (volume) around MA_other intervals. Considering that our sample includes 12,917 intervals with earnings announcements and 10,040 intervals with "other" macro releases, the total amount of information conveyed around earnings announcements is on-par with what is conveyed through the "other" macro indicators.

Drawing on the rich literature on stock market under- or overreaction to earnings information at the firm level (e.g., Bernard and Thomas 1989; Cheng and Eshleman 2014; Ramnath 2002; Thomas and Zhang 2008), we examine potential return reversal or drift associated with EAs over the sample period. In particular, we sort the EAs and MAs into quintiles based on the magnitude of the announcement-window residual return (ERET), calculated as the average 15-minute residual return over the three consecutive intervals comprising the announcement window (t - 1, t and t +1). We then accumulate returns starting in interval t-10 and ending in period t+30.

Figure 4 contains plots for the cumulative residual returns averaged within each ERET quintile, from the highest (eret_r5) to the lowest (eret_r1) for a 41-interval period surrounding a 15-minute interval containing EA or MA. The lines represent residual returns accumulated starting in interval t-10. The upper two plots pertain to the full sample period of 2004 – 2021. Though there is little evidence of a pronounced pre-announcement drift, we observe a post-announcement drift following the EA-window return—the prices over intervals t+2 onwards continue to move in the direction to the initial price reaction for the extreme quintiles. The drift is especially pronounced following the negative announcement-window returns. We find no compelling evidence of a drift associated with an average macroeconomic announcement, but we do observe a reversal over the first five 15-minute intervals after the announcement. These findings imply that the initial reaction to earnings announcements that we measure in the immediate interval surrounding the information release may understate the informativeness of the EA events for the market.

4.3 Intraday announcement timing

Most earnings announcements in our sample (88%) occur outside of the regular stock market trading session, compared with 56% of macroeconomic releases. Prior research suggests that the information content of overnight and daytime returns differs significantly both in the stock market (Lou, Polk, and Skouros 2019; Hendershott, Livdan, and Rosch 2020) and in the futures market (Bondarenko and Muravyev 2020; Boyarchenko, Larsen, and Whelan 2020). Across both markets, the overnight returns account for a disproportionate share of the return premium (e.g., Kelly and Clark 2011; Lou, Polk, and Skouros 2019; Bondarenko and Muravyev 2020; Boyarchenko, Larsen, and Whelan 2020). Our setting allows us to contribute to this research by investigating any differences in the macro information transfer between the overnight and daytime EAs in the futures market. In particular, we expand the market activity tests discussed in the previous sections to differentiate between the trading-hour and overnight announcement intervals.

Table 3, panel A reports the results of estimating regression (1) with separate dummies for the EAs and MAs that fall into the daytime (*EA*Daytime* and *MA*Daytime*) and overnight (*EA*Overnight* and *MA*Overnight*) periods. Similar to Table 2, the coefficients on these dummies can be interpreted as an abnormal announcement-period absolute return relative to no-event intervals. The results suggest that the market reacts more strongly to the overnight EAs. Specifically, only overnight EAs are associated with significant abnormal volatility while trading-hour EAs elicit little abnormal market reaction. By contrast, the abnormal volatility associated with MAs is significant both during the day and overnight. Considering only the overnight trading intervals, the abnormal volatility associated with EAs amounts, on average, to 21% of the magnitude associated with an average MA (the coefficients on *EA*Overnight* and *MA*Overnight* are 0.568 and 2.701, respectively) when estimated using the full sample. Similar inferences obtain when we exclude the recessionary periods. Taking into account that there are 1.6 times more overnight EA intervals than MA intervals (11,419 intervals versus 7,118

intervals, respectively), EAs are an especially important source of market-wide news outside the regular trading hours.

A recent study by Lyle et al. (2021) finds that stock market reactions to post-close and pre-open earnings announcements exhibit systematic differences, with pre-open announcements experiencing lower earnings response coefficients, lower volatility, lower trading volume, and having greater post-earnings announcement drift than post-close announcements, even though there is no evidence that the information content of the announcements differ across the two groups. Building on their findings, we examine if a similar difference exists in the macro spillover effects of the largest firms' EAs conditional on the intraday timing of the announcements. Similar to our previous analysis, we first plot the change in return volatility and log volume over a 41-interval period (30 intervals before and 10 intervals after) surrounding a 15-minute interval containing either a post-close (4pm – 12am) or pre-open (12am – 9:30am) earnings announcement (EA). In particular, we estimate the following regression $MKTACT_t=\beta_0+\sum_{k=-30}^{10}\delta_k*EA_t^k+\sum_{k=-30}^{10}\gamma_k*MA_t^k+Controls+\text{FE}+\varepsilon_t$ separately for post-close and pre-open EAs, with all variables defined in the same way as before. The coefficient estimates δ (γ) are plotted on the left (right) side of Figure 5. In line with the firm-level evidence in Lyle et al. (2021), we also observe a muted index-wide reaction to EAs over the pre-open period, while there is significant abnormal market activities around EAs over the post-close window.

We formally gauge the differential market reactions to post-close and pre-open announcements by interacting *EA* and *MA* in regression (1) with indicators *Preopen*, *Postclose*, and *Daytime*. Daytime EAs continue to generate little abnormal volatility under this specification. However, post-close EAs elicit approximately three times (seven times) abnormal volatility (volume) as that generated by pre-open EAs, as indicated in column (1) and (5). The relative magnitude of the coefficients is qualitatively similar when we exclude the recessionary periods in column (3), (4), (7) and

(8). These results suggest that the usefulness of the largest firms' earnings announcements as a source of index-level information varies with the timing of the announcements.

In a similar spirit to Figure 4, we explore if there is any return drift or reversal following the post-close and pre-open EAs. Figure 6 plots the cumulative residual returns over the 41-interval period [t-30, t+30], relative to the announcement at interval t. While there is little evidence of a drift or reversal for post-close EAs, there is some evidence of a drift for pre-open EAs, especially when they imply bad news to the market. However, the magnitudes of the cumulative returns over the full 41-interval period for pre-open EAs are comparable to those for post-close EAs for the top and bottom quintiles, suggesting that the drift cannot fully account for the difference in the announcement-window market reactions between these two types of EAs. **4.4 Timing of announcements within the earnings announcement cycle**

Prior research on intra-industry information suggests that the spillover effects of the announcing firms are stronger when they announce early in the season (e.g., Ramnath 2002; Thomas and Zhang 2008). By the same token, we examine if the index-moving ability of the largest firms' EAs varies with the timing of the announcements within the earnings announcement cycle. Specifically, we designate announcements that fall into the first month of the calendar quarter (i.e., Jan., Apr., Jul., Oct.) as "early" announcements and those that fall into the rest of the months "late" announcements. We then modify regression (1) by interacting *EA* and *MA* with the *Early* and *Late* indicators. The results are reported in Table 4, panel A. Although both early and late EAs elicit abnormal volume around the announcement window, only early EAs are associated with higher abnormal volatilities, suggesting that the EAs are more informative to the futures market when they are announced earlier in the cycle. However, the informativeness of MAs does not seem to vary with announcement timing, as both early and late MAs are associated with abnormal volatility and volume. In panel B, we separate the announcements into post-close, pre-open and daytime and interact them with the *Early* and *Late*

indicators. Consistent with the results in Table 3, daytime EAs are not associated with abnormal volatility regardless of the announcement timing. Both post-close and pre-open EAs generate higher volatilities when they are announced earlier in the season. Overall, evidence in Table 4 is consistent with findings in intra-industry information transfer that the effects of the spillover are the strongest for early announcers.

4.5 Intertemporal variation

There is growing concern among both academics and the financial media that the stock market has become increasingly disconnected from the macroeconomy and that the market performance is mainly driven by a handful of high-market-cap firms (e.g., Bessembinder 2018; Flynn and Ghent 2020; Schlingemann and Stulz 2020). To investigate the possibility that the importance of large firms' earnings announcements has shifted over time when compared to the macroeconomic announcements in terms of generating and explaining the index price movement, we document the intertemporal variation in the index-moving ability of the EAs and MAs in the futures market.

We first provide a graphical representation for the trends in abnormal volatility over EA and MA intervals over our sample period (2004 - 2021) in Figure 7. Specifically, we estimate the time-series regression (1) separately for each year in our sample period. The coefficients capture the average abnormal volatility surrounding the EAs and MAs in a particular year after controlling for the institutional features of the futures market and the fixed effects. Figure 7 shows an overall decrease in abnormal volatility associated with EAs and MAs over our sample period. In addition, the abnormal volatility around EAs exhibits a pronounced spike around the onset of the financial crisis in 2008 and remains significantly elevated throughout the Great Recession period ending June 2009. These findings differ from the firm-level evidence of an increasing trend in the abnormal volatility over EA days and a significant drop in EA informativeness around 2008-2009 (Beaver et al. 2020). The elevated

aggregate abnormal volatility around EAs during the recessionary periods is, however, consistent with a greater demand for financial information during periods of high aggregate uncertainty (Bonsall, Green, Muller 2020).

Figure 7 also plots the decile ranks for the 90-day trailing-average CBOE implied volatility index (VIX) over our sample period. The plot confirms that the recessionary periods are associated with higher aggregate uncertainty, but points out a significant variation in aggregate uncertainty beyond the business cycle partitions. To formally tease out the effects that time trend, business cycle and aggregate uncertainty have on the market reactions to both earnings and macro announcements, we estimate the time-series regression (1) augmented with interaction terms between the EA and MA dummies and the time trend indicator (EA*Year and MA*Year, respectively), the recession indicator (EA*Rec and MA*Rec) and the aggregate volatility deciles (EA*Vixr10 and MA*Vixr10, respectively). Year is a categorical variable with a value of 0 for the start year of the sample (2004), incremented by 1 for each of the following years. Rec is an indicator variable that is equal to 1 if a day falls into the NBER recessionary period (December 2007 – June 2009 and February 2020 – April 2020) and 0 otherwise. VIXr10 is the decile rankings of the AVG_VIX variable defined as the average daily VIX over the past 90 days ending one day before the current day. The regressions include the main effect for VIXr10; the main effects for Year and Rec are subsumed by the year-quarter fixed effects.

The results are reported in Table 5, panel A. The time-trend regression estimates in columns (1) and (2) confirm the downward-sloping trend in the market reactions to EAs and MAs. The coefficient on EA is statistically significant at the 1% level, indicating significant abnormal volatility over EA intervals at the beginning of the sample period (when Year equals zero). The coefficient on the interaction term EA*Year is significantly negative, suggesting a decreasing trend in the index reaction to large firms' EAs, which is accompanied by a similar downward-sloping trend in the index reaction to MAs (both major and other) over the years. Columns (3) and (4) formally estimate the

difference between the abnormal volatility around announcements in the recessionary and expansionary periods. The coefficients on the interaction terms EA*Rec and MA*Rec are both positive and statistically significant, indicating a higher reaction during the recessionary period, although the significance on the EA*Rec interaction becomes marginal once the macro announcements are split into major and other. Columns (5) and (6) present the results for the variation in abnormal volatility over EA and MA intervals associated with aggregate uncertainty. The results suggest that abnormal volatility surrounding the EA intervals increases significantly with aggregate uncertainty, as indicated by the significantly positive coefficient on EA*VixR10. A similar positive relationship between abnormal volatility and VIX levels is also observed for the MAs (both major and other). Finally, the regressions in columns (7) and (8) include interaction terms for all three variables. The interaction terms for the time trend and aggregate uncertainty variable remain statistically significant, while the interaction with the recession indicator is no longer statistically significant at the conventional level. Overall, these results suggest that the downward time-series trend in the abnormal market activity associated with both earnings and macro announcements is not entirely driven by the changes in aggregate uncertainty or the presence of the Great Recession in the earlier part of the sample; at the same time, aggregate uncertainty appear to have substantial influence on the abnormal market reactions to both earnings and macro announcements beyond the financial crisis.

Regarding the drift and reversal patterns following the announcements, we plot the average cumulative residual returns over a 41-interval period surrounding the event window over the early (2004 – 2012) and late (2013 – 2021) half of the sample in Figure 4. The drift following EAs in the lowest quintile of announcement-window residual return is more pronounced in the early half than in the later half. With respect to MAs, we find no evidence of a drift associated with an average MA, but we do observe a reversal over ten 15-minute intervals following the negative-return MA windows in

the second half of the sample. These findings suggest that the downward-slopping trend in the abnormal volatility around EAs and MAs is unlikely to be explained by market under- or overreaction.

We further explore the intertemporal trend in the informativeness of EAs by their intraday announcement timing in Table 5, panel B. In appears that the decreasing trend in abnormal volatility around EAs is mainly driven by pre-open EAs, as evidenced by the significantly negative coefficient on *EA*Preopen*Year* in column (1) and (7), while the informativeness of post-close and daytime EAs does not vary with *Year*. Interestingly, while pre-open and daytime EAs are associated with higher abnormal volatility when aggregate uncertainty is higher, abnormal volatility around post-close EAs is decreasing in uncertainty. These results suggest that the relationship between the usefulness of firm EAs as a source of macro information and aggregate uncertainty is more nuanced than suggested by previous research and warrants further investigation.

4.6 Robustness checks and additional results

We conduct several tests (untabulated) to ensure the robustness of our results. For the abnormal market activity tests, inferences are qualitatively similar if we replace year-quarter fixed effects with rollover-period fixed effects, with each rollover period spanning the days between the rollover dates of the previous and the current contracts. We also conduct additional tests gauging the correlation between announcement-interval returns and the value-weighted and equal-weighted CRSP index returns excluding the announcing firms. The latter measures the contribution of the S&P500 index futures returns over the EA-windows to the daily volatility of broader indices. We find that EA-window futures returns are significantly associated with the daily volatility of the broader indices (that exclude the announcing firms returns). These results suggest that individual large firms' announcements impact index prices beyond the mechanical effect generated through a price jump of an individual constituent firm announcing earnings.

5. Conclusion

This paper aims to characterize the extent of macro information transfer from the largest firms in the futures market. This evidence can contribute to developing a better understanding of the role that the largest firms ("superstars") play in the financial markets and help inform the debate about the reasons behind a potential disconnect between the stock market and the economy at large.

Using the intraday round-the-clock trading data from the highly liquid S&P 500 e-mini futures market, we find that earnings announcement of the largest one hundred firms convey a significant amount of index-level information that is of comparable magnitude to the information contained in macroeconomic announcements. Specifically, the abnormal market reactions, as measured by return volatility, over the EA intervals amount to approximately 25% of the abnormal volatility over the macroeconomic announcement intervals. The contribution of earnings announcements to the overall index volatility exhibits a decreasing trend over time and we find no evidence of an increase in the abnormal market activity around EA windows, which is contrary to the claim in the financial press that individual firms are exerting increasing influence on the market prices in recent years.

Our research design allows us to compare and contrast the market-wide reactions to individual firms' earnings announcements to the firm-level results documented in prior research. Some of the documented market-level evidence differs significantly from the firm-level results. In particular, the downward trend in the market-wide reaction to earnings announcements is opposite to the upward trend in the firm-specific information contained in EAs documented over a similar time frame (Beaver et al. 2020). The market-level evidence also points to an increased reaction to individual firms' earnings over the recessionary periods, which is opposite to a decreased reaction to earnings announcements at the firm-level. Although the above differences may be driven by our focus on the largest firms or intraday price discovery, our market-level findings may suggest that some of our understanding of the

capital markets consequences of accounting information at the firm level may not pertain to the market level, especially with respect to the largest firms. Given the growing importance of these "superstar" firms in the modern economy, further research into the effects of their information disclosures is perhaps warranted.

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Appendix 1. Variable definitions

Variable	Definition
VOLUME	The number of contracts traded during a 15-minutes interval.
LOG_VOLUME	The logarithm of one plus the number of contracts traded during a 15-minutes interval.
RET	The continuously compounded 15-minutes interval return.
ABSRET	The absolute value of the continuously compounded 15-minutes interval return.
EA	An indicator variable that is equal to 1 if a large firm announced earnings during the preceding (t-1), the present (t), and the following (t+1) interval, and 0 otherwise.
MA	An indicator variable that is equal to 1 if there is a macroeconomic announcement during the preceding (t-1), the present (t), and the following (t+1) interval, and 0 otherwise.
MA_major	An indicator variable that is equal to 1 if there is a major macroeconomic announcement (i.e., CPI, PPI, FOMC, Unemployment, and Advance GDP) during the preceding (t-1), the present (t), and the following (t+1) interval, and 0 otherwise.
MA_other	An indicator variable that is equal to 1 if there are other macroeconomic announcements (i.e., Balance of Payment, Business Inventories, Capacity Utilization, Chicago PMI, Construction Spending, Consumer Credit, Durable Goods, Preliminary GDP, Final GDP, Government Deficit, Housing Starts, Industrial Production, ISM PMI, Preliminary Michigan Consumer Sentiment Index, Final Michigan Consumer Sentiment Index, New Home Sales, New Orders, Personal Income, Retail Sales) during the preceding (t-1), the present (t), and the following (t+1) interval, and 0 otherwise.
Rollover	An indicator variable equal to 1 if a day belongs to the rollover window, which starts 10 days prior to the contract expiration date and ends on the date of contract expiration, and 0 otherwise.
Days	The logarithm of one plus the number of days since the beginning of the month.
Year	A categorical variable with a value of 0 for the first year of the sample (2004), incremented by 1 for each of the following years.
VixR10	A decile rank of *AVG_VIX* that takes the value of 0 (9) for days in the lowest (highest) *AVG_VIX* decile. *AVG_VIX* is the average daily VIX over the previous 90 days (not including the current day).
Rec	An indicator variable that is equal to 1 if a day belongs to the NBER recessionary period, and 0 otherwise.
Overnight (*Daytime*)	*Overnight* is an indicator variable that is equal to 1 if the announcement occurs during the overnight period (i.e., 4:00 p.m. to 9:30 a.m. the next day), and 0 otherwise. *Daytime* is equal to 1 – *Overnight*.

Figure 1. The calendar-year distribution of earnings and macro announcements

Figure 1 plots the frequencies of large firm earnings announcements and macroeconomic announcements by day of the year for the 2004-2021 sample period. The frequencies are expressed as the percentage of trading intervals with the *EA* (*MA*) equal to 1 for each day. *EA* (*MA*) is an indicator variable that is equal to 1 if a large firm announced earnings (there is a macroeconomic announcement) during the preceding (t-1), the present (t), and the following (t+1) interval, and 0 otherwise.

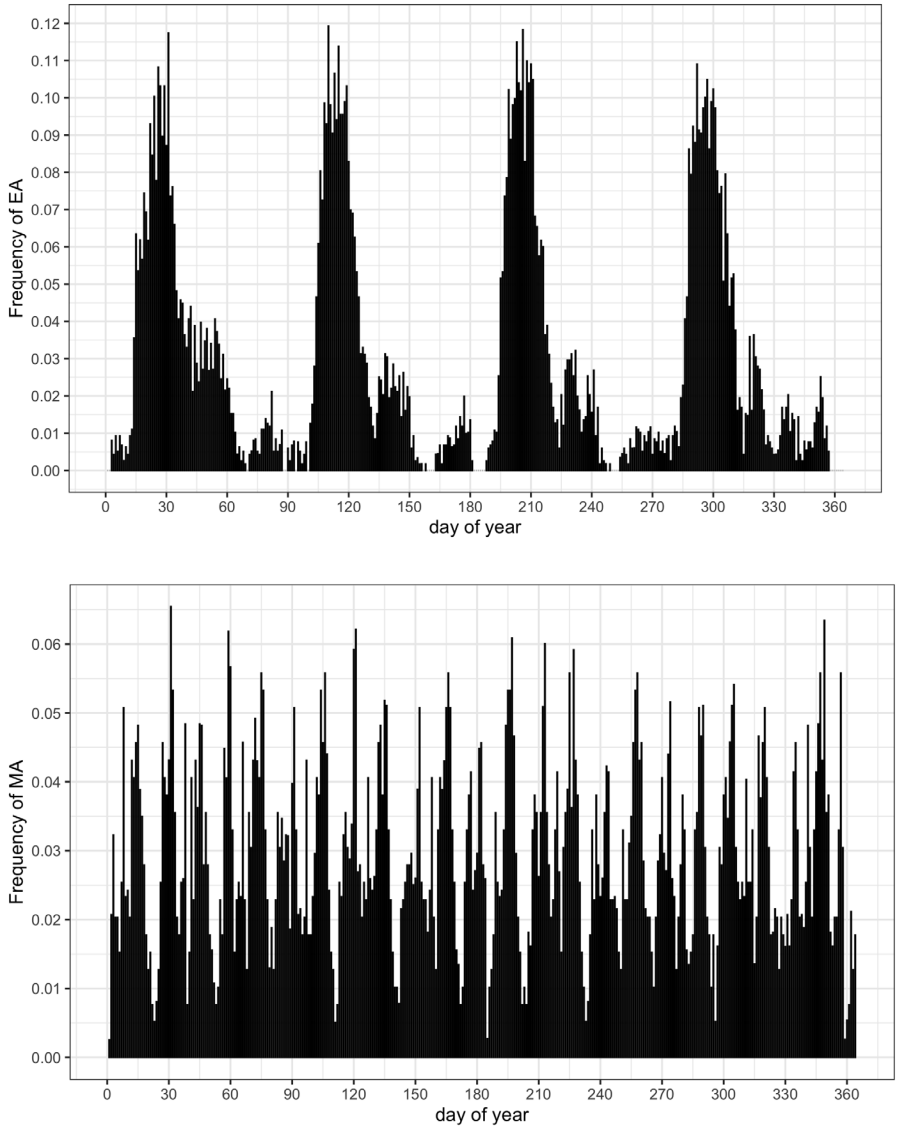


Figure 2. The intra-day distribution of announcement times

Figure 2 plots the frequencies of the earnings and macro announcement intervals for the 2004 – 2021 sample period. The frequencies are expressed as the percentage of observations with *EA* (*MA*) equal to 1 within each 15-minute interval. *EA* (*MA*) is an indicator variable that is equal to 1 if a large firm announced earnings (there is a macroeconomic announcement) during the preceding (t-1), the present (t), or the following (t+1) interval, and 0 otherwise. The timeline indicates the 15-minute intervals between the opening of S&P500 futures trading at 6pm ET and the closing at 5pm ET the following day. The vertical lines indicate the opening and closing times of the U.S. stock exchanges (9:30am and 4:00 pm ET, respectively).

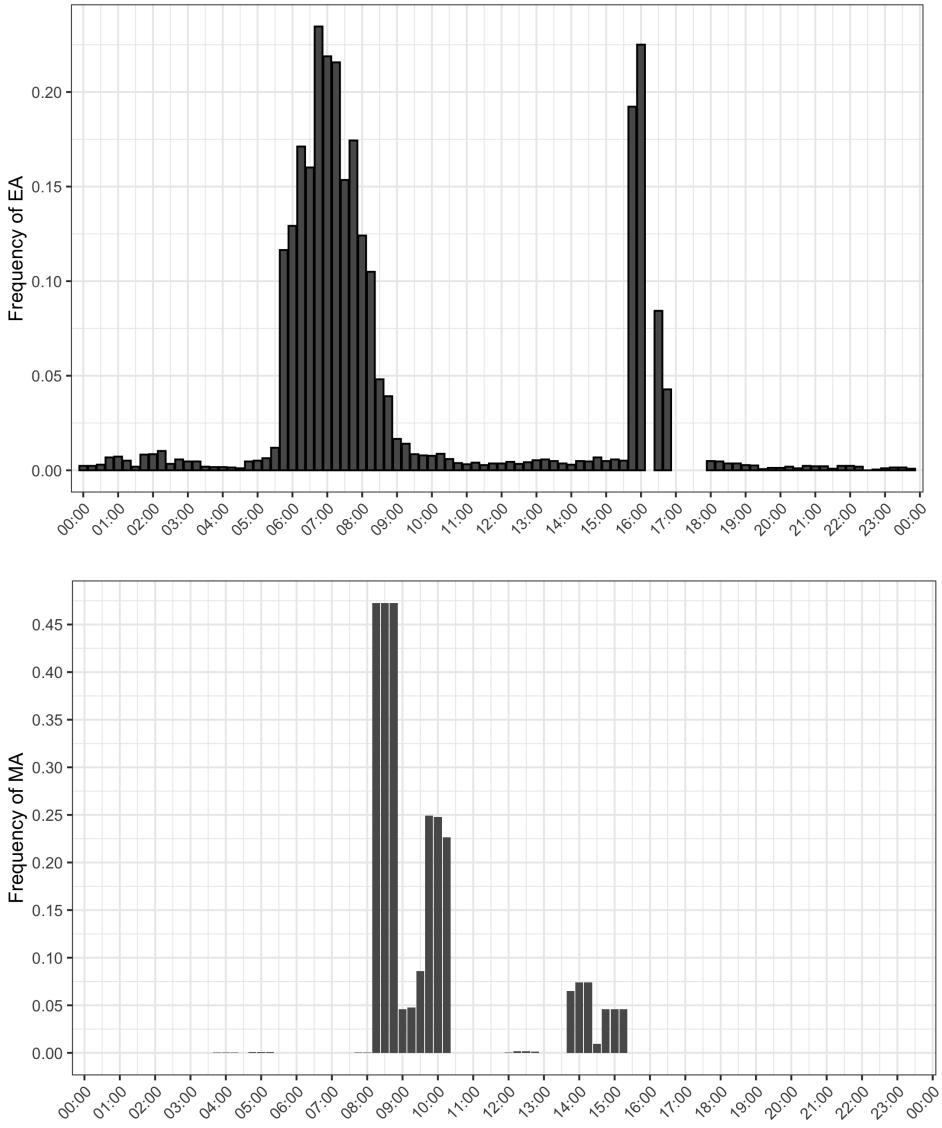


Figure 3. Market activity around announcement intervals

Figure 3 plots the change in log volume and return volatility over a 21-interval period (10 intervals before and 10 intervals after) surrounding a 15-minute interval containing either an earnings or macro announcement. In particular, the plots on the left (right) contain the δ (γ) coefficient estimates from the following regression: $MKTACT_t = \beta_0 + \sum_{k=-10}^{10} \delta_k * EA_t^k + \sum_{k=-10}^{10} \gamma_k * MA_t^k + Controls + \text{FE} + \varepsilon_t$, where *MKTACT* is either the logarithm of one plus the number of contracts traded during an interval (*LOG_VOLUME*) or the absolute value of the continuously compounded interval return expressed in basis points (*ABSRET*); EA_t^k (MA_t^k) is an indicator variable that is equal to 1 if there is at least one large firm announcing earnings (at least one macroeconomic announcement) in a 15-minute interval $t+k$, and 0 otherwise; Controls include three lags of a dependent variable, an indicator for the rollover window, and a log of one plus the number of days since the beginning of the month; fixed effects (FE) include trading interval, weekday, month, and year-quarter. The top two graphs contain regressions for the *ABSRET*. The bottom two graphs contain regressions *LOG_VOLUME*.

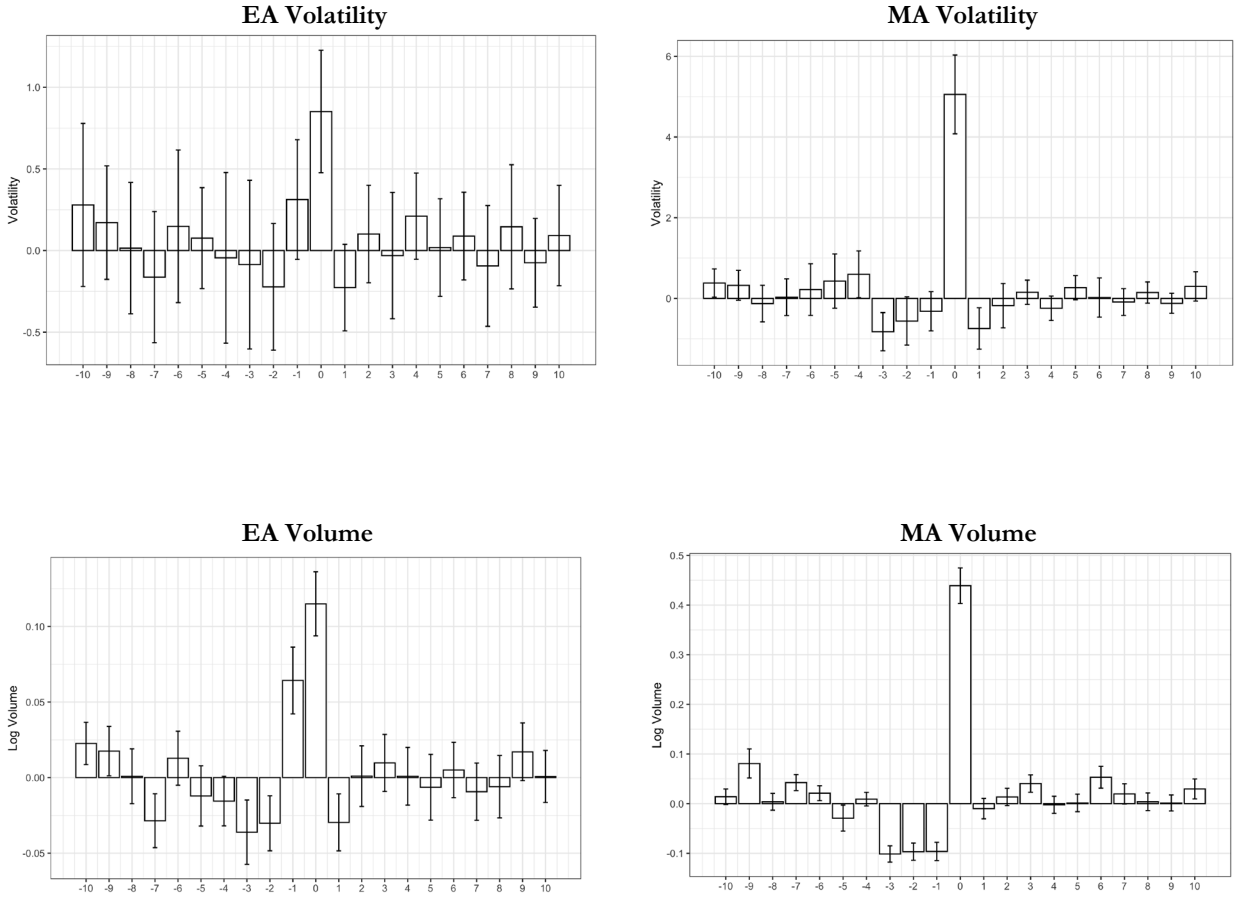


Figure 4. Signed returns around announcement windows

Figure 4 plots the average cumulative residual returns over a 41-interval period surrounding a 15-minute interval containing an earnings announcement (EA) or macroeconomic announcement (MA) (i.e, interval *t*) over 2004-2021 period. The EAs or MAs are sorted into quintiles based on the magnitude of the announcement-window residual return, *ERET*. Announcement window includes intervals *t* - 1, *t* and *t* +1. The lines represent residual returns accumulated starting in interval *t*-10, averaged over each *ERET* quintile, from the highest (eret_r5) to the lowest (eret_r1). The early (late) half of the sample is from 2004 - 2012 (2013 – 2021). The returns are in basis points. Detailed variable description is available in Appendix 1.

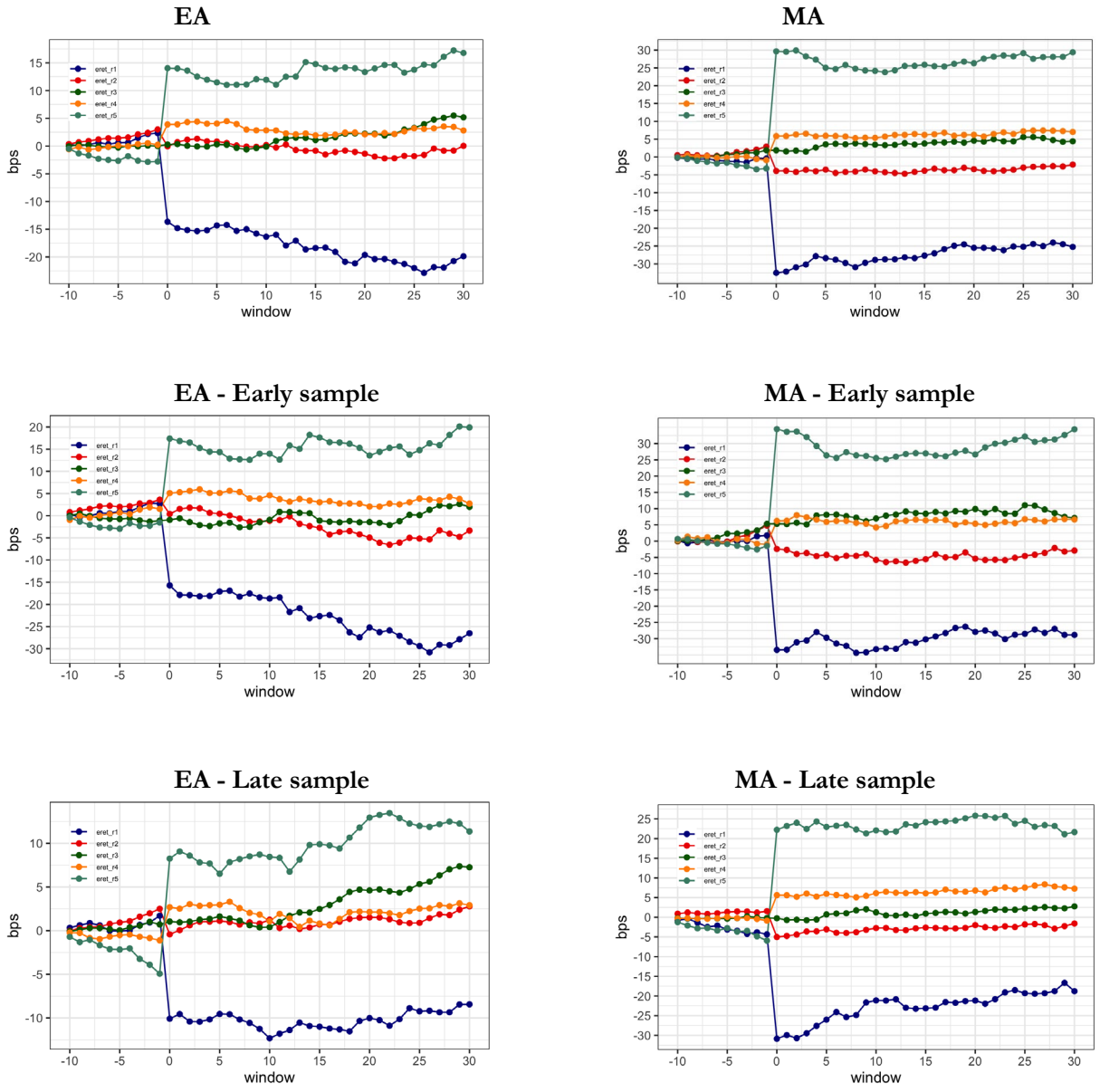
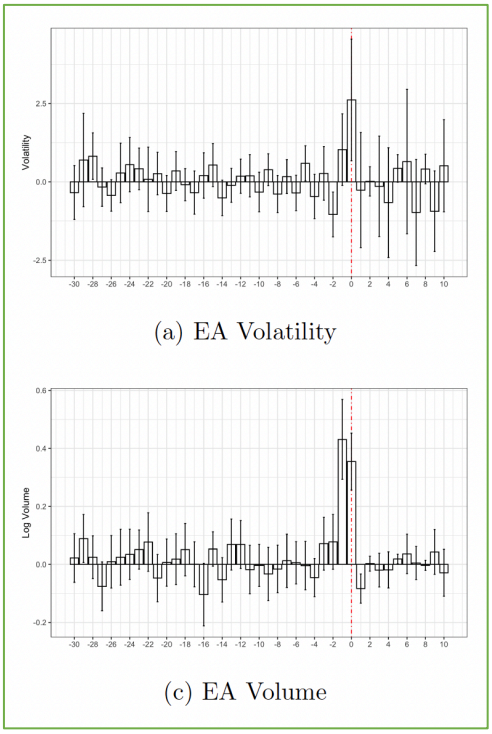


Figure 5. Market activity around announcement intervals

Figure 5 plots the change in return volatility and log volume over a 41-interval period (30 intervals before and 10 intervals after) surrounding a 15-minute interval containing either a post-close (4pm – 12am) or pre-open (12am – 9:30am) earnings announcement (EA). In particular, the plots on the left (right) contain the δ (γ) coefficient estimates from the following regression: $MKTACT_t = \beta_0 + \sum_{k=-30}^{10} \delta_k * EA_t^k + \sum_{k=-30}^{10} \gamma_k * MA_t^k + Controls + FE + \varepsilon_t$, where *MKTACT* is either the logarithm of one plus the number of contracts traded during an interval (*LOG_VOLUME*) or the absolute value of the continuously compounded interval return expressed in basis points (*ABSRET*); EA_t^k (MA_t^k) is an indicator variable that is equal to 1 if there is at least one large firm announcing earnings (at least one macroeconomic announcement) in a 15-minute interval $t+k$, and 0 otherwise; Controls include three lags of a dependent variable, an indicator for the rollover window, and a log of one plus the number of days since the beginning of the month; fixed effects (FE) include trading interval, weekday, month, and year-quarter. The top two graphs contain regressions for the *ABSRET*. The bottom two graphs contain regressions *LOG_VOLUME*.

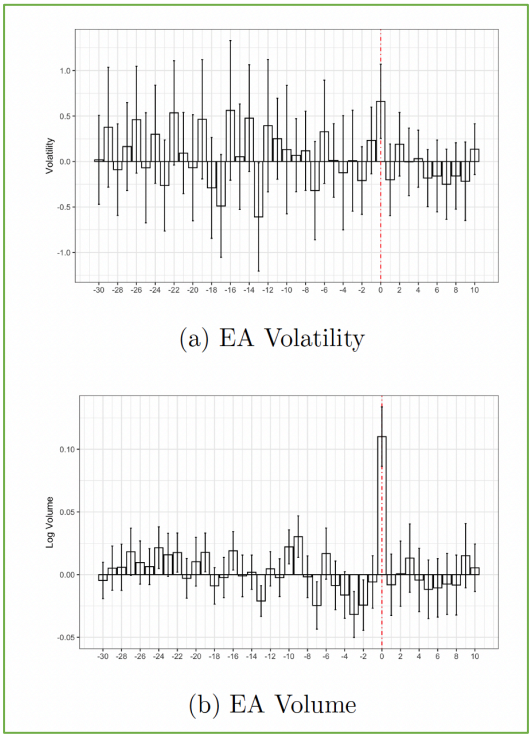
Post-close (4pm – 12am)



(a) EA Volatility

(c) EA Volume

Pre-open (12am – 9:30am)



(a) EA Volatility

(b) EA Volume

Figure 6. Price discovery around post-close and pre-open earnings announcements

Figure 6 plots the average cumulative residual returns over a 41-interval period surrounding a 15-minute interval containing either a post-close or a pre-open earnings announcement (EA) (i.e, interval *t*) over 2004-2021 period. The EAs are sorted into quintiles based on the magnitude of the announcement-window residual return, *ERET*. Announcement window includes intervals *t* - 1, *t* and *t* +1. The lines represent residual returns accumulated starting in interval *t*-10, averaged over each *ERET* quintile, from the highest (eret_r5) to the lowest (eret_r1). The post-close (pre-open) EAs are over 4pm – 12am (12am – 9:30am). The returns are in basis points. Detailed variable description is available in Appendix 1.

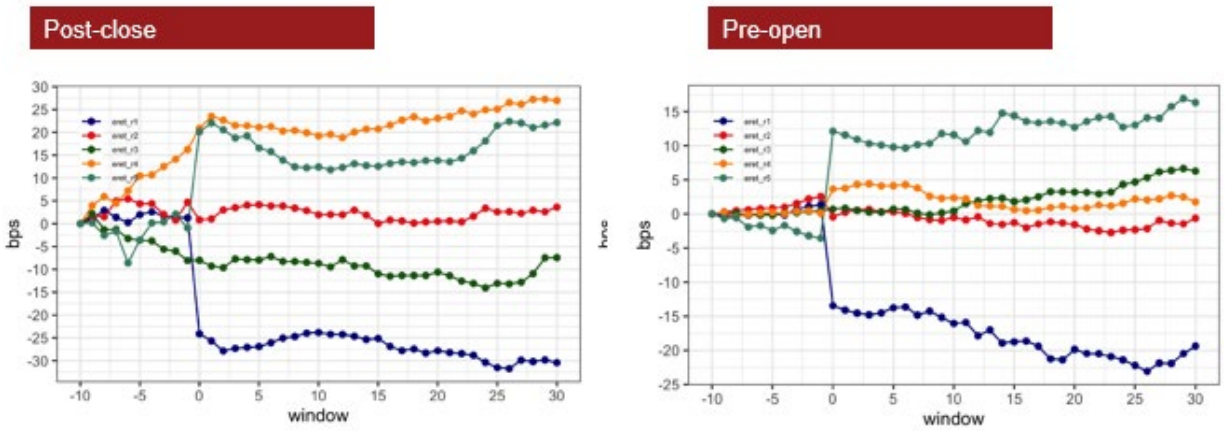


Figure 7. Market activity over announcement intervals by year

Figure 7 describes the trend in the market abnormal volatility (*ABSRET*) over the earnings announcement (EA) and macro announcement intervals (MA). Specifically, we plot the coefficients on the EA and MA dummies in the time-series regression (1) estimated separately for each year in our sample. The coefficients plotted by blue and red lines with circles (*b_EA* and *b_MA*) capture the average market reactions to large firm earnings announcements and macro announcements within a particular year, after controlling for the institutional features of the futures market and the fixed effects.

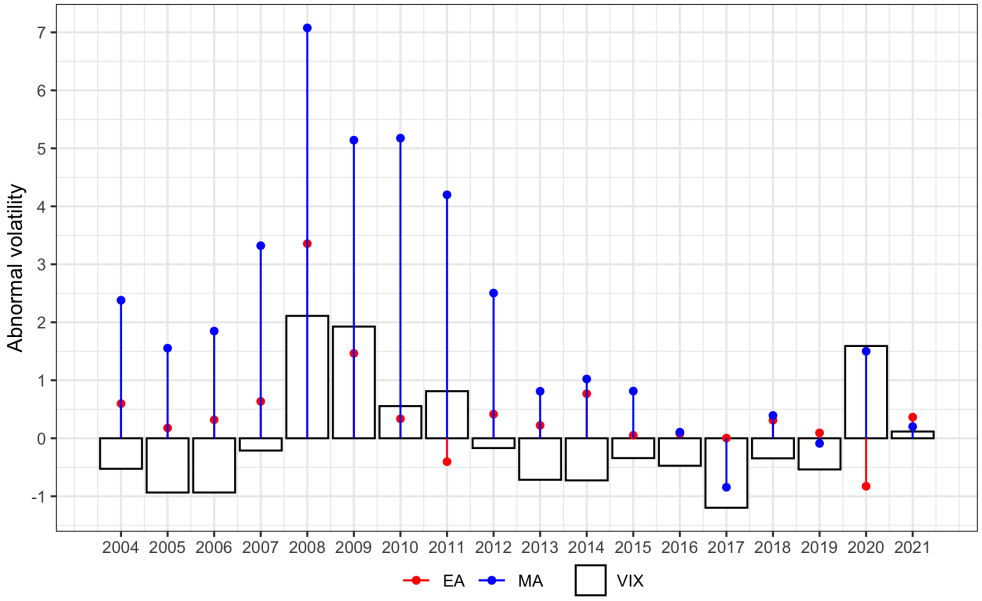


Table 1. Descriptive statistics

Table 1 provides the descriptive statistics of the sample. Panel A reports the number of unique intervals with large firm earnings announcements (EA), macroeconomic announcements (MA), major macroeconomic announcements (MA_MAJOR) and other non-major macroeconomic announcements (MA_OTHER). Major macro announcements include CPI, PPI, FOMC, Unemployment, and Advance GDP. Other macro announcements include Balance of Payment, Business Inventories, Capacity Utilization, Chicago PMI, Construction Spending, Consumer Credit, Durable Goods, Preliminary GDP, Final GDP, Government Deficit, Housing Starts, Industrial Production, ISM PMI, Preliminary Michigan Consumer Sentiment Index, Final Michigan Consumer Sentiment Index, New Home Sales, New Orders, Personal Income, Retail Sales. Panel B reports summary statistics on the return and volume variables. *RET* is the continuously compounded interval return and *ABSRET* is the absolute value of *RET*, all expressed in basis points. *VOLUME* is the number of contracts traded during an interval and *LOG_VOLUME* is the logarithm of one plus *VOLUME*.

Panel A: Frequencies of MA and EA

	Total	Overnight	Trading hour
MA	12635	7118	5517
MA_other	10040	4958	5082
MA_major	2595	2160	435
EA	12917	11419	1498

Panel B: Summary Statistics

var_name	mean	sd	p25	med	p75	n
RET	0.037	14.374	-3.718	0.000	3.949	427403
ABSRET	7.320	12.371	1.658	3.813	8.585	427403
VOLUME	16506.869	29583.854	848.000	3333.000	18697.500	427403
LOG_VOLUME	8.025	2.336	6.744	8.112	9.836	427403

Table 2. Abnormal market activity around announcement windows

Table 2 presents evidence on the abnormal market activity over large firm earnings announcement (EA) and macroeconomic announcement (MA) windows from a time-series regression between 2004 and 2021. Specifically, we regress *ABSRET* (or *LOG_VOLUME*) on *EA*, *MA* (or *MA_major* and *MA_other*), *Rollover*, *Days*, and three lags of the dependent variable, along with interval, weekday, and year-quarter fixed effects. Columns (3), (4), (7), and (8) exclude recession periods. Detailed variable definitions are provided in Appendix 1. Returns are in basis points. The t-statistics in brackets are based on standard errors are clustered by quarter-year. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	Dependent variable:							
	absret				log_volume			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
dum_EA	0.505***	0.452***	0.392***	0.350***	0.078***	0.075***	0.079***	0.075***
	(0.109)	(0.106)	(0.079)	(0.078)	(0.007)	(0.007)	(0.008)	(0.007)
dum_MA	2.035***		2.038***		0.167***		0.170***	
	(0.243)		(0.216)		(0.010)		(0.010)	
dum_MA_major		6.655***		6.149***		0.471***		0.486***
		(0.449)		(0.452)		(0.025)		(0.026)
dum_MA_other		1.018***		1.138***		0.100***		0.101***
		(0.241)		(0.190)		(0.008)		(0.008)
rollover1	0.331**	0.308**	0.173	0.153	0.014**	0.013*	0.017**	0.015**
	(0.153)	(0.153)	(0.119)	(0.119)	(0.006)	(0.006)	(0.006)	(0.006)
ndays_mstart	0.012	0.016	−0.038	−0.034	0.003	0.003	0.003	0.003
	(0.044)	(0.044)	(0.039)	(0.039)	(0.003)	(0.003)	(0.003)	(0.003)
lag1_absret	0.184***	0.183***	0.176***	0.174***				
	(0.008)	(0.008)	(0.010)	(0.010)				
lag2_absret	0.178***	0.178***	0.150***	0.151***				
	(0.011)	(0.010)	(0.007)	(0.007)				
lag3_absret	0.154***	0.155***	0.132***	0.132***				
	(0.010)	(0.010)	(0.008)	(0.008)				
lag1_log_volume					0.583***	0.582***	0.573***	0.572***
					(0.012)	(0.012)	(0.012)	(0.012)
lag2_log_volume					0.228***	0.228***	0.229***	0.229***
					(0.006)	(0.006)	(0.007)	(0.007)
lag3_log_volume					0.133***	0.133***	0.138***	0.139***
					(0.006)	(0.006)	(0.006)	(0.006)
Observations	427,403	427,403	385,974	385,974	427,403	427,403	385,974	385,974
R^2	0.354	0.355	0.288	0.289	0.907	0.907	0.905	0.905
Adjusted R^2	0.354	0.355	0.287	0.289	0.907	0.907	0.905	0.905

Table 3. Intraday timing of the announcements

Table 3 presents evidence on the abnormal market activity over large firm earnings announcement (EA) and macroeconomic announcement (MA) intervals by intraday announcement timing from a time-series regression between 2004 and 2021. In panel A, we regress *ABSRET* and *LOG_VOLUME* on the interactions between *EA*, *MA* (or *MA_major* and *MA_other*) and *Overnight* and *Daytime*. In panel B, we further split the overnight announcements into post-close and pre-open. *Rollover*, *Days*, and three lags of the dependent variable, along with interval, weekday, and year-quarter fixed effects are included in the regression. In both panels, columns (3), (4), (7), and (8) exclude recession periods. Returns are in basis points. Detailed variable definitions are provided in Appendix 1. The t-statistics in brackets are based on standard errors are clustered by quarter-year. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Intraday and overnight announcements

	Dependent variable:							
	absret				log_volume			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EA_overnight	0.568***	0.533***	0.412***	0.386***	0.084***	0.082***	0.084***	0.082***
	(0.103)	(0.100)	(0.079)	(0.078)	(0.007)	(0.007)	(0.008)	(0.008)
EA_daytime	−0.023	−0.041	0.205	0.189	0.030**	0.029**	0.029*	0.028*
	(0.639)	(0.639)	(0.396)	(0.396)	(0.013)	(0.013)	(0.015)	(0.015)
MA_overnight	2.701***		2.413***		0.243***		0.246***	
	(0.230)		(0.217)		(0.015)		(0.016)	
MA_daytime	1.460***		1.716***		0.102***		0.105***	
	(0.354)		(0.273)		(0.008)		(0.008)	
MA_major_overnight		5.722***		5.024***		0.447***		0.461***
		(0.420)		(0.379)		(0.027)		(0.028)
MA_major_daytime		11.346***		11.295***		0.665***		0.679***
		(1.391)		(1.477)		(0.031)		(0.032)
MA_other_overnight		1.472***		1.358***		0.160***		0.159***
		(0.194)		(0.191)		(0.013)		(0.014)
MA_other_daytime		0.497		0.783***		0.047***		0.049***
		(0.330)		(0.212)		(0.007)		(0.007)
rollover1	0.331**	0.308**	0.173	0.152	0.014**	0.013**	0.017**	0.015**
	(0.153)	(0.153)	(0.119)	(0.118)	(0.006)	(0.006)	(0.006)	(0.006)
ndays_mstart	0.010	0.012	−0.039	−0.037	0.003	0.003	0.003	0.003
	(0.044)	(0.044)	(0.039)	(0.039)	(0.003)	(0.003)	(0.003)	(0.003)
lag1_absret	0.184***	0.183***	0.176***	0.174***				
	(0.008)	(0.009)	(0.010)	(0.010)				
lag2_absret	0.178***	0.178***	0.150***	0.151***				
	(0.010)	(0.010)	(0.007)	(0.007)				
lag3_absret	0.154***	0.155***	0.132***	0.133***				
	(0.010)	(0.010)	(0.008)	(0.008)				
lag1_log_volume					0.583***	0.582***	0.573***	0.572***
					(0.012)	(0.012)	(0.012)	(0.012)
lag2_log_volume					0.228***	0.228***	0.229***	0.229***
					(0.006)	(0.006)	(0.007)	(0.007)
lag3_log_volume					0.133***	0.133***	0.138***	0.139***
					(0.006)	(0.006)	(0.006)	(0.006)
Observations	427,403	427,403	385,974	385,974	427,403	427,403	385,974	385,974
R^2	0.354	0.355	0.288	0.290	0.907	0.907	0.905	0.906
Adjusted R^2	0.354	0.355	0.287	0.290	0.907	0.907	0.905	0.905

Panel B. Intraday and overnight announcements – pre-open and post-close

	Dependent variable:							
	absret				log_volume			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EA_preopen	0.437***	0.395***	0.312***	0.280***	0.043***	0.040***	0.045***	0.043***
	(0.099)	(0.097)	(0.071)	(0.070)	(0.005)	(0.005)	(0.006)	(0.005)
EA_postclose	1.222***	1.221***	0.904***	0.905***	0.288***	0.288***	0.277***	0.276***
	(0.254)	(0.253)	(0.240)	(0.240)	(0.032)	(0.032)	(0.034)	(0.034)
EA_daytime	−0.023	−0.041	0.205	0.189	0.030**	0.029**	0.029*	0.028*
	(0.639)	(0.639)	(0.396)	(0.396)	(0.013)	(0.013)	(0.015)	(0.015)
MA_overnight	2.707***		2.417***		0.245***		0.247***	
	(0.231)		(0.217)		(0.015)		(0.016)	
MA_daytime	1.459***		1.716***		0.101***		0.105***	
	(0.354)		(0.273)		(0.008)		(0.008)	
MA_major_overnight		5.732***		5.031***		0.450***		0.464***
		(0.421)		(0.379)		(0.027)		(0.028)
MA_major_daytime		11.347***		11.296***		0.665***		0.679***
		(1.391)		(1.477)		(0.031)		(0.032)
MA_other_overnight		1.476***		1.361***		0.161***		0.160***
		(0.194)		(0.191)		(0.013)		(0.014)
MA_other_daytime		0.497		0.782***		0.047***		0.049***
		(0.330)		(0.212)		(0.007)		(0.007)
rollover1	0.331**	0.308**	0.173	0.152	0.014**	0.012*	0.017**	0.015**
	(0.153)	(0.153)	(0.119)	(0.118)	(0.006)	(0.006)	(0.006)	(0.006)
ndays_mstart	0.011	0.013	−0.039	−0.037	0.003	0.003	0.003	0.003
	(0.044)	(0.044)	(0.039)	(0.039)	(0.003)	(0.003)	(0.003)	(0.003)
lag1_absret	0.184***	0.183***	0.176***	0.174***				
	(0.008)	(0.009)	(0.010)	(0.010)				
lag2_absret	0.178***	0.178***	0.150***	0.151***				
	(0.011)	(0.010)	(0.007)	(0.007)				
lag3_absret	0.154***	0.155***	0.132***	0.133***				
	(0.010)	(0.010)	(0.008)	(0.008)				
lag1_log_volume					0.583***	0.582***	0.573***	0.572***
					(0.012)	(0.012)	(0.012)	(0.012)
lag2_log_volume					0.228***	0.228***	0.229***	0.230***
					(0.006)	(0.006)	(0.007)	(0.007)
lag3_log_volume					0.133***	0.133***	0.138***	0.138***
					(0.006)	(0.006)	(0.006)	(0.006)
Observations	427,403	427,403	385,974	385,974	427,403	427,403	385,974	385,974
R^2	0.354	0.355	0.288	0.290	0.907	0.907	0.905	0.906
Adjusted R^2	0.354	0.355	0.287	0.290	0.907	0.907	0.905	0.906

Table 4. Timing of announcements within the earnings announcement cycle

Table 4 presents evidence on the abnormal market activity over large firm earnings announcement (EA) and macroeconomic announcement (MA) intervals by announcement timeliness within an earnings season from a time-series regression between 2004 and 2021. In panel A, we regress *ABSRET* and *LOG_VOLUME* on the interactions between *EA*, *MA* (or *MA_major* and *MA_other*) and *Early* and *Late*. *Early* is an indicator variable that is equal to 1 if an announcement falls in the first month of the calendar quarter (i.e., Jan., Apr., Jul., and Oct.), and 0 otherwise. *Late* is defined as 1 – *Early*. In panel B, we further split the overnight announcements into post-close and pre-open. *Rollover*, *Days*, and three lags of the dependent variable, along with interval, weekday, and year-quarter fixed effects are included in the regression. In both panels, columns (3), (4), (7), and (8) exclude recession periods. Returns are in basis points. Detailed variable definitions are provided in Appendix 1. The t-statistics in brackets are based on standard errors are clustered by quarter-year. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Early vs. late announcements

	Dependent variable:							
	absret				log_volume			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EA_early	0.757***	0.717***	0.536***	0.504***	0.095***	0.091***	0.091***	0.088***
	(0.156)	(0.155)	(0.085)	(0.084)	(0.009)	(0.009)	(0.010)	(0.010)
EA_late	0.127	0.076	0.172	0.137	0.055***	0.052***	0.060***	0.058***
	(0.120)	(0.117)	(0.126)	(0.124)	(0.010)	(0.010)	(0.010)	(0.010)
MA_early	2.099***		2.146***		0.158***		0.162***	
	(0.324)		(0.243)		(0.011)		(0.012)	
MA_late	2.000***		1.983***		0.171***		0.174***	
	(0.250)		(0.239)		(0.011)		(0.012)	
MA_major_early		5.650***		5.199***		0.431***		0.442***
		(0.561)		(0.550)		(0.024)		(0.026)
MA_major_late		7.259***		6.713***		0.494***		0.511***
		(0.521)		(0.511)		(0.029)		(0.030)
MA_other_early		1.175***		1.366***		0.086***		0.088***
		(0.321)		(0.216)		(0.009)		(0.010)
MA_other_late		0.937***		1.025***		0.107***		0.107***
		(0.245)		(0.216)		(0.009)		(0.010)
rollover1	0.331**	0.304*	0.174	0.150	0.014**	0.012*	0.017**	0.015**
	(0.153)	(0.153)	(0.119)	(0.119)	(0.006)	(0.006)	(0.006)	(0.006)
ndays_mstart	0.006	0.011	−0.042	−0.037	0.002	0.003	0.002	0.003
	(0.044)	(0.044)	(0.039)	(0.039)	(0.003)	(0.003)	(0.003)	(0.003)
lag1_absret	0.184***	0.183***	0.176***	0.174***				
	(0.008)	(0.008)	(0.010)	(0.010)				
lag2_absret	0.178***	0.178***	0.150***	0.151***				
	(0.011)	(0.010)	(0.007)	(0.007)				
lag3_absret	0.154***	0.155***	0.132***	0.133***				
	(0.010)	(0.010)	(0.008)	(0.008)				
lag1_log_volume					0.583***	0.582***	0.573***	0.572***
					(0.012)	(0.012)	(0.012)	(0.012)
lag2_log_volume					0.228***	0.228***	0.229***	0.229***
					(0.006)	(0.006)	(0.007)	(0.007)
lag3_log_volume					0.133***	0.133***	0.138***	0.139***
					(0.006)	(0.006)	(0.006)	(0.006)
Observations	427,403	427,403	385,974	385,974	427,403	427,403	385,974	385,974
R^2	0.354	0.355	0.288	0.289	0.907	0.907	0.905	0.906
Adjusted R^2	0.354	0.355	0.287	0.289	0.907	0.907	0.905	0.905

Panel B. Post-close and pre-open announcements

	Dependent variable:							
	absret				log_volume			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EA_pre_early	0.554***	0.527***	0.359***	0.337***	0.047***	0.045***	0.046***	0.044***
	(0.123)	(0.121)	(0.080)	(0.079)	(0.007)	(0.006)	(0.007)	(0.007)
EA_pre_late	0.239*	0.196	0.231*	0.203*	0.038***	0.035***	0.045***	0.043***
	(0.124)	(0.121)	(0.122)	(0.121)	(0.009)	(0.009)	(0.010)	(0.009)
EA_post_early	2.043***	2.044***	1.911***	1.913***	0.418***	0.418***	0.399***	0.399***
	(0.326)	(0.326)	(0.295)	(0.295)	(0.043)	(0.043)	(0.046)	(0.046)
EA_post_late	0.324	0.320	−0.160	−0.163	0.145***	0.144***	0.146***	0.146***
	(0.405)	(0.404)	(0.344)	(0.344)	(0.035)	(0.035)	(0.035)	(0.035)
EA_daytime_early	0.558	0.547	0.093	0.083	0.030	0.029	0.033	0.033
	(1.100)	(1.100)	(0.503)	(0.503)	(0.018)	(0.018)	(0.021)	(0.021)
EA_daytime_late	−0.671	−0.705	0.339	0.307	0.032**	0.030**	0.025	0.023
	(0.581)	(0.583)	(0.496)	(0.500)	(0.014)	(0.013)	(0.015)	(0.015)
MA_overnight_early	2.830***		2.555***		0.245***		0.245***	
	(0.289)		(0.271)		(0.016)		(0.018)	
MA_overnight_late	2.641***		2.345***		0.244***		0.249***	
	(0.266)		(0.227)		(0.016)		(0.018)	
MA_daytime_early	1.475***		1.811***		0.088***		0.095***	
	(0.465)		(0.305)		(0.012)		(0.012)	
MA_daytime_late	1.451***		1.669***		0.108***		0.110***	
	(0.385)		(0.359)		(0.008)		(0.009)	
MA_major_overnight_early		5.546***		4.870***		0.432***		0.444***
		(0.547)		(0.520)		(0.028)		(0.030)
MA_major_overnight_late		5.852***		5.137***		0.461***		0.477***
		(0.506)		(0.406)		(0.030)		(0.031)
MA_major_daytime_early		6.728***		7.150***		0.584***		0.591***
		(1.570)		(1.574)		(0.046)		(0.048)
MA_major_daytime_late		13.299***		12.928***		0.699***		0.714***
		(1.769)		(1.818)		(0.036)		(0.038)
MA_other_overnight_early		1.371***		1.324***		0.144***		0.139***
		(0.249)		(0.224)		(0.014)		(0.015)
MA_other_overnight_late		1.518***		1.375***		0.169***		0.169***
		(0.229)		(0.214)		(0.014)		(0.016)
MA_other_daytime_early		0.953**		1.304***		0.043***		0.052***
		(0.462)		(0.305)		(0.011)		(0.011)
MA_other_daytime_late		0.269		0.524*		0.048***		0.048***
		(0.334)		(0.269)		(0.007)		(0.008)
Observations	427,403	427,403	385,974	385,974	427,403	427,403	385,974	385,974
R^2	0.354	0.355	0.288	0.290	0.907	0.907	0.905	0.906
Adjusted R^2	0.354	0.355	0.288	0.290	0.907	0.907	0.905	0.906

Table 5. Intertemporal variation

Table 5 presents evidence on the intertemporal trends in the relative importance of large firm earnings announcement (EA) and macroeconomic announcement (MA) as a source of index-wide news from 2004 to 2021. In panel A, we estimate the time-series regression (1) with *ABSRET* as the dependent variable and add the interactions between *EA*, *MA* (or *MA_major* and *MA_other*) and indicators for various time-series partitions: *Year*, *VixR10* and *Rec*. In panel B, we further split the overnight announcements into post-close and pre-open. The coefficients on control variables (*Rollover*, *Days* and three lags of dependent variable) are suppressed. The *t*-statistics in brackets are based on standard errors clustered by quarter-year. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively. Returns are in basis points. Detailed variable definitions are provided in Appendix 1.

Panel A. Intertemporal variation in abnormal market activity

	Dependent variable:							
	absret							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
dum_EA	0.985***	0.923***	0.275***	0.231**	−0.347	−0.373	0.238	0.197
	(0.296)	(0.290)	(0.104)	(0.104)	(0.309)	(0.307)	(0.217)	(0.217)
EA_year	−0.063**	−0.062**					−0.051*	−0.050*
	(0.029)	(0.029)					(0.026)	(0.025)
EA_rec			2.184*	2.073*			1.757	1.651
			(1.124)	(1.128)			(1.100)	(1.105)
EA_vixr10					0.155**	0.150**	0.085**	0.082**
					(0.066)	(0.065)	(0.037)	(0.036)
dum_MA	4.114***		1.538***		−0.732		1.488***	
	(0.497)		(0.306)		(0.522)		(0.410)	
MA_year	−0.243***						−0.234***	
	(0.044)						(0.031)	
dum_MA_major		9.929***		5.831***		2.431***		5.935***
		(0.863)		(0.466)		(0.848)		(0.783)
MA_major_year		−0.383***						−0.364***
		(0.080)						(0.059)
MA_major_rec				8.373***				5.048***
				(1.198)				(1.475)
MA_major_vixr10						0.773***		0.610***
						(0.165)		(0.112)
dum_MA_other		2.775***		0.608**		−1.359***		0.514
		(0.465)		(0.299)		(0.478)		(0.391)
MA_other_year		−0.205***						−0.200***
		(0.039)						(0.030)
MA_rec			5.203***				2.886***	
			(0.808)				(1.061)	
MA_other_rec				4.335***				2.295**
				(0.754)				(1.006)
MA_vixr10					0.508***		0.419***	
					(0.095)		(0.081)	
MA_other_vixr10						0.436***		0.368***
						(0.087)		(0.086)
rollover1	0.333**	0.312**	0.334**	0.311**	0.327**	0.304*	0.330**	0.308*
	(0.153)	(0.153)	(0.154)	(0.154)	(0.156)	(0.156)	(0.156)	(0.156)
ndays_mstart	0.011	0.015	0.011	0.015	0.009	0.013	0.007	0.011
	(0.044)	(0.044)	(0.044)	(0.044)	(0.040)	(0.040)	(0.041)	(0.041)
vixr10					0.551*	0.551*	0.555*	0.556*
					(0.326)	(0.326)	(0.325)	(0.326)
lag1_absret	0.184***	0.183***	0.183***	0.182***	0.181***	0.180***	0.180***	0.179***
	(0.008)	(0.009)	(0.008)	(0.009)	(0.007)	(0.007)	(0.007)	(0.007)
lag2_absret	0.178***	0.178***	0.177***	0.178***	0.175***	0.176***	0.175***	0.175***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)
lag3_absret	0.154***	0.155***	0.154***	0.155***	0.152***	0.152***	0.152***	0.152***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)
Observations	427,403	427,403	427,403	427,403	427,403	427,403	427,403	427,403
R^2	0.354	0.355	0.355	0.356	0.356	0.357	0.356	0.357
Adjusted R^2	0.354	0.355	0.354	0.355	0.355	0.356	0.356	0.357

Panel B. Intertemporal variation in abnormal market activity – post-close and pre-open

	Dependent variable:							
	absret							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EA_preopen	0.938***	0.852***	0.308***	0.250***	−0.114	−0.147	0.417*	0.359
	(0.263)	(0.255)	(0.088)	(0.088)	(0.180)	(0.179)	(0.237)	(0.235)
EA_postclose	1.832***	1.832***	1.302***	1.298***	2.283***	2.276***	2.741***	2.737***
	(0.494)	(0.494)	(0.308)	(0.308)	(0.593)	(0.593)	(0.650)	(0.650)
EA_daytime	0.504	0.496	−1.272	−1.288	−4.750**	−4.763**	−3.245***	−3.255***
	(1.413)	(1.412)	(0.779)	(0.780)	(2.117)	(2.116)	(0.950)	(0.947)
EA_pre_year	−0.063**	−0.062**					−0.056**	−0.054**
	(0.026)	(0.025)					(0.025)	(0.024)
EA_post_year	−0.073	−0.073					−0.068	−0.069
	(0.050)	(0.049)					(0.052)	(0.052)
EA_daytime_year	−0.081	−0.082					−0.066	−0.067
	(0.148)	(0.148)					(0.105)	(0.105)
EA_pre_rec			1.292**	1.143**			0.906*	0.764
			(0.496)	(0.491)			(0.526)	(0.524)
EA_post_rec			−0.915	−0.907			−0.397	−0.392
			(1.637)	(1.636)			(1.656)	(1.655)
EA_daytime_rec			10.567	10.550			8.475	8.452
			(7.403)	(7.403)			(6.883)	(6.883)
EA_pre_vixr10					0.101**	0.095**	0.065*	0.062*
					(0.039)	(0.038)	(0.037)	(0.037)
EA_post_vixr10					−0.195**	−0.195**	−0.167*	−0.167*
					(0.096)	(0.096)	(0.094)	(0.094)
EA_daytime_vixr10					0.894*	0.894*	0.501***	0.502***
					(0.453)	(0.453)	(0.144)	(0.143)
dum_MA	4.119***		1.539***		−0.729		1.502***	
	(0.496)		(0.306)		(0.523)		(0.407)	
MA_year	−0.243***						−0.235***	
	(0.044)						(0.031)	
dum_MA_major		9.938***		5.828***		2.415***		5.939***
		(0.865)		(0.467)		(0.855)		(0.785)
MA_major_year		−0.384***						−0.365***
		(0.080)						(0.059)
MA_major_rec				8.516***				5.185***
				(1.235)				(1.491)
MA_major_vixr10						0.777***		0.611***
						(0.166)		(0.113)
dum_MA_other		2.779***		0.610**		−1.351***		0.532
		(0.463)		(0.298)		(0.477)		(0.387)
MA_other_year		−0.206***						−0.201***
		(0.039)						(0.030)
MA_rec			5.256***				2.938***	
			(0.812)				(1.060)	
MA_other_rec				4.368***				2.327**
				(0.751)				(1.002)
MA_vixr10					0.509***		0.418***	
					(0.095)		(0.081)	
MA_other_vixr10						0.436***		0.367***
						(0.087)		(0.086)
Observations	427,403	427,403	427,403	427,403	427,403	427,403	427,403	427,403
R^2	0.354	0.355	0.355	0.356	0.356	0.357	0.357	0.358
Adjusted R^2	0.354	0.355	0.354	0.355	0.356	0.357	0.356	0.357