

# Liquidity, investor attention, and adverse selection around macroeconomic announcements

Doojin Ryu<sup>a,\*</sup> | Robert I. Webb<sup>b</sup> | Jinyoung Yu<sup>a</sup>

<sup>a</sup>College of Economics, Sungkyunkwan University, Seoul, Republic of Korea

<sup>b</sup>McIntire School of Commerce, University of Virginia, United States of America

## Contact

*E-mail:* [sharpjin@skku.edu](mailto:sharpjin@skku.edu), ORCID: <https://orcid.org/0000-0002-0059-4887> (DR)

*E-mail:* [riw4j@comm.virginia.edu](mailto:riw4j@comm.virginia.edu), ORCID: <https://orcid.org/0000-0003-1714-5778> (RIW)

*E-mail:* [mydkfkqldk@skku.edu](mailto:mydkfkqldk@skku.edu), ORCID: <https://orcid.org/0000-0001-5670-2720> (JY)

## Correspondence

\*Doojin Ryu, College of Economics, Sungkyunkwan University, 25-2, Sungkyunkwan-ro, Jongno-gu, Seoul 110-745, Republic of Korea. Tel: +82-2-760-0429, Fax: +85-760-0950, *E-mail:* [sharpjin@skku.edu](mailto:sharpjin@skku.edu)

## HIGHLIGHTS

- Macroeconomic announcements impact market liquidity via investor attention.
- Informed foreign institutions consume liquidity before macroeconomic news releases.
- Domestic institutions provide liquidity in response to the increased attention from foreign investors.
- Fears of adverse selection significantly determine the bid-ask spread in the order-driven market.

## Abstract

By analyzing an informative transaction-level dataset, this study reveals the microstructural liquidity dynamics around scheduled macroeconomic announcements. We examine whether investor attention contributes to liquidity fluctuations in a highly liquid and purely order-driven index futures market. We find that increased foreign institutions' attention impairs market liquidity by consuming the spread and increasing adverse selection costs, whereas domestic institutions provide liquidity in response to the influx of foreign institutions around macroeconomic announcements, in general. Domestic individuals are noisy and participate

significantly less after announcements. Our findings are pronounced around monetary policy announcements in particular.

**Keywords:** Adverse selection cost; Index futures; Investor attention; Macroeconomic announcements; Market liquidity; Market microstructure

**JEL classification:** E44; G11; G14

## 1. Introduction

Macroeconomic news announcements provide the most official and updated assessments of financial markets' macroeconomic fundamentals (Andersen, Bollerslev, Diebold, and Vega, 2003). Revising and maintaining macroeconomic indices convey critical information about financial markets to participants and are highly likely to shape the dynamics of intraday market states. Existing studies assume that macroeconomic announcements are public information (Ehrmann, Gaballo, Hoffmann, and Strasser, 2019; Gilbert, 2011; Mitchell and Mulherin, 1994), supporting the traditional perspective of the efficient market hypothesis (Malkiel, 2003). They implicitly impose two strong assumptions: *i*) there is absolutely no leakage of macroeconomic news before the precise moment of its release, and *ii*) macroeconomic news is immediately and completely incorporated into the financial market by the asset price adjustment process after its announcement. Contrarily, a number of empirical findings in real-world markets contradict these assumptions (Lucca and Moench, 2015; Savor and Wilson, 2013). Our study contributes to the literature on the market response to macroeconomic announcements by allowing for potential information leaks, market frictions, and market inefficiency.

There is substantial literature on the effects of macroeconomic news announcements on market fundamentals. Both major strands of the literature support the existence of pre-announcement market reactions or the evidence of somewhat inefficient price discovery processes. One strand of the literature focuses on the impact of macroeconomic news on *price (or return)* dynamics in equity and derivatives markets (Ai and Bansal, 2018; Hu, Pan, and Wang, 2017). Birz and Lott (2011) use newspaper headlines to construct a news indicator

reflecting macroeconomic information and find that this indicator positively affects the return process for the U.S. stock market index. They discover that this impact is more pronounced around the gross domestic product (GDP) and unemployment rate (UR) announcements. Savor and Wilson (2013) show that macroeconomic news induces significantly positive excess returns as well as elevated risk in the stock market following the news announcements. They explain that these abnormal returns are the premia for risk-taking investments and that the majority of the annual equity risk premium is earned on macroeconomic announcement days. There is also evidence of information leakage before macroeconomic and monetary policy announcements. For instance, Lucca and Moench (2015) find a significant increase in excess stock returns before monetary policy announcements following the Federal Open Market Committee (FOMC). Similar pre-FOMC return movements are also observed in other major stock market indices, such as those in Germany and Britain. Kurov, Sancetta, Strasser, and Wolfe (2019) examine the prevalence of informed trading in the index futures market before announcements of U.S. macroeconomic news. They conclude that the price dynamics around the macroeconomic announcement can be explained by the types of institutions that disclose the news.

Another strand of studies shows that market *volatility* also depends on macroeconomic announcements (Bollerslev, Cai, and Song, 2000; Hussain and Omrane, 2021). Ederington and Lee (1993) investigate the impact of various macroeconomic announcements, such as the monthly producer price index and the monthly consumer price index (CPI). They report evidence that the futures market reacts very quickly, and also discover that major macroeconomic announcements play a significant role in shaping intraday volatility dynamics and such impacts on the volatility processes persist longer than those on the return processes. Chen and Clements (2007) also find that the S&P 500 implied volatility decreases significantly on FOMC announcement dates. Lee and Ryu (2019) examine the reactions of options-implied volatility processes to the releases of scheduled macroeconomic indices. They show that the implied volatilities for both calls and puts are greater when macroeconomic news is announced. This relationship becomes more pronounced since the global financial crisis and when base rate (BR) announcements are considered.

As opposed to the above literature on the reactions of return and volatility dynamics

to macro news announcements, only a handful of studies attempt to investigate the reaction of *market liquidity* to macroeconomic news releases in global financial markets. Several studies report that some macroeconomic announcements (e.g., FOMC announcements) impair stock market liquidity. Riordan, Storkenmaier, Wagener, and Zhang (2013) consider the message that the macroeconomic news contains and suggest that market liquidity rises (falls) when positive (negative) news is released. Lucca and Moench (2015) report that market liquidity becomes scarcer before FOMC announcements but rapidly increases at the moment of these announcements. Smales and Lucey (2019) claim that market liquidity sharply deteriorates before the macro news release. However, these studies, in general, fail to provide an in-depth analysis on the microstructural liquidity dynamics. Our study fills this void in the literature.

First, most existing studies neglect to highlight the mechanism or channel by which macroeconomic announcements influence liquidity. We propose *investor attention* as an important factor to account for the inconsistent conclusions of previous studies. Black (1986) lays the groundwork for this literature by stating that noise traders contribute to the formation of market liquidity. Nofsinger (2001) finds that individual investors' reactions are significantly greater on good news and smaller on bad news compared to those of institutional investors. Bloomfield, O'Hara, and Saar (2009) and Peress and Schmidt (2020) experimentally and empirically confirm a positive relationship between noisy, retail investors' trading and market liquidity. Chen, Liu, Lu, and Tang (2016) show that investor attention is greater when macroeconomic news is released in the Chinese index futures market. Other studies further show that market liquidity depends on the participation of different types of investors. For instance, Rhee and Wang (2009) investigate the emerging stock market in Indonesia and suggest that foreign investors' participation impairs market liquidity. From these clues, we conjecture that each group of investors (i.e., retail, institutional, or foreign investors) might react to the same macroeconomic news announcements in a heterogeneous manner. Further, we suggest that investor attention might explain the link between the announcements and liquidity reactions and resolve the inconsistency found in previous studies.

Second, we examine the drivers of liquidity fluctuations with respect to the components of the bid-ask spread (Ho and Stoll, 1983; Stoll, 1989). Previous studies mostly focus on the inventory-holding costs (Bollen, Smith, and Whaley, 2004). Fleming and

Remolona (1999) investigate the reaction of the stock market around macroeconomic announcements and claim that both trading volume and the bid/ask spread become more illiquid after news releases. They argue that the increase in the bid-ask spread is due to the rise in market makers' inventory-holding risk. Rühl and Stein (2015) empirically find that the intraday bid-ask spread significantly reacts to major macroeconomic announcements by the European Central Bank owing to dealers' uncertainty when holding assets. However, these previous studies provide limited insight regarding contemporary financial markets, which are mostly purely order-driven without designated market makers and dominated by high-frequency trading. Because inventory-holding uncertainty owing to macro announcements are likely to be minimal in such markets (de Jong, Nijman, and Röell, 1996; Madhavan and Smidt, 1991), we test whether changes in informed trading patterns around macroeconomic news releases contribute to increases in the bid/ask spread due to increases in adverse selection costs (Chang and Wang, 2015; Kim and Verrecchia, 1994; Kyle, 1985).

Another limitation of existing studies is that most of them employ single liquidity measures and/or low-frequency liquidity proxies that only reflect partial information about the market's liquidity state. We attempt to comprehensively address financial market liquidity dynamics by analyzing a set of high-frequency liquidity proxies in order to understand intraday liquidity fluctuations in a highly liquid index futures market. The concept of liquidity is rather ambiguously defined, and different liquidity proxies reflect distinct liquidity features. Amihud (2002) and Goyenko, Holden, and Trzcinka (2009) point out that there is no single measure that fully represents the various aspects of market liquidity. Thus, we instead consider distinct microstructural liquidity components<sup>1</sup> (i.e., the bid-ask spread, market depth, and duration between trades) to exhaustively incorporate diverse aspects of liquidity by utilizing a high-quality microstructure dataset with specific information on market states and investor identifications. The bid-ask spread captures ex-ante market illiquidity by measuring the implicit transaction cost investors encounter when trading. The market depth also captures ex-ante illiquidity, but it measures liquidity related to the market's ability to absorb large market

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<sup>1</sup> While trading volume, which is calculated as the number of asset contracts traded within a given time period, is also considered an ex-post market liquidity measure that reflects how actively investors participate in the market, it is excluded in this study to account for heterogeneity among investor types.

orders. On the other hand, the duration between trades (i.e., inter-transaction time) indicates how frequently and quickly transactions are made regardless of order sizes, indicating ex-post market liquidity. By simultaneously employing these four microstructural liquidity measures (Ryu, 2016), we try to resolve the shortcomings of previous studies that only focus on fragmentary features of liquidity. The dominance of high-frequency trading on recent financial markets supports that our analyses on the intraday dynamics of the microstructural liquidity measures are more appropriate in the era of high-frequency trading. They have a clear advantage over employing widely known low-frequency liquidity measures, such as Amihud's (2002) liquidity measure.

Our major findings include the following. First, macroeconomic news announcements, in general, significantly reduce market liquidity. Second, the composition of investors who participate in the index futures market around scheduled macroeconomic announcements differs from that on normal trading days. In particular, the attention of foreign institutional investors on the financial market drastically increases around these announcements. Third, foreign institutional investors consume liquidity in the futures market during the pre-announcement periods. This indicates either potential information leakage or more sophisticated trading skills of foreign institutional investors. In contrast, the trades of domestic institutions provide liquidity and become less informative prior to announcements. Fourth, monetary policy announcements (i.e., the BR and the CPI) exert the strongest impact on market liquidity, with the liquidity-consuming trades of foreign investors most evident before monetary policy announcements.

Empirical analyses exploiting the detailed investor-type information contained in our high-quality microstructure dataset contribute to existing academic literature. First, we newly attempt to identify the mechanism by which macroeconomic announcements impact market liquidity. Our empirical results suggest that changes in investor attention, such as the influx of informed and/or sophisticated investors, significantly determine the relationship between macro news announcements and liquidity dynamics and may contribute to explaining the disparate conclusions of previous studies. Second, we outline the roles of different investor types regarding liquidity formation in the context of a highly liquid, efficiently priced, and speculative market where various market players participate in a balanced manner. We find that

foreign investors increase their aggregate trading volumes and consume liquidity around macroeconomic news announcements. Domestic institutions' trades also increase around announcements but, conversely, improve market liquidity by decreasing the bid-ask spread and increasing the market depth. Domestic individual investors' attention on the index futures market is not significantly affected by the news announcements. Finally, our findings from separately investigating the trading patterns of domestic and foreign institutions support the adverse selection cost theory to explain the illiquidity premium on the bid-ask spread (Brennan, Huh, and Subrahmanyam, 2016; Brennan and Subrahmanyam, 1996; Easley, Hvidkjaer, and O'Hara, 2002). While some studies emphasize other determinants, such as the inventory holding or order-processing cost (Gârleanu and Pedersen, 2004; Lee and Chung, 2018), our findings imply that, in the order-driven financial market in which order-processing and inventory-holding costs are minimal, the adverse selection cost due to information asymmetry among investors significantly determines the spread around macroeconomic news releases (Krinsky and Lee, 1996; Levi and Zhang, 2015).

The remainder of this paper is organized as follows. Section 2 describes the sample data composition regarding macroeconomic announcements, microstructural liquidity components, and investor attention proxies. Section 3 discusses the methodology. Section 4 shows the empirical findings and interprets their implications. Section 5 concludes.

## **2. Sample Data**

This study uses tick-by-tick trade-and-quote data from the Korea Composite Stock Price Index (KOSPI) 200 futures market from January 2010 to June 2014. Employing this dataset provides some crucial advantages in studying this topic. First, the index futures market is characterized by abundant liquidity and efficient price discovery owing to the highly speculative trading of its participants. These market conditions provide an adequate and stable environment to observe the reactions of market liquidity in response to macroeconomic announcements. Second, this market is a representative emerging (but fully matured) market with participation by diverse groups of investors (i.e., domestic retail, domestic institutional, and foreign institutional investors). Along with abundant liquidity, such diversity allows us to assess the role of each investor type's attention around the news announcements. Third, our market

microstructure dataset from the index futures market comprises rich and accurate information about the exact transaction time, buy-sell indicator, and which party initiated each transaction. The microstructure analyses on the high-quality dataset provide further insights into the exact role of each particular investor type when macro news is announced. We collect and construct other major variables, including the data on macroeconomic announcements, microstructural liquidity, and investor attention, as follows.

## **2.1. Macroeconomic news announcements**

Macroeconomic indices are released on a regular basis and on pre-scheduled dates and times in the Korean market. We manually identify the press release documents reported by government departments and collect announcement data for six major macroeconomic reports. Our dataset contains the exact minute-by-minute information on when each specific macroeconomic report is released.<sup>2</sup> It comprises 285 announcements in aggregate. We confirm that none of the announcements overlaps on the same date. Table I summarizes the distribution of the announcements by the time of day.

[Table I here]

### **2.1.1. Business cycle indices**

We employ the announcement data of macroeconomic indices belonging to three different categories (i.e., business cycle, monetary policy, and trade indicators), as shown in Panel A of Table I. The business cycle indices are publicly provided by Statistics Korea and include the GDP growth rate, the index of all industry production (IAIP) growth rate, and the UR. The GDP denotes the aggregate value of all end products within an economy. Korea's GDP is

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<sup>2</sup> The macroeconomic reports are released by governmental authorities (i.e., the Bank of Korea, the Ministry of Trade, Industry and Energy, and Statistics Korea) to the press before the announcements with an embargo until the scheduled time. Because the press companies have an incentive to report the information as soon as possible, the macroeconomic news is, in general, released on time. For example, the first news article on the GDP growth rate report is always released exactly at 8:00 a.m. during our sample period.

announced quarterly and released during nontrading hours (i.e., at 8:00 a.m.).<sup>3</sup> We use the GDP growth rate; thus, its mean value of 0.86 indicates that the economy's average quarterly growth rate is about 0.86%. The IAIP represents the production of goods and services in all industrial sectors, which is released monthly. We use its growth rate. The UR reflects the proportion of the jobless population within the labor force in percentage terms. The mean value of UR indicates that the average unemployment rate is 3.39%. Both the IAIP and the UR were announced during trading hours (i.e., at 1:30 p.m.) before April 2010, but they have been announced at 8:00 a.m. since then.

### **2.1.2. Trade index**

The trade index includes the balance of trade (BoT), which denotes a country's net export value. The Ministry of Trade, Industry and Energy announces the BoT on the first business day of every month at 11:00 a.m. We use the level data for this macroeconomic index in our analysis; thus, its mean value of 3,436 indicates that the Korean economy has experienced trade surpluses on average, during the sample period.

### **2.1.3. Monetary policy indices**

The monetary policy indices are set and released by the Bank of Korea and include the BR and the growth rate in the CPI. The BR is the reference interest rate set by the central bank as a standard for banks' activities, such as opening deposits and offering loans. The BR is announced around the tenth of the month at 10:00 a.m. The CPI represents the price level of the major goods and services that are generally purchased by consumers. We use the growth rate of the CPI, which implies the inflation rate, in percentage terms, and, thus, the mean value of the CPI indicates that the average monthly inflation rate is 0.22%. The CPI is announced at the beginning of each month and was released at 1:30 p.m. before May 2010. Since then, the Bank of Korea has released CPI reports at 8:00 a.m., before the market opens.

## **2.2. Microstructural liquidity components**

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<sup>3</sup> All major financial markets (e.g., the spot, index futures, index options, single stock futures, single stock options, and even the U.S. dollar derivatives markets) in Korea open at 9:00 a.m.

The concept of *liquidity* depends on the context and field of study, classified as *i*) market liquidity, *ii*) funding liquidity, and *iii*) monetary liquidity (Foucault, Pagano, and Röell, 2013). Market liquidity is often used in financial economics and indicates where transactions demanded by participants can be executed without explicit or implicit costs or delay. Funding liquidity concerns the ability of financial firms to absorb potential shocks arising from liquidity shortages, for example, during bank runs. Monetary liquidity indicates the abundance of money within an economy. This concept is closely related to governmental monetary policies regarding the money supply. In our study, liquidity refers to the concept of market liquidity.

The current literature does not provide a universal measurement of liquidity but rather suggests using various measures because each of them illuminates a different aspect of market liquidity (Black, 1971; Kyle, 1985). In addition, financial markets, especially many emerging markets that adopt electronic and automated exchanges, are predominantly driven by high-frequency trading in recent years (Kirilenko, Kyle, Samadi, and Tuzun, 2017; Menkveld, 2013). These changes in markets raise questions about the validity of traditional liquidity proxies, which are measured using low-frequency data (Holden and Jacobsen, 2014). Furthermore, high-frequency data are important when investigating the effects of intraday macroeconomic announcements because they help to precisely estimate the announcement impacts and resolve potential endogeneity (Almeida, Goodhart, and Payne, 1998; Chaboud, Chernenko, and Wright, 2008; Hussain, 2011). This study employs a market microstructural approach in order to overcome these challenges.

We use a highly informative intraday dataset that includes all transacted orders and quotes in the index futures market and construct four microstructural liquidity measures in 15-minute intervals (Ederington and Lee, 1993). The liquidity measures are the bid-ask spread, market depth, and duration between trades, and each can be categorized as either an ex-ante or an ex-post measure. The ex-ante liquidity measures include the bid-ask spread and market depth. These proxies are measured immediately before transactions and represent the actual market liquidity encountered by the investor who submitted the last order. The bid-ask spread, calculated as the difference between the best ask price and best bid price, explicitly measures a type of transaction cost paid by investors (Hagströmer, Henricsson, and Nordén, 2016). The market depth, calculated as the sum of all standing bid- and ask-order volumes up to the fifth-

best bid and ask quotes, measures the market's ability to absorb shocks from large-volume trades (Dionne and Zhou, 2020; Riordan, Storkenmaier, Wagener, and Zhang, 2013). The bid-ask spread and the market depth at time  $t$  are constructed as shown in Equations (1) and (2), respectively.

$$\text{Bid-ask spread}_t = (\text{Best ask quote})_t - (\text{Best bid quote})_t. \quad (1)$$

$$\text{Market depth}_t = \sum_{i=1}^{i=5} (i^{\text{th}} \text{ best bid orders})_t + \sum_{i=1}^{i=5} (i^{\text{th}} \text{ best ask orders})_t. \quad (2)$$

The ex-post liquidity proxy, which measures the state of liquidity at the precise moment that a transaction is made, includes the duration between trades. The duration between trades indicates the inter-transaction time between the two consecutive traded orders made at  $t$  and  $t-1$  (Brogaard, Hagströmer, Nordén, and Riordan, 2015; Furfine, 2007). It is calculated, as shown in Equation (3). Table II shows the descriptive statistics for these microstructural liquidity proxies.

$$\text{Duration between trades}_t = (\text{Time stamp})_t - (\text{Time stamp})_{t-1}. \quad (3)$$

[Table II here]

### 2.3. Investor attention proxies

*Investor attention*, in the financial market, refers to the degree to which the market is watched by attentive investors. Some studies proxy investors' attention or behavior using search frequencies provided by major search engines (e.g., Google and Baidu) (Andrei and Hasler, 2015; Aouadi, Arouri, and Teulon, 2013; Da, Engelberg, and Gao, 2011). Although this measure effectively gauges investors' attention on individual stocks or sentimental behavior (Da, Engelberg, and Gao, 2015; Kostopoulos, Meyer, and Uhr, 2020), it is less appropriate for estimating attention on the stock index market because of the difficulty in determining representative keywords. Furthermore, investor attention proxies based on search information primarily focus on retail investors' attention because these investors are the dominant users of

search engines. As an alternative, another strand of the literature suggests using trading volumes to proxy investor attention (Barber and Odean, 2008; Peress and Schmidt, 2020; Yuan, 2015). This measure accounts for the intensity of general investors' participation but does not consider the different trading patterns of various investor types.

We consider such shortcomings of previous measures and employ the participation rate of each investor group to proxy for their attention on the market. In addition, using high-quality transaction data, we identify the investors who initiate each transaction as being either domestic individual, domestic institutional, or foreign institutional investors. These measures are calculated as shown in Equation (4).

$$Inv_m = \frac{(Trading\ volume)_m^{Inv}}{(Total\ trading\ volume)_m}, \text{ where } Inv \in \{Ind, Ins, For\}. \quad (4)$$

Here,  $Inv_m$  is the investor attention proxy for the given investor type during 15-minute interval  $m$ .  $Ind$ ,  $Ins$ , and  $For$  denote the participation rates of domestic individual, domestic institutional, and foreign institutional investors, respectively.  $(Trading\ volume)_m^{Inv}$  denotes the trading volume of investor type  $Inv$  during interval  $m$ . We consider that investors of a certain type pay more attention to the market when their participation rate is higher. Each of these measures is standardized to have mean zero and standard deviation one, as shown in Panel B of Table II.

### 3. Methodology

We investigate the impacts of macroeconomic news announcements on market liquidity and examine whether a certain investor type's attention explains liquidity reactions in the following order. First, we estimate the impact of macroeconomic announcements on the microstructural liquidity proxies during the post- and pre-announcement periods using the regression models given by Equations (5) and (6), respectively.

$$Liq_m = \alpha + \sum_{i=0}^{i=3} \beta_{Liq,i} \cdot Ann_{m+i} + \gamma' \cdot MacroCon_m + \varepsilon_m, \quad (5)$$

$$Liq_m = \alpha + \sum_{i=-1}^{i=0} \beta_{Liq,i} \cdot Ann_{m+i} + \gamma' \cdot MacroCon_m + \varepsilon_m, \quad (6)$$

where  $Liq_m$  indicates the microstructural liquidity proxy, which includes the bid-ask spread, the market depth, and the duration between trades, during interval  $m$ .  $Ann_{m+i}$  is the announcement indicator variable that equals one during interval  $m+i$  when macroeconomic news is released at the beginning of interval  $m$ .<sup>4</sup> The significantly positive (negative) value of  $\beta_{Liq,i}$  indicates the increase (decrease) in market liquidity in response to macroeconomic announcements.  $MacroCon_m$  denotes the set of macroeconomic variables that serve as control variables. They include lagged futures returns, daily KOSPI 200 index returns (Goncalves-Pinto, Grundy, Hameed, van der Heijden, and Zhu, 2020), daily implied volatility (i.e., the VKOSPI) returns (Song, Ryu, and Webb, 2018), the daily credit spread, the daily term spread, the daily USD/KRW exchange rate, and the daily risk-free rate (Ryu, Ryu, and Yang, 2021).  $\gamma'$  is the vector of coefficients for the control variables.  $\alpha$  is the intercept, and  $\varepsilon_m$  is the error term.

Second, using the same frameworks, we investigate the impacts of macroeconomic news announcements on attention from different types of market participants. The regression models in Equations (7) and (8) measure the post- and pre-announcement dynamics of investor attention, respectively. Here, the significantly positive (negative) value of  $\beta_{Inv,i}$  indicates the increased (decreased) attention from the given investor type around macroeconomic announcements.

$$Inv_m = \alpha + \sum_{i=0}^{i=3} \beta_{Inv,i} \cdot Ann_{m+i} + \gamma' \cdot MacroCon_m + \varepsilon_m. \quad (7)$$

$$Inv_m = \alpha + \sum_{i=-1}^{i=0} \beta_{Inv,i} \cdot Ann_{m+i} + \gamma' \cdot MacroCon_m + \varepsilon_m. \quad (8)$$

Finally, we examine the role of investor attention in market liquidity formation around macroeconomic announcements by employing a difference-in-differences approach. The

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<sup>4</sup> We assume that the macroeconomic announcements released during nontrading hours are reflected when the market opens at 9:00 a.m.

trading days with (without) macroeconomic announcements are classified as the treatment (control) group observations. Equations (9) and (10) show the resulting regression models for the post- and pre-announcement periods, respectively. The estimation window is from the announcement to 60 minutes after announcements (i.e.,  $[m, m+3]$ ) for the model in Equation (9) and from 15 minutes before announcements to 15 minutes after (i.e.,  $[m-1, m]$ ) for the model in Equation (10).

$$Liq_{j,m} = \alpha + \sum_{i=0}^{i=3} \beta_{INT,i} \cdot (Inv_{j,m} \times Ann_{j,m+i}) + \sum_{i=0}^{i=3} \beta_{Liq,i} \cdot Ann_{j,m+i} + \gamma' \cdot MacroCon_{j,m} + v_m + \varepsilon_{j,m}. \quad (9)$$

$$Liq_{j,m} = \alpha + \sum_{i=-1}^{i=0} \beta_{INT,i} \cdot (Inv_{j,m} \times Ann_{j,m+i}) + \sum_{i=-1}^{i=0} \beta_{Liq,i} \cdot Ann_{j,m+i} + \gamma' \cdot MacroCon_{j,m} + v_m + \varepsilon_{j,m}. \quad (10)$$

Here, the interaction terms (i.e.,  $Inv_{j,m} \times Ann_{j,m+i}$ ) between the investor attention proxies and the announcement indicators capture the effect of investor attention on microstructural liquidity components around macroeconomic news releases after controlling for the intraday seasonality across time intervals (i.e.,  $v_m$ ) and the announcement effects (i.e.,  $Ann_{j,m+i}$ ). The significant deviation of the coefficient of an interaction term ( $\beta_{INT,i}$ ) from zero implies that the given investor type's attention drives liquidity dynamics during the event window.

## 4. Empirical Results

### 4.1. Market liquidity dynamics around macroeconomic announcements

In this section, we examine the impacts of macroeconomic announcements on the microstructural liquidity components in the KOSPI 200 futures market. We proxy for market liquidity using four different liquidity measures, as aforementioned. Figure 1 roughly illustrates the dynamics of the liquidity components over the period from 15 minutes before to an hour after announcements. We measure these dynamics in 15-minute intervals and compare them to the dynamics on days without announcements. Panels A, B, C, and D show the fluctuations of the bid-ask spread, market depth, and duration between trades, respectively. The solid (dashed)

line in each panel indicates the fluctuations of the given liquidity measure on announcement (non-announcement) days. The vertical dotted line in each panel represents the time of macroeconomic announcements ( $t=0$ ).

[Figure 1 here]

Figure 1 shows that the market liquidity dynamics exhibit different patterns on macroeconomic announcement days from those on typical non-announcement trading days. In Panel A, the bid-ask spread appears to increase before macroeconomic announcements and decrease back to its normal level during the last interval (i.e., 45 to 60 minutes after an announcement). Panel B indicates that the market depth also drops at the time of announcements and remains shallower than normal trading days for up to 45 minutes after news releases. Panel C shows that the duration between trades increases around announcements but falls back to its typical level approximately 45 minutes later. These findings collectively imply pre-announcement decreases in market liquidity. This relative illiquidity persists up to around 45 minutes after announcements before converging back to the normal state, which is a meaningfully long time horizon in current financial markets.

Table III shows the results of statistical analysis on the microstructural liquidity dynamics in response to scheduled macroeconomic announcements. Panel A investigates the post-announcement movements of the liquidity components. We confirm that, in general, macroeconomic announcements reduce market liquidity (Chung, Elder, and Kim, 2013). The bid-ask spread is significantly wider (0.0014) on announcement dates than on non-announcement dates. The spread remains wider up to 45 minutes after announcements. The duration between trades also decreases during the first 15-minute interval after an announcement, indicating that the trade speed slows down immediately after macroeconomic indices are announced. The market depth does not significantly react to news announcements; instead, based on the relatively high adjusted  $R$ -squared value (0.6155), we can conclude that it is largely explained by longer-term macroeconomic control variables. This result may arise because the market depth is defined as the stack of limit orders, which accumulates over a

longer time horizon. These results statistically confirm the findings in Figure 1 that market liquidity is impaired during the post-announcement periods.

[Table III here]

Panel B of Table III presents the pre-announcement drifts of market liquidity proxies. We find that the bid-ask spread significantly increases 15 minutes before macroeconomic announcements. Moreover, its pre-announcement increase (0.0008) is greater than increases in any other post-announcement periods apart from the instantaneous reaction during the first 15 minutes (0.0014). Likewise, the market depth decreases (-0.0083), and the duration between trades increases (0.1554) before announcements. The overall results consistently suggest that liquidity is impaired prior to macroeconomic news releases.

#### **4.2. Investor attention around macroeconomic announcements**

Using a similar framework, we investigate the changes in investor attention before and after macroeconomic announcements. Figure 2 shows the dynamics of the investor attention proxies for different types of investors. Panels A, B, and C (D, E, and F) show trends in the trading volume (participation rate) on days with and without announcements for domestic individual, domestic institutional, and foreign institutional investors, respectively. In each panel, the solid and dashed lines indicate trends on the announcement and non-announcement days, respectively.

[Figure 2 here]

Domestic retail investors' participation falls shortly after announcements, implying that these investors do not play the role of liquidity providers in this emerging market. This contradicts the convention suggested by existing studies (Bloomfield, O'Hara, and Saar, 2009; Peress and Schmidt, 2020). Whereas retail investors do not appear to alter their trading intensity during the first 15-minute period after an announcement, both domestic and foreign institutions trade more actively near macro news announcements. Domestic institutions' trading behavior

does not change much before announcements, but their trading volume jumps instantly after announcements. Foreign institutional investors' trading volume and participation rate both increase sharply prior to announcements. These changes in foreign investors' trading behavior somewhat explain the substantial drop in domestic institutions' participation rate on announcement days, as shown in Panel E, despite the increase in their trading volume, as shown in Panel B. We observe that all of the abnormal trading patterns revert back to usual patterns 45 to 60 minutes after an announcement.

Table IV confirms some characteristic changes in trading patterns of different investor types shown in Figure 2. First, individual investors' trading patterns are not significantly affected by macroeconomic announcements. Although their participation rate significantly decreases, their trading volume is not clearly affected. This finding implies that the decrease in retail investors' relative participation is mainly driven by the increase in foreign investors' participation rather than by a decrease in their trading volume. The adjusted *R*-squared values (0.0621 and 0.0611) for the columns labeled *Ind* in Panels A and B are relatively low compared to those in columns labeled *Ins* (0.4170 and 0.4172) and *For* (0.3244 and 0.3243), indicating that announcements of major macroeconomic indices and macroeconomic control variables (e.g., the VKOSPI, credit spread, and term spread) only marginally explain individual investors' activity in the index futures market. These findings altogether suggest that retail investors trade irrespective of these announcement events and are noise traders. Second, domestic institutional investors behave somewhat similarly to individual investors, but their attention significantly increases during the first 15 minutes after news releases. Third, foreign institutional investors' attention dominates this market both before and after announcements, indicating that these investors pay significantly greater attention to the market. Because foreign investors in emerging markets are often acknowledged to possess superior information and order-processing skills, their sudden influx may induce greater bid-ask spreads or general illiquidity in the market (Du, Fung, and Loveland, 2018).

[Table IV here]

#### **4.3. Roles of investor attention**

Thus far, our results suggest that market liquidity significantly drops before and after announcements and that different types of investors react differently to these announcements. Next, we examine whether investor attention explains liquidity formation around macro news releases after controlling for the announcement and time effects. Table V reports the difference-in-differences regression results for post-announcement impacts of the domestic individual (Panel A), domestic institutional (Panel B), and foreign institutional investors' attention (Panel C) on market liquidity proxies. Panel B suggests that domestic institutional investors generally provide liquidity as all of the microstructural liquidity measures improve following the increase in attention from domestic institutions. As the participation of domestic institutional investors increases, the bid-ask spread starts to shrink immediately after the announcement, implying that these investors' trades convey less information around macro news announcements. In contrast, Panel C indicates that the participation of foreign institutional investors consumes liquidity, indicating that these investors likely have information superiority owing to information leakages or based on their trading or information-processing skills. These results potentially imply that liquidity, particularly the spread measure, reacts to the macroeconomic news owing to its adverse selection component. In addition, the overall announcement effects (i.e.,  $Ann_{(i)}$ ) are weaker shortly after the announcement, indicating that investor attention significantly explains the reaction of market microstructural liquidity to the macro news.

[Table V here]

We can draw similar implications for the pre-announcement period from the results in Table VI. In Panels A and B, both domestic individual and institutional traders provide liquidity, as their attention narrows the bid-ask spread, and shortens the duration between trades. The tendency is especially more evident for institutional investors since they improve all liquidity proxies besides the time between trades at the moment of announcements. This finding suggests that domestic investors improve market liquidity and participate more actively around macroeconomic announcements. The liquidity improvement may be driven by either information inferiority or domestic institutions intentionally providing liquidity to offset the liquidity-consuming pressure from foreign investors' trades (Hendershott and Riordan, 2013).

On the other hand, in Panel C, foreign institutions expand the bid-ask spread even before announcements by consuming liquidity (Glosten and Milgrom, 1985). We suggest two explanations for these pre-announcement drifts. *i*) Foreign investors may have access to information about announcements owing to leakages during embargoes (Bernile, Hu, and Tang, 2016; Cieslak, Morse, and Vissing-Jorgensen, 2019). *ii*) Foreign investors are more experienced and skilled in processing market-wide information and, thus, can be better at predicting macroeconomic indices in advance (Gu and Kurov, 2018; Kurov, Sancetta, Strasser, and Wolfe, 2019). In sum, Tables 5 and 6 consistently confirm that investor attention from various types of investors serves as distinct channels that macroeconomic announcements affect liquidity in the index futures market. Furthermore, they show that foreign investors' potentially informed trading consumes market liquidity, supporting the evidence of adverse selection costs as an important determinant of the bid-ask spread in a purely order-driven market.

[Table VI here]

#### 4.4. Informed trading dynamics before announcements

To check the robustness of the findings and further investigate the driving forces of the pre-announcement dynamics, we analyze the patterns of informed trading before macroeconomic announcements. In this section, we utilize order imbalances data for each investor type to examine the informativeness of their transactions prior to macroeconomic news releases (Lee, Ryu, and Yang, 2021; Schlag and Stoll, 2005). The regression model is given by Equation (11).

$$Ret_m = \alpha + \beta_{OI,Inv} \cdot Inv_{m-1}^{OI} + \beta_{Ann,inv} \cdot (Inv_{m-1}^{OI} \times Ann_{m-1}) + \gamma' MacroCon_m + e_m, \quad (11)$$

where  $Ret_m$  is the spot index return during interval  $m$ .  $Inv_{m-1}^{OI}$  indicates the order imbalance, calculated as the net buying volume divided by the total trading volume, of investor type  $Inv$  during interval  $m-1$ .  $Ann_{m-1}$  is the lagged announcement indicator variable that equals one for interval  $m-1$  when an announcement is made at the beginning of interval  $m$ . The

significantly positive (negative) coefficient of the interaction term ( $Inv_{m-1}^{OI} \times Ann_{m-1}$ ) indicates the increase (decrease) in the informativeness of the given investor type's trades.

Table VII reports the estimation results of Equation (11) as follows. First, the table shows that foreign institutions are the most informed traders in this market (Chen, Johnson, Lin, and Liu, 2009). Their trades significantly predict future spot returns and have the greatest coefficient (0.1611 with a heteroskedasticity-consistent  $t$ -statistics of 6.46). This finding confirms our conjecture that foreign investors tend to consume liquidity and is in line with the conventional wisdom regarding the adverse selection cost theory. Second, because foreign institutions' informativeness does not significantly change in response to macroeconomic announcements, we may conclude that these investors are more informed owing to their trading skills rather than information leakages regarding the macroeconomic reports before their announcements. Overall, foreign investors participate more in the futures market around macroeconomic announcements; however, they are not better informed about the macroeconomic news. Third, information asymmetry is intensified prior to macroeconomic announcements (Crego, 2020), by the decrease in the informativeness of domestic institutions' transactions, implied by the significantly negative coefficient of  $Ins^{OI} \times Ann$  (-0.2671), rather than the increased informativeness of foreign institutions' trading. This finding suggests that domestic institutions trade for different purposes around announcements and that their trading reduces the bid/ask spread by providing liquidity and mitigating adverse selection costs. Along with the increased trading of foreign institutions (see Tables 5 and 6), this result implies that domestic institutions alter their trading purposes during this period in response to the influx of informed foreign traders.

[Table VII here]

#### **4.5. Analysis by macroeconomic news announcement type**

In this section, we dissect macroeconomic news in order to gauge the impacts of each type of announcement. For brevity, we only report the reactions of the bid-ask spread, which is the liquidity proxy that is most directly related to the adverse selection cost theory.

In Table VIII, we separately examine the announcement effects of six macroeconomic reports that are released periodically during our sample period. We find that announcements of macroeconomic news generally impair market liquidity, with the exception of BoT announcements. Notably, we observe that these phenomena, indicating decreases in liquidity, are most evident around monetary policy (i.e., BR and CPI) announcements. Our finding is consistent with the liquidity impairment after monetary policy announcements observed in advanced financial markets (Chung, Elder, and Kim, 2013; Lucca and Moench, 2015; Smales and Lucey, 2019); it also supports previous studies' conclusions that central banks' decisions to supply or reduce monetary liquidity significantly determine market liquidity in the context of emerging markets (Chaboud, Chernenko, and Wright, 2008; Foucault, Pagano, and Röell, 2013).

[Table VIII here]

We further analyze the sources of liquidity changes around each type of macroeconomic announcement and the role of investor attention, as shown in Table IX.<sup>5</sup> The important findings of this analysis are as follows. First, the effect of investor attention is primarily concentrated around monetary policy announcements. Foreign institutional investors significantly consume market liquidity, and potentially carry out informed trading, prior to the BR and CPI news. Second, the significantly negative coefficients of  $Ind \times Ann_{(-15)}$  (-0.0009 and -0.0010) indicate that domestic institutions' attention negatively impacts market liquidity, particularly before BR and CPI announcements, for which foreign investors' liquidity consumption is pronounced. This finding supports our conjecture that domestic institutions may provide liquidity in response to the increase in informed trades by foreign institutions. Third, we confirm that retail investors are mostly noisy and uninformed traders. Prior to all types of news announcements, aside from IAIP announcements, domestic individual investors

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<sup>5</sup> We also investigate the effects of macroeconomic index announcements while accounting for the directions of the revisions (i.e., upward or downward revisions). An announcement is considered an upward (downward) revision when the index is greater (smaller) than its expected value. The results confirm our previous findings regarding the roles of domestic and foreign institutions around monetary policy announcements.

exhibit no liquidity-consuming behavior. Instead, they either provide liquidity or remain indifferent to announcements, indicating that they do not have any advantage regarding pre-announcement information leakages and lack sophisticated trading techniques.

[Table IX here]

## **5. Conclusion**

This study shows that market microstructural liquidity is significantly impaired by macroeconomic news announcements and that such dynamics can be attributed to changes in investor attention. Specifically, we find that foreign institutional investors pay more attention to the index futures market during the pre-announcement period, and our analyses reveal that they consume market liquidity owing to experienced trading and information-processing skills rather than information leakages before announcements. Conversely, domestic institutions provide liquidity, potentially in response to foreign investors' increased liquidity consumption. We also analyze each type of macroeconomic announcement separately and show that our main findings are pronounced for monetary policy announcements.

Our contributions to the financial economics literature include the following. First, we use investor attention to investigate the sources of market liquidity reactions to macroeconomic news, which is a novel approach in the literature. Abrupt increases in foreign investors' attention significantly explain the drop in liquidity prior to announcements. Second, we address the roles of different investor types in an emerging market and identify whether certain investor types consume or provide liquidity. Third, our results provide supporting evidence for the adverse selection cost theory in an order-driven financial market.

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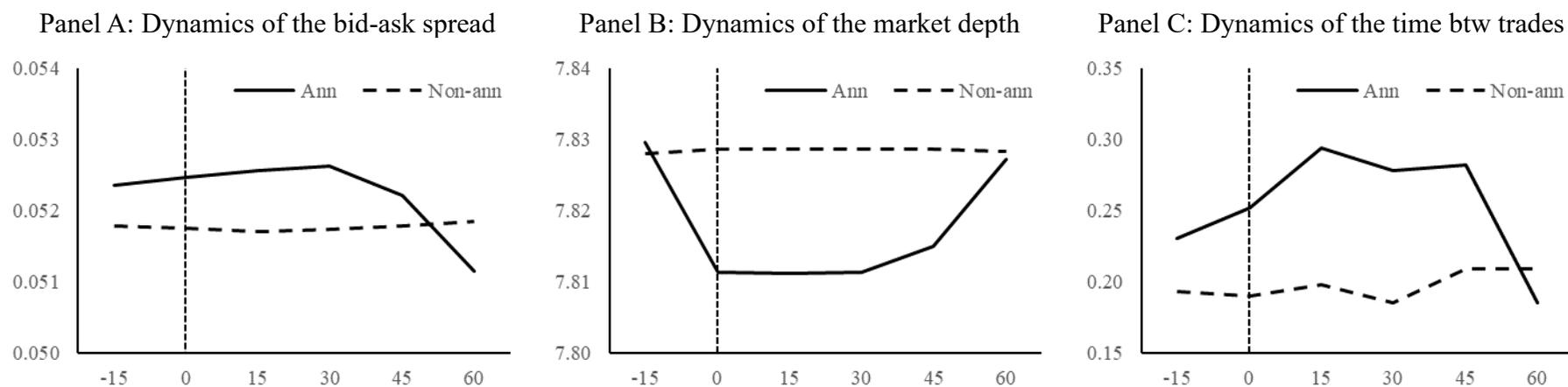
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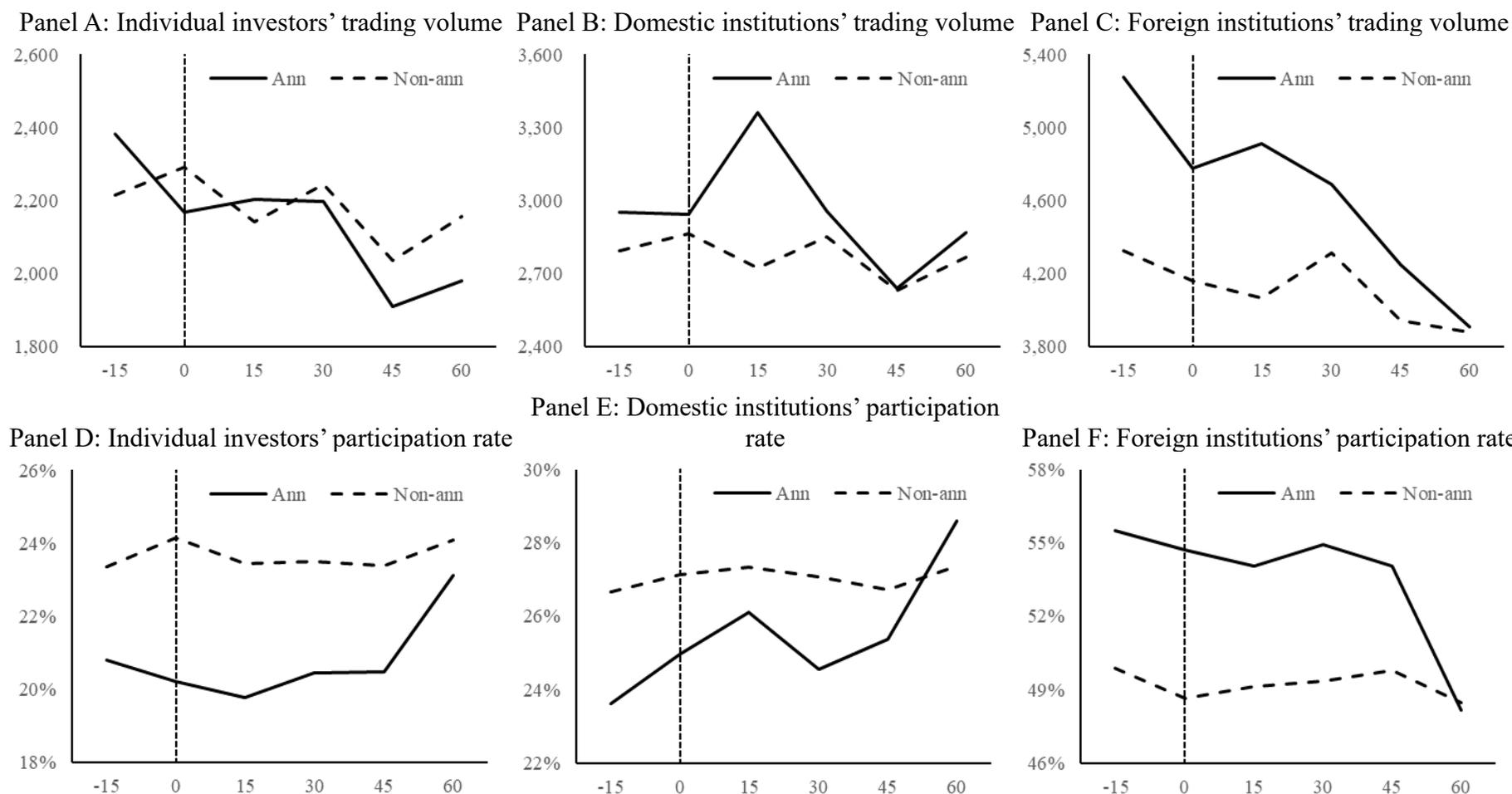
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**Figure 1.** Dynamics of market liquidity proxies around macroeconomic announcements. This figure illustrates the market microstructural liquidity dynamics around macroeconomic announcements. Panels A, B, and C report the fluctuations of the bid-ask spread, market depth, and time btw trades, respectively. The solid (*Ann*) and dashed (*Non-ann*) lines indicate the dynamics of a given liquidity proxy on the announcement and non-announcement days, respectively. The vertical dotted line denotes the time of announcement. The *y*-axis represents the level of the given liquidity proxy, and the *x*-axis represents the time frame around macro announcements.



**Figure 2.** Dynamics of investor attention proxies around macroeconomic announcements. This figure illustrates the dynamics of investor attention proxies around macroeconomic announcements. Panels A, B, and C (D, E, and F) report the fluctuations of the trading volume (participation rate) for domestic individual, domestic institutional, foreign institutional investors, respectively. The solid (*Ann*) and dashed (*Non-ann*) lines indicate the dynamics of a given liquidity proxy on the announcement and non-announcement days, respectively. The vertical dotted line denotes the time of announcement. The y-axis represents the level of the given investor attention proxy, and the x-axis represents the time frame around macro announcements.

**Table I.** Descriptive statistics for macroeconomic announcements

*Notes.* This table reports the time-based distribution (Panel A) and summary statistics (Panel B) of the macroeconomic announcements. The columns labeled *Business cycle* show macroeconomic indices related to business fluctuations, including the gross domestic product growth rate (*GDP*), index of all industry production growth rate (*IAIP*), and unemployment rate (*UR*). The column labeled *Trade* shows the balance of trade (*BoT*). The columns labeled *Monetary policy* show the central bank's monetary policy rates, including the base rate (*BR*) and consumer price index growth rate (*CPI*). *Mean* and *Std. Dev.* denote the mean and standard deviation for each announcement, respectively. *Min.*, *Q1*, *Med.*, *Q3*, and *Max.* denote the minimum, first quartile, median, third quartile, and maximum values, respectively. Sources: Bank of Korea; Ministry of Trade, Industry and Energy; Statistics Korea.

Panel A: Time-based distribution of macroeconomic news releases

	Business cycle			Trade	Monetary policy	
	GDP	IAIP	UR	BoT	BR	CPI
08:00 a.m.	17	51	51			50
10:00 a.m.					54	
11:00 a.m.				53		
01:30 p.m.		3	3			3
Total	17	54	54	53	54	53

Panel B: Summary statistics of macroeconomic reports

	Mean	Std. Dev.	Min.	Q1	Med.	Q3	Max.
GDP	0.86	0.43	0.20	0.50	0.90	1.10	1.80
IAIP	0.30	1.84	-4.20	-0.80	0.30	1.40	4.60
UR	3.39	0.37	2.90	3.10	3.20	3.60	4.80
BoT	3,436	2,172	-1,957	2,193	3,357	4,899	7,472
BR	2.69	0.42	2.00	2.50	2.75	3.00	3.25
CPI	0.22	0.37	-0.60	-0.10	0.20	0.40	1.10

**Table II.** Descriptive statistics for microstructural liquidity components and investor attention proxies

*Notes.* This table reports the summary statistics of the market microstructural liquidity (Panel A) and investor attention (Panel B) proxies. *Bid-ask spread*, *Market depth*, and *Time btw trades* denote the quoted bid-ask spread, logarithm of the market depth, and duration between trades, respectively. *Ind*, *Ins*, and *For* are the investor attention proxies for domestic individual, domestic institutional, and foreign institutional investors, respectively. *Mean* and *Std. Dev.* denote the mean and standard deviation, respectively. *Min.*, *Q1*, *Med*, *Q3*, and *Max.* denote the minimum, first quartile, median, third quartile, and maximum values, respectively.

Panel A: Summary statistics of microstructural liquidity components

	Mean	Std. Dev.	Min.	Q1	Med	Q3	Max.
Bid-ask spread	0.0518	0.0019	0.0500	0.0507	0.0514	0.0525	0.1057
Market depth	7.8283	0.0727	7.6127	7.7864	7.8419	7.8775	7.9954
Time btw trades	0.2002	0.1878	0.0265	0.0991	0.1461	0.2308	3.2319

Panel B: Summary statistics of investor attention proxies

	Mean	Std. Dev.	Min.	Q1	Med	Q3	Max.
Ind	0.0000	1.0000	-3.2408	-0.6933	-0.0387	0.6529	6.2127
Ins	0.0000	1.0000	-2.4762	-0.7528	-0.0781	0.7085	4.1587
For	0.0000	1.0000	-2.9511	-0.7177	-0.0502	0.6628	3.7718

**Table III.** Impacts of macroeconomic announcements on microstructural liquidity components  
*Notes.* This table reports the regression results for market liquidity dynamics after (Panel A) and before (Panel B) macroeconomic announcements, and the columns labeled *Bid-ask spread*, *Market depth*, and *Time btw trades* show the results using the quoted bid-ask spread, logarithm of the market depth, and duration between trades, respectively, as dependent variables. *Intercept* is the intercept term.  $Ann_{(0)}$  indicates the dummy variable that equals one when a macroeconomic index is announced.  $Ann_{(-i)}$  ( $Ann_{(+i)}$ ) denotes the dummy variable that equals one if it is  $i$  minute before (after) an announcement. The control variables include lagged futures return ( $Fu\_Ret$ ), daily KOSPI 200 index return ( $Spot\_Ret$ ), daily VKOSPI return ( $Vkospi$ ), daily credit spread ( $Credit$ ), daily term spread ( $Term$ ), USD/KRW exchange rate ( $Exch$ ), and daily risk-free rate ( $Rf$ ). The columns labeled *Coef.* and *t-stat.* show the fitted coefficients and the corresponding  $t$ -statistics, respectively. Heteroskedasticity-consistent standard errors are considered.  $Adj. R^2$  denotes the adjusted  $R$ -squared value. \*\*\*, \*\*, and \* indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Post-announcement reactions of market liquidity components

	Bid-ask spread		Market depth		Time btw trades	
	Coef.	$t$ -stat.	Coef.	$t$ -stat.	Coef.	$t$ -stat.
Intercept	0.0408***	(71.26)	8.5107***	(539.20)	1.6474***	(7.94)
<b>Ann<sub>(0)</sub></b>	0.0014***	(7.74)	0.0002	(0.09)	-0.6792***	(-7.23)
<b>Ann<sub>(+15)</sub></b>	0.0005***	(4.05)	0.0002	(0.09)	0.0131	(0.79)
<b>Ann<sub>(+30)</sub></b>	0.0004***	(3.01)	0.0003	(0.11)	0.0251*	(1.74)
<b>Ann<sub>(+45)</sub></b>	0.0003**	(2.42)	0.0002	(0.09)	0.0448***	(2.73)
$Fu\_Ret$	0.0068*	(0.43)	-0.2480	(-0.98)	-0.8050	(-0.46)
$Spot\_Ret$	-0.0002***	(-9.37)	0.0038***	(10.27)	0.0102***	(4.16)
$Vkospi$	-0.0094***	(-22.24)	-0.9066***	(-92.19)	0.4206***	(3.09)
$Credit$	0.0018***	(17.70)	-0.0703***	(-24.96)	-0.0653*	(-1.74)
$Term$	-0.0011***	(-35.81)	-0.0127***	(-13.12)	-0.0107	(-0.89)
$Exch$	0.0000***	(6.63)	-0.0004***	(-52.35)	-0.0007***	(-6.70)
$Rf$	0.0072***	(2.89)	4.5121***	(79.52)	-4.7189***	(-5.41)
$Adj. R^2$	0.1434		0.6155		0.0208	

Panel B: Pre-announcement movements of market liquidity components

	Bid-ask spread		Market depth		Time btw trades	
	Coef.	$t$ -stat.	Coef.	$t$ -stat.	Coef.	$t$ -stat.
Intercept	0.0408***	(71.11)	8.5108***	(539.31)	1.6445***	(7.93)
<b>Ann<sub>(-15)</sub></b>	0.0008***	(3.13)	-0.0083*	(-1.81)	0.1554***	(3.47)
<b>Ann<sub>(0)</sub></b>	0.0014***	(7.69)	0.0002	(0.08)	-0.6794***	(-7.23)
$Fu\_Ret$	0.0073	(0.46)	-0.2494	(-0.98)	-0.7567	(-0.43)
$Spot\_Ret$	-0.0002***	(-9.32)	0.0038***	(10.29)	0.0102***	(4.17)
$Vkospi$	-0.0094***	(-22.24)	-0.9065***	(-92.17)	0.4191***	(3.08)
$Credit$	0.0018***	(17.72)	-0.0703***	(-24.97)	-0.0649*	(-1.73)
$Term$	-0.0011***	(-35.83)	-0.0127***	(-13.12)	-0.0111	(-0.92)
$Exch$	0.0000***	(6.66)	-0.0004***	(-52.37)	-0.0007***	(-6.68)
$Rf$	0.0071***	(2.86)	4.5122***	(79.53)	-4.7249***	(-5.42)
$Adj. R^2$	0.1428		0.6156		0.0210	

**Table IV.** Impacts of macroeconomic announcements on investor attention

*Notes.* This table reports the regressions results for investor attention dynamics after (Panel A) and before (Panel B) macroeconomic announcements, and the columns labeled *Ind*, *Ins*, and *For* show the results using the attention from domestic individual, domestic institutional, and foreign institutional investors as dependent variables, respectively. *Intercept* is the intercept term.  $Ann_{(0)}$  indicates the dummy variable that equals one when a macroeconomic index is announced.  $Ann_{(-i)}$  ( $Ann_{(+i)}$ ) denotes the dummy variable that equals one if it is  $i$  minute before (after) an announcement. The control variables include lagged futures return (*Fu\_Ret*), daily spot index return (*Spot\_Ret*), daily VKOSPI return (*Vkospi*), daily credit spread (*Credit*), daily term spread (*Term*), USD/KRW exchange rate (*Exch*), and daily risk-free rate (*Rf*). We omit the results for control variables for brevity. The columns labeled *Coef.* and *t-stat.* show the fitted coefficients and the corresponding  $t$ -statistics, respectively. Heteroskedasticity-consistent standard errors are considered.  $Adj. R^2$  denotes the adjusted  $R$ -squared value. \*\*\* and \*\* indicate statistical significance at the 1% and 5% levels, respectively.

Panel A: Post-announcement reactions by investor type

	Ind		Ins		For	
	Coef.	$t$ -stat.	Coef.	$t$ -stat.	Coef.	$t$ -stat.
Intercept	-0.2719***	(-11.62)	-0.7834***	(-24.37)	2.0468***	(53.92)
<b>Ann<sub>(0)</sub></b>	0.0056	(1.37)	0.0139**	(2.49)	-0.0196**	(-2.53)
<b>Ann<sub>(+15)</sub></b>	-0.0198***	(-4.79)	-0.0014	(-0.28)	0.0212***	(3.06)
<b>Ann<sub>(+30)</sub></b>	-0.0173***	(-4.18)	-0.0169***	(-3.28)	0.0341***	(4.82)
<b>Ann<sub>(+45)</sub></b>	-0.0243***	(-5.89)	-0.0234***	(-4.59)	0.0475***	(6.72)
Fu_Ret	-0.1145	(-0.51)	0.0345	(0.12)	0.0794	(0.22)
Spot_Ret	0.0001	(0.26)	-0.0021***	(-5.01)	0.0020***	(4.14)
Vkospi	-0.1906***	(-11.28)	-0.0541**	(-2.54)	0.2469***	(9.52)
Credit	0.0407***	(8.93)	0.0624***	(10.08)	-0.1032***	(-14.22)
Term	-0.0199***	(-13.73)	0.0770***	(39.86)	-0.0569***	(-25.32)
Exch	0.0002***	(16.61)	0.0004***	(21.65)	-0.0006***	(-27.00)
Rf	1.0689***	(10.60)	2.8632***	(21.28)	-3.9192***	(-24.89)
Adj. R <sup>2</sup>	0.0621		0.4170		0.3244	

Panel B: Pre-announcement movements by investor type

	Ind		Ins		For	
	Coef.	$t$ -stat.	Coef.	$t$ -stat.	Coef.	$t$ -stat.
Intercept	-0.2706***	(-11.56)	-0.7823***	(-24.33)	2.0443***	(53.82)
<b>Ann<sub>(-15)</sub></b>	-0.0451***	(-6.05)	-0.0545***	(-5.65)	0.0997***	(6.75)
<b>Ann<sub>(0)</sub></b>	0.0061	(1.47)	0.0141**	(2.53)	-0.0203***	(-2.61)
Fu_Ret	-0.1382	(-0.61)	0.0156	(0.05)	0.1220	(0.34)
Spot_Ret	0.0000	(0.11)	-0.0021***	(-5.06)	0.0020***	(4.28)
Vkospi	-0.1903***	(-11.25)	-0.0536**	(-2.52)	0.2461***	(9.49)
Credit	0.0404***	(8.86)	0.0623***	(10.05)	-0.1027***	(-14.15)
Term	-0.0197***	(-13.63)	0.0772***	(39.92)	-0.0572***	(-25.42)
Exch	0.0002***	(16.57)	0.0004***	(21.62)	-0.0006***	(-26.94)
Rf	1.0723***	(10.62)	2.8658***	(21.30)	-3.9252***	(-24.92)
Adj. R <sup>2</sup>	0.0611		0.4172		0.3243	

**Table V.** Post-announcement impacts of investor attention on market liquidity

*Notes.* This table reports the difference-in-differences regressions results examining the impacts of the attention from domestic individual (Panel A), domestic institutional (Panel B), and foreign institutional investors (Panel C) on market liquidity dynamics after macroeconomic announcements. The columns labeled *Bid-ask spread*, *Market depth*, and *Time btw trades* show the results using the bid-ask spread, logarithm of the market depth, and duration between trades, respectively, as dependent variables. *Intercept* is the intercept term. *Ind*, *Ins*, and *For* denote the investor attention proxies for domestic individual, domestic institutional, and foreign institutional investors, respectively.  $Ann_{(0)}$  indicates the dummy variable that equals one when a macroeconomic report is released.  $Ann_{(+i)}$  denotes the dummy variable that equals one if it is  $i$  minute after an announcement.  $Ind \times Ann_{(i)}$ ,  $Ins \times Ann_{(i)}$ , and  $For \times Ann_{(i)}$  denote the corresponding interaction terms. The control variables include lagged futures return, daily spot index return, daily VKOSPI return, daily credit spread, daily term spread, USD/KRW exchange rate, and daily risk-free rate. *Coef.* and *t-stat.* denote the fitted coefficients and the corresponding  $t$ -statistics, respectively. Heteroskedasticity-consistent standard errors are considered. *Adj. R<sup>2</sup>* denotes the adjusted  $R$ -squared value. \*\*\*, \*\*, and \* indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Post-announcement impact of domestic individual investor attention

	Bid-ask spread		Market depth		Time btw trades	
	Coef.	$t$ -stat	Coef.	$t$ -stat	Coef.	$t$ -stat
<b>Ind</b> $\times$ <b>Ann</b> <sub>(0)</sub>	-0.0005**	(-2.45)	0.0005	(0.19)	0.0528	(0.83)
<b>Ind</b> $\times$ <b>Ann</b> <sub>(+15)</sub>	-0.0004***	(-2.79)	-0.0058**	(-2.17)	-0.1093***	(-3.88)
<b>Ind</b> $\times$ <b>Ann</b> <sub>(+30)</sub>	-0.0003	(-1.55)	-0.0065**	(-2.23)	-0.0890***	(-3.62)
<b>Ind</b> $\times$ <b>Ann</b> <sub>(+45)</sub>	-0.0003	(-1.48)	-0.0064**	(-2.14)	-0.0868***	(-3.20)
<b>Ann</b> <sub>(0)</sub>	0.0003	(1.37)	0.0003	(0.09)	0.2295**	(2.38)
<b>Ann</b> <sub>(+15)</sub>	0.0003**	(2.11)	-0.0014	(-0.46)	0.0017	(0.17)
<b>Ann</b> <sub>(+30)</sub>	0.0002*	(1.91)	-0.0013	(-0.43)	0.0059	(0.59)
<b>Ann</b> <sub>(+45)</sub>	0.0004***	(3.59)	-0.0020	(-0.66)	-0.0267**	(-2.42)
Adj. R <sup>2</sup>	0.1813		0.6154		0.2581	

Panel B: Post-announcement impact of domestic institutional investor attention

	Bid-ask spread		Market depth		Time btw trades	
	Coef.	$t$ -stat	Coef.	$t$ -stat	Coef.	$t$ -stat
<b>Ins</b> $\times$ <b>Ann</b> <sub>(0)</sub>	-0.0006***	(-2.65)	0.0069***	(2.68)	-0.0018	(-0.02)
<b>Ins</b> $\times$ <b>Ann</b> <sub>(+15)</sub>	-0.0006***	(-3.29)	0.0053**	(1.98)	-0.1127***	(-3.80)
<b>Ins</b> $\times$ <b>Ann</b> <sub>(+30)</sub>	-0.0009***	(-4.97)	0.0050*	(1.82)	-0.0951***	(-4.12)
<b>Ins</b> $\times$ <b>Ann</b> <sub>(+45)</sub>	-0.0006***	(-3.76)	0.0056**	(2.05)	-0.1035***	(-3.77)
<b>Ann</b> <sub>(0)</sub>	0.0003*	(1.71)	-0.0006	(-0.21)	0.2331**	(2.37)
<b>Ann</b> <sub>(+15)</sub>	0.0004***	(2.99)	0.0003	(0.12)	0.0341**	(2.23)
<b>Ann</b> <sub>(+30)</sub>	0.0002*	(1.81)	0.0011	(0.38)	0.0150	(1.39)
<b>Ann</b> <sub>(+45)</sub>	0.0003***	(3.57)	0.0014	(0.49)	-0.0173	(-1.58)
Adj. R <sup>2</sup>	0.1840		0.6154		0.2580	

Panel C: Post-announcement impact of foreign institutional investor attention

	Bid-ask spread		Market depth		Time btw trades	
	Coef.	$t$ -stat	Coef.	$t$ -stat	Coef.	$t$ -stat
<b>For</b> $\times$ <b>Ann</b> <sub>(0)</sub>	0.0007***	(3.29)	-0.0051**	(-2.29)	-0.0241	(-0.31)
<b>For</b> $\times$ <b>Ann</b> <sub>(+15)</sub>	0.0007***	(4.11)	-0.0008	(-0.31)	0.1472***	(4.72)

<b>For×Ann(+30)</b>	0.0008 <sup>***</sup>	(4.67)	-0.0004	(-0.13)	0.1178 <sup>***</sup>	(4.66)
<b>For×Ann(+45)</b>	0.0006 <sup>***</sup>	(3.09)	-0.0010	(-0.39)	0.1230 <sup>***</sup>	(4.16)
Ann <sub>(0)</sub>	0.0003 <sup>*</sup>	(1.81)	-0.0005	(-0.16)	0.2294 <sup>**</sup>	(2.33)
Ann(+15)	0.0003 <sup>**</sup>	(2.33)	0.0004	(0.15)	0.0104	(1.03)
Ann(+30)	0.0001	(1.01)	0.0005	(0.15)	-0.0024	(-0.30)
Ann(+45)	0.0002 <sup>***</sup>	(2.65)	0.0006	(0.20)	-0.0411 <sup>***</sup>	(-4.56)
Adj. R <sup>2</sup>	0.1848		0.6152		0.2587	

**Table VI.** Pre-announcement impacts of investor attention on market liquidity

*Notes.* This table reports the difference-in-differences regressions results examining the impacts of the attention from domestic individual (Panel A), domestic institutional (Panel B), and foreign institutional investors (Panel C) on market liquidity dynamics before macroeconomic announcements. The columns labeled *Bid-ask spread*, *Market depth*, and *Time btw trades* show the results using the bid-ask spread, logarithm of the market depth, and duration between trades, respectively, as dependent variables. *Ind*, *Ins*, and *For* denote the investor attention proxies for domestic individual, domestic institutional, and foreign institutional investors, respectively.  $Ann_{(0)}$  indicates the dummy variable that equals one when a macroeconomic index is announced.  $Ann_{(-i)}$  denotes the dummy variable that equals one if it is  $i$  minutes before an announcement.  $Ind \times Ann_{(i)}$ ,  $Ins \times Ann_{(i)}$ , and  $For \times Ann_{(i)}$  denote the corresponding interaction terms. The control variables include lagged futures return, daily spot index return, daily VKOSPI return, daily credit spread, daily term spread, USD/KRW exchange rate, and daily risk-free rate. *Coef.* and *t-stat.* denote the fitted coefficients and the corresponding  $t$ -statistics, respectively. Heteroskedasticity-consistent standard errors are considered. *Adj. R<sup>2</sup>* denotes the adjusted  $R$ -squared value. \*\*\*, \*\*, and \* indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Pre-announcement impact of attention from domestic individual investors

	Bid-ask spread		Market depth		Time btw trades	
	Coef.	$t$ -stat	Coef.	$t$ -stat	Coef.	$t$ -stat
<b>Ind<math>\times</math>Ann<sub>(-15)</sub></b>	-0.0008**	(-2.19)	-0.0063	(-1.30)	-0.2554***	(-5.41)
<b>Ind<math>\times</math>Ann<sub>(0)</sub></b>	-0.0005**	(-2.45)	0.0005	(0.19)	0.0529	(0.83)
Ann <sub>(-15)</sub>	0.0004	(1.48)	-0.0128**	(-2.08)	-0.0729***	(-2.81)
Ann <sub>(0)</sub>	0.0003	(1.37)	0.0002	(0.09)	0.2295**	(2.38)
Adj. R <sup>2</sup>	0.1809		0.6153		0.2582	

Panel B: Pre-announcement impact of attention from domestic institutional investors

	Bid-ask spread		Market depth		Time btw trades	
	Coef.	$t$ -stat	Coef.	$t$ -stat	Coef.	$t$ -stat
<b>Ins<math>\times</math>Ann<sub>(-15)</sub></b>	-0.0009***	(-3.41)	-0.0041	(-0.99)	-0.1975***	(-4.69)
<b>Ins<math>\times</math>Ann<sub>(0)</sub></b>	-0.0006***	(-2.63)	0.0068***	(2.66)	-0.0011	(-0.01)
Ann <sub>(-15)</sub>	0.0007***	(3.68)	-0.0097*	(-1.95)	0.0415	(1.40)
Ann <sub>(0)</sub>	0.0003*	(1.70)	-0.0006	(-0.21)	0.2331**	(2.37)
Adj. R <sup>2</sup>	0.1815		0.6154		0.2579	

Panel C: Pre-announcement impact of attention from foreign institutional investors

	Bid-ask spread		Market depth		Time btw trades	
	Coef.	$t$ -stat	Coef.	$t$ -stat	Coef.	$t$ -stat
<b>For<math>\times</math>Ann<sub>(-15)</sub></b>	0.0008***	(3.28)	0.0050	(1.45)	0.2207***	(5.72)
<b>For<math>\times</math>Ann<sub>(0)</sub></b>	0.0007***	(3.27)	-0.0051**	(-2.29)	-0.0245	(-0.32)
Ann <sub>(-15)</sub>	0.0004**	(2.17)	-0.0117**	(-2.11)	-0.0410*	(-1.94)
Ann <sub>(0)</sub>	0.0003*	(1.81)	-0.0005	(-0.16)	0.2293**	(2.33)
Adj. R <sup>2</sup>	0.1820		0.6154		0.2582	

**Table VII.** Pre-announcement informed trading patterns by investor type

*Notes.* This table reports changes in informed trading by each investor type before macroeconomic announcements, using the spot index return as the dependent variable. The columns labeled *Individual*, *Institutional*, and *Foreign* show the regression results for the order imbalances of domestic individual, domestic institutional, and foreign institutional investors, respectively. The columns labeled *All* show the regression results using a unified framework.  $Ind^{OI}$ ,  $Ins^{OI}$ , and  $For^{OI}$  denote the lagged order imbalances for domestic individual, domestic institutional, and foreign institutional investors, respectively. *Ann* indicates the dummy variable that equals one when a macroeconomic report is released.  $Ind^{OI} \times Ann$ ,  $Ins^{OI} \times Ann$ , and  $For^{OI} \times Ann$  denote the corresponding interaction terms. The control variables include lagged spot return, daily VKOSPI return, daily credit spread, daily term spread, USD/KRW exchange rate, and daily risk-free rate. The columns labeled *Coef.* and *t-stat.* show the fitted coefficients and the corresponding *t*-statistics, respectively. Heteroskedasticity-consistent standard errors are considered. *Adj. R*<sup>2</sup> denotes the adjusted *R*-squared value. \*\*\*, \*\*, and \* indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Individual		Institutional		Foreign		All	
	Coef.	<i>t</i> -stat	Coef.	<i>t</i> -stat	Coef.	<i>t</i> -stat	Coef.	<i>t</i> -stat
<b>Ind<sup>OI</sup></b>	0.0904***	(6.12)					0.0646***	(4.69)
<b>Ind<sup>OI</sup>×Ann</b>	-0.0516	(-0.40)					0.0909	(0.53)
<b>Ins<sup>OI</sup></b>			0.0941***	(6.90)			0.0503***	(4.47)
<b>Ins<sup>OI</sup>×Ann</b>			-0.2671**	(-2.13)			-0.3281*	(-1.91)
<b>For<sup>OI</sup></b>					0.1611***	(6.46)	0.1246***	(5.41)
<b>For<sup>OI</sup>×Ann</b>					-0.3238	(-0.60)	-0.5447	(-0.86)
<b>Adj. R<sup>2</sup></b>	0.0037		0.0031		0.0022		0.0057	

**Table VIII.** Impacts of six types of macroeconomic announcements on the bid-ask spread

*Notes.* This table reports the regression results examining market liquidity dynamics around the announcements of each macroeconomic index, using the bid-ask spread as the dependent variable. *GDP*, *IAIP*, *UR*, *BoT*, *BR*, and *CPI* indicate the gross domestic product growth rate, index of all industry production growth rate, unemployment rate, balance of trade, base rate, consumer price index growth rate, respectively.  $Ann_{(0)}$  indicates the dummy variable that equals one when a macroeconomic index is announced.  $Ann_{(-i)}$  ( $Ann_{(+i)}$ ) denotes the dummy variable that equals one if it is  $i$  minute before (after) an announcement. The control variables include lagged futures return, daily spot index return, daily VKOSPI return, daily credit spread, daily term spread, USD/KRW exchange rate, and daily risk-free rate. Figures in parentheses denote  $t$ -statistics. Heteroskedasticity-consistent standard errors are considered. *Adj. R*<sup>2</sup> denotes the adjusted  $R$ -squared value. \*\*\* and \* indicate statistical significance at the 1% and 10% levels, respectively.

	GDP	IAIP	UR	BoT	BR	CPI
<b>Ann(-15)</b>		0.0003 (0.84)	0.0004*** (3.90)	-0.0002 (-1.02)	0.0014*** (3.52)	0.0008*** (4.11)
<b>Ann(0)</b>	0.0011*** (3.81)	0.0020*** (3.46)	0.0015*** (4.55)	-0.0005*** (-3.96)	0.0016*** (4.36)	0.0017*** (5.60)
<b>Ann(15)</b>	0.0001 (0.51)	0.0002* (1.67)	0.0004 (1.37)	-0.0001 (-0.45)	0.0015*** (4.00)	0.0005* (1.94)
<b>Ann(30)</b>	0.0001 (0.27)	0.0001 (0.93)	0.0001 (0.54)	-0.0001 (-0.36)	0.0016*** (3.75)	0.0001 (0.59)
<b>Ann(45)</b>	-0.0002 (-1.21)	0.0000 (0.28)	0.0000 (0.22)	-0.0003 (-1.57)	0.0015*** (3.41)	0.0003 (1.43)
<b>Adj. R<sup>2</sup></b>	0.1586	0.1580	0.1618	0.1572	0.1423	0.1601

**Table IX.** Impacts of investor attention on the bid-ask spread around each macroeconomic announcement

*Notes.* This table reports the regression results examining the impacts of the attention from domestic individual (Panel A), domestic institutional (Panel B), and foreign institutional investors (Panel C) on market liquidity dynamics, proxied by the bid-ask spread. *GDP*, *IAIP*, *UR*, *BoT*, *BR*, and *CPI* indicate the gross domestic product growth rate, index of all industry production growth rate, unemployment rate, balance of trade, base rate, consumer price index growth rate, respectively. *Ind*, *Ins*, and *For* denote the investor attention proxies for domestic individual, domestic institutional, and foreign institutional investors, respectively.  $Ann_{(0)}$  indicates the dummy variable that equals one when each macroeconomic index is announced.  $Ann_{(-i)}$  ( $Ann_{(+i)}$ ) denotes the dummy variable that equals one if it is  $i$  minutes before (after) an announcement.  $Ind \times Ann_{(i)}$ ,  $Ins \times Ann_{(i)}$ , and  $For \times Ann_{(i)}$  denote the corresponding interaction terms. The control variables include lagged futures return, daily spot index return, daily VKOSPI return, daily credit spread, daily term spread, USD/KRW exchange rate, and daily risk-free rate. Figures in parentheses denote  $t$ -statistics. Heteroskedasticity-consistent standard errors are considered. *Adj. R*<sup>2</sup> denotes the adjusted  $R$ -squared value. \*\*\*, \*\*, and \* indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Role of domestic individual investors' attention

	GDP	IAIP	UR	BoT	BR	CPI
<b>Ind</b> $\times$ <b>Ann</b> <sub>(-15)</sub>		0.0010*** (3.63)	-0.0007 (-1.57)	0.0003 (1.42)	-0.0009** (-2.21)	-0.0001 (-0.48)
<b>Ind</b> $\times$ <b>Ann</b> <sub>(0)</sub>	-0.0004 (-1.23)	0.0002 (0.23)	0.0009*** (3.95)	0.0000 (0.10)	-0.0006* (-1.80)	0.0007 (1.28)
<b>Ind</b> $\times$ <b>Ann</b> <sub>(+15)</sub>	0.0001 (0.58)	0.0003 (1.07)	0.0004* (1.96)	0.0000 (-0.31)	-0.0007** (-2.07)	-0.0005 (-0.71)
<b>Ind</b> $\times$ <b>Ann</b> <sub>(+30)</sub>	-0.0001 (-0.36)	0.0002 (1.22)	0.0006*** (3.29)	-0.0001 (-0.36)	-0.0006 (-1.35)	0.0005* (1.70)
<b>Ind</b> $\times$ <b>Ann</b> <sub>(+45)</sub>	-0.0002 (-1.27)	0.0001 (0.40)	0.0001 (0.53)	-0.0001 (-0.42)	-0.0008** (-2.56)	0.0001 (0.60)
Adj. R <sup>2</sup>	0.1584	0.1578	0.1620	0.1569	0.1441	0.1602

Panel B: Role of domestic institutional investors' attention

	GDP	IAIP	UR	BoT	BR	CPI
<b>Ins</b> $\times$ <b>Ann</b> <sub>(-15)</sub>		0.0004 (0.88)	0.0003*** (2.99)	-0.0002 (-1.06)	-0.0009*** (-2.64)	-0.0010*** (-20.75)
<b>Ins</b> $\times$ <b>Ann</b> <sub>(0)</sub>	-0.0005* (-1.66)	0.0005 (0.41)	-0.0004 (-1.19)	0.0000 (0.10)	-0.0010*** (-3.25)	-0.0007 (-1.47)
<b>Ins</b> $\times$ <b>Ann</b> <sub>(+15)</sub>	-0.0005* (-1.82)	-0.0005*** (-2.77)	-0.0004* (-1.74)	-0.0003 (-1.00)	-0.0006** (-2.18)	0.0002 (0.38)
<b>Ins</b> $\times$ <b>Ann</b> <sub>(+30)</sub>	0.0000 (-0.19)	-0.0005*** (-3.00)	-0.0002 (-1.34)	-0.0006 (-1.10)	-0.0014*** (-4.06)	-0.0004*** (-2.89)
<b>Ins</b> $\times$ <b>Ann</b> <sub>(+45)</sub>	-0.0001 (-0.62)	-0.0006*** (-2.96)	-0.0001 (-0.47)	-0.0004 (-1.01)	-0.0010*** (-3.64)	-0.0002 (-1.28)
Adj. R <sup>2</sup>	0.1585	0.1582	0.1616	0.1571	0.1457	0.1602

Panel C: Role of foreign institutional investors' attention

	GDP	IAIP	UR	BoT	BR	CPI
<b>For</b> $\times$ <b>Ann</b> <sub>(-15)</sub>		-0.0010***	-0.0004***	0.0001	0.0008***	0.0003*

		(-3.36)	(-3.36)	(0.20)	(2.69)	(1.88)
<b>For×Ann<sub>(0)</sub></b>	0.0009** (2.29)	-0.0007 (-0.59)	-0.0001 (-0.37)	0.0000 (-0.13)	0.0009*** (3.18)	0.0004 (1.09)
<b>For×Ann<sub>(+15)</sub></b>	0.0004 (1.58)	0.0003* (1.75)	0.0001 (0.41)	0.0005 (1.09)	0.0006** (2.39)	0.0001 (0.18)
<b>For×Ann<sub>(+30)</sub></b>	0.0001 (0.33)	0.0004** (2.35)	-0.0001 (-0.79)	0.0008* (1.87)	0.0010*** (3.75)	0.0003 (1.41)
<b>For×Ann<sub>(+45)</sub></b>	0.0002 (1.21)	0.0005*** (2.86)	0.0000 (0.12)	0.0003 (0.86)	0.0008*** (3.67)	0.0001 (0.95)
Adj. R <sup>2</sup>	0.1585	0.1581	0.1615	0.1571	0.1459	0.1600