Information uncertainty, market sentiment, and analyst reports

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Highlight

•Sentiment and information uncertainty affect the stock market response to analyst recommendation changes.

•Sentiment explains the stock market reactions to analyst recommendation changes under only high information uncertainty.

•Analyst recommendations become less informative if information uncertainty is low.

Abstract

This study examines the effects of investor sentiment and information uncertainty on the stock market response to analyst recommendation changes within a unified framework. Recent progress in the field of behavioral finance suggests that sentiment affects the classical relationship between analyst recommendations and stock return dynamics. Our novel findings suggest that the degree of information uncertainty should be considered when investigating the effect of sentiment. Although investor sentiment significantly explains the observed stock market reactions to analyst recommendation changes under high information uncertainty, it loses its explanatory power under low information uncertainty. Furthermore, analyst recommendations convey significant trading indications if information uncertainty is high, but they are less informative if information uncertainty is low.

KEYWORDS: Analyst recommendation; Firm size; Information uncertainty; Investor sentiment; Market competition; Stock return

JEL CLASSIFICATION: G10; G14; G41

1. Introduction

Some studies argue that analyst recommendations and reports mainly convey public information and do not provide genuinely new information to financial markets (Altinkiliç and Hansen, 2009; Marhfor, M'Zali, Cosset, and Charest, 2013). However, analyst reports are widely believed to cover a wide range of information and content at the individual firm, industry, and market levels, and analyst recommendation changes reflect market experts' opinions and refined advice based on market research. Most studies find that analyst recommendation changes affect stock market returns by providing useful information to market participants (Green, 2006; Howe, Unlu, and Yan, 2009; Huang, Zang, and Zheng, 2014; Kecskés, Michaely, and Womack, 2016; Womack, 1996). According to Asquith, Mikhail, and Au (2005), although analysts' research reports are based on public information, their research highlights the new trading implications of this public information. As a result, analyst recommendation changes significantly affect stock market dynamics. Naturally, the quality of analysts' reports and the effects of their recommendation changes may differ depending on their experience levels, skills, and knowledge (Bradley, Gokkaya, and Liu, 2017; Fang and Yasuda, 2014; Sorescu and Subrahmanyam, 2006). Furthermore, analysts' incentives to provide high-quality information also vary across market conditions and industrial environments (Green, Jame, Markov, and Subasi, 2014). However, their recommendations share a common feature in that they mitigate information asymmetry among market participants by providing useful information on individual companies and suggesting trading indications to the general public (Barber, Lehavy, and Trueman, 2010; Frankel and Li, 2004; Ivković and Jegadeesh, 2004).

Previous studies focus on investors' underreactions as a reason that the stock market reacts to analyst recommendation changes. Some studies claim that informed investors receive early recommendation changes from analysts and then underreact when the analyst reports are made public (Chen and Zhao, 2012; Christophe, Ferri, and Hsieh, 2010). Lin and Lu (2015) show that analysts provide upcoming recommendation changes or earnings forecasts to informed investors, and, thus, informed trading could predict and affect post-event returns. Other studies claim that uninformed investors are overconfident about their investing abilities and also underreact when analyst reports are released (Daniel, Hirshleifer, and Subrahmanyam, 2001; Zhang, 2006). Using individual firms' turnover ratios to reflect investors' levels of attention to corresponding firms, Loh (2010) finds that analyst recommendation changes more significantly affect stocks with greater investor attention and higher sentiment. Hribar and McInnis (2012) find that analysts tend to release positive recommendations for stocks with high investor sentiment. Kim, Ryu, and Yang (2019) argue that the stock market reacts more significantly to analyst recommendation changes when the change is a downgrade than when it is an upgrade. They attribute this asymmetry to investor sentiment, implying that analyst reports and coverage form the expectations and behaviors of uninformed or noisy investors in financial markets.

Recent behavioral finance studies are innovative in that they emphasize the role of investor sentiment, focusing on investor demand, in the relationship between analyst recommendation changes and stock price movements. In this study, we go a step further in investigating this relationship by considering both the demand and supply sides. Drawing on the economics and industrial organization literature, we note that market competition (or market concentration) determines the market environment and the degree of information uncertainty in each industry. Higher market competition (i.e., lower market concentration) indicates higher information uncertainty regarding firm values and lower barriers to entry, whereas lower market competition (i.e., higher market concentration) indicates lower information uncertainty and higher barriers to entry (Armstrong, Core, Taylor, and Verrecchia, 2011; Hou and Robinson, 2006; McAfee, Mialon, and Williams, 2004). The lower barriers to entry when market competition is higher induce more peer firms to enter the market, and these individual firms tend to be small and capture only tiny market shares. When providing information to market participants, analysts have different incentives depending on certain aspects of the industry environment, such as the size of firms, the number of firms, and the degree of information uncertainty. Hope and Zhao (2018) find that a firm's stock return responds significantly not only to analyst recommendation changes for that firm but also to changes for peer firms in the same industry. Thus, when market competition is high and the number of peer firms is greater, stock price movements are more likely to be affected by analyst recommendation changes. Moreover, the high market competition also means that analyst forecasts tend to be more dispersed because of the higher degree of information uncertainty (Datta, Iskandar-Datta, and Singh, 2013; Haw, Hu, and Lee, 2015), suggesting that the relationships among market competition, analyst recommendation changes, and stock market returns are still open empirical questions. Furthermore, whereas informed investors underreact irrespective of information uncertainty (Chen and Zhao, 2012), uninformed investors' underreactions vary depending on the degree of information uncertainty because these uninformed investors become more overconfident about their abilities as the uncertainty increases (Daniel, Hirshleifer, and Subrahmanyam, 2001; Zhang, 2006). Accordingly, if we use investor sentiment, which is mostly a product of uninformed investors' behavior, to explain this mechanism, the causality and dynamics become more complicated.

This study is motivated by the limitations of previous studies, which individually and independently analyze only two or three of the factors of information uncertainty, analyst recommendation changes, investor sentiment, and stock returns. We examine all four factors in a unified framework to account for their intermingled dynamics. Specifically, by considering the theoretical and empirical relationship among the research variables, we investigate whether the role of investor sentiment can vary depending on the degree of information uncertainty. Our study also answers the question of whether the stock market reaction to firm-specific news is due to information uncertainty or investor irrationality.

We use the Hirschman-Herfindahl index (HHI) and firm size as proxies for information uncertainty to examine the different relationships among stock returns, analyst recommendation changes, and investor sentiment across different levels of information uncertainty. We analyze a relatively long period of time by using a dataset from the Korean market that spans the sample period from 2010 to 2018. The Korean market dataset provides a stable and refined research environment for us to study this topic for several reasons. First, this market is characterized by vast differences in information asymmetry levels across firms (Chung, Cho, Ryu, and Ryu, 2019; Jung, Chae, Yang, and Moon, 2006). In other words, gathering information about some firms (e.g., small, new, and young firms) is very difficult for investors; whereas, gathering information about other firms (e.g., large, established, and major firms) is relatively easy. Because analysts' recommendations and reports mitigate information asymmetry among market participants (Asquith, Mikhail, and Au, 2005; Frankel and Li, 2004; Ivković and Jegadeesh, 2004), the effects of analyst reports and the roles of analysts can be demonstrated more clearly in the Korean market (Kim, Yang, and Ryu, 2020). While many previous studies focus on developed markets, this topic is rather unexplored in emerging markets. Considering the influence of the Korean market and its interactions with developed markets, investigating the Korean stock market can contribute to the literature, as it still lacks insights regarding the role of analyst reports in emerging markets. Second, the Korean market is a representative and leading emerging market (Chun, Cho, and Ryu, 2020). It is one of the most well-organized markets in the world with effective financial policies and sound regulations, which led to its marked economic growth over past decades (Liu and Hsu, 2006; Ryu, Webb, and Yu, 2020; Yu and Ryu, *forthcoming*).[1] Third, the Korean stock market is characterized by the active participation of individual traders (Chung, Kang, and Ryu, 2017; Chung and Wang, 2016; Kim, Park, and Park, 2017). Although the proportion of shares owned by domestic individual investors is smaller than that owned by foreign institutional investors, the trading volume of individual investors in the Korean market is enormous (Kim and Ryu, *forthcoming*). Specifically, their trading volume is about four-fifths of the total trading volume of the Korea Composite Stock Price Index (KOSPI) market. Because individual investors are perceived as uninformed investors who are more driven by sentiment relative to institutional investors (Ahn, Kang, and Ryu, 2008; Ryu, 2013, 2015; Ryu and Yang, 2018, 2020; Yang, Kutan, and Ryu, 2019), their decision-making processes are highly likely to depend on analyst recommendations. The Korean stock market, which features the active participation of individual investors, is well-suited for studying the effects of investor sentiment

[1] The Korean market is one of the largest and most well-organized economies worldwide even though it is still considered an emerging market. Specifically, in 2019, its GDP was about USD 1.690 trillion, which ranked 14th in the world, and its trade volume was about USD 1.046 trillion, including total exports (imports) of USD 541.85 billion (504.17 billion), according to the World Bank. The volume of trade between Korea and the United States is about USD 134.63 billion, and that between Korea and Eurozone countries is about USD 80.90 billion. Furthermore, foreign investors in the Korean market own about one-third of the total market share, indicating Korea's higher dependency on and greater interaction with developed markets. For the details, refer to the following document. *OECD Economic Surveys: Korea* (http://www.oecd.org/economy/korea-economic-snapshot).

and the roles of analysts.

We analyze a high-quality dataset that contains the detailed information necessary to investigate this research topic, and we derive the following results. First, we investigate whether the stock market response to analyst recommendation changes differs significantly depending on the degree of information uncertainty. We find that the reaction of the stock market is more sensitive to analyst recommendation changes when the HHI index is lower and firm size is smaller, implying that the market reaction becomes more sensitive to these changes when information uncertainty is high. In other words, the effect of analyst reports on the stock market increases as the quality of investors' information about firm value worsens. Next, we explore whether the effect of sentiment on the stock market reaction also varies with the degree of information uncertainty. We discover that the sentiment effect on the reaction of the stock market is more significant when the HHI index is lower and firm size is smaller, implying that a lack of information on individual stocks leads investors to become more irrational. Additionally, this result provides evidence that information uncertainty may be more important than investor sentiment in explaining stock market reactions. In sum, although previous studies claim that considering investor sentiment is essential when investigating the market reaction to analyst recommendation changes (Hribar and McInnis, 2012; Loh, 2010; Walther and Willis, 2013), we find that information uncertainty can explain the relationship between analyst reports and financial market dynamics more significantly than investor sentiment can.

The remainder of this paper proceeds as follows. Section 2 explains our hypotheses. We describe our sample data and methodology in section 3. Section 4 provides our empirical findings and robustness checks. Section 5 presents the conclusion.

2. Related Literature and Research Hypotheses

Our study aims to examine whether investor sentiment or information uncertainty has a more dominant influence on the stock market response to public announcements, represented by analyst recommendation changes. Before we consider the relationship between investor sentiment and information uncertainty further, we hypothesize that the stock market's reaction to analyst recommendation changes can differ according to the degree of information uncertainty. Analyst coverage and reports, which generate representative public information, can mitigate information asymmetry among market participants and can yield meaningful trading indications, even for stocks with higher information uncertainty (Armstrong, Core, Taylor, and Verrecchia, 2009; Asquith, Mikhail, and Au, 2005; Frankel and Li, 2004). Berkman and Yang (2019) find that country-level analyst recommendations predict international stock market reactions, implying that analyst recommendations are seen as useful in international markets. Keskek, Tse, and Tucker (2014) find that early public analyst reports contain high-quality information because analysts who provide earlier forecasts are likely to have either private information or stronger analytical abilities. Lin and Lu (2015) find that analysts give tips regarding their upcoming recommendations to informed traders, implying that analyst reports contain private information to an extent. Based on the empirical studies that consistently claim that analyst reports contain meaningful information, such as market-wide, firm-level, or private information (Bradley, Gokkaya, and Liu, 2017; Kadan, Michaely, and Moulton, 2018; Markov, Muslu, and Subasi, 2017; Thaker and Mohamad, 2019), we assume that analyst reports significantly affect stock market dynamics and focus on the relationship between analyst recommendation changes and information uncertainty. Specifically, we anticipate that the stock returns of firms with higher (lower) information uncertainty react more (less) sensitively to analyst recommendation changes.

Zhang (2006) defines information uncertainty as a lack of information about firm value. In the case of a firm, higher information uncertainty indicates more ambiguity around firm value owing to greater volatility in the firm's fundamental value or poorer information about the firm. The effect of analyst reports on the stock market may be greater under high information uncertainty than under low information uncertainty because the cost of gathering information on such stocks is very high for general investors in the market. Chen, Jung, and Ronen (2017) discover the relationship between analyst reports and information uncertainty and provide the interpretation that information uncertainty about a stock's value is reduced when analysts reiterate their recommendations because investors use these reiterations to confirm the information in the stock market. Based on these findings, we conjecture that the stock returns of firms with higher information uncertainty are more sensitive to public announcements or market-wide information, such as analyst recommendations, than those of firms with lower information uncertainty are because investors lack information on firms with higher information uncertainty. Given the documented roles of analyst reports and recommendations in terms of providing information, we can hypothesize that stock returns react more sensitively to public information when information uncertainty is higher and information on firm-specific events (e.g., earnings news, dividend announcements, and ownership changes) is more difficult to obtain.

H1: The stock returns of firms with higher (lower) information uncertainty react more (less) sensitively to analyst recommendation changes.

Next, we consider the possible association between investor sentiment and information uncertainty. Previous behavioral finance studies consistently report that uninformed or noisy investors are overconfident in their investing skills, information processing abilities, and trading knowledge. Specifically, they are likely to overreact to their own (incomplete) information but underreact to public information, including analyst reports (Black, 1986; Daniel, Hirshleifer, and Subrahmanyam, 2001). Their under- and overreactions induce mispricing in stock markets and create investor sentiment (Brown and Cliff, 2005; Kim, Ryu, and Seo, 2014). Thus, recent behavioral finance studies propose various methodologies to capture investor sentiment in financial markets and focus on the relations between investor sentiment and stock market dynamics, public announcements, investor participation, and trading behavior (Baker and Wurgler, 2006; Kumar, Page, and Spalt, 2013; Lee and Ryu, 2019; McLean and Zhao, 2014; Ruan, Wang, Zhou, and Lv, 2019; Stambaugh, Yu, and Yuan, 2012; Yang, Ahn, Kim, and Ryu, 2017). Chen and Lien (2017) use macroeconomic news as a proxy for public information and find that expected stock returns are more significantly related to public signals when sentiment is high, that is, higher (lower) returns follow good (bad) news. Mian and Sankaraguruswamy (2012) find that an individual firm's stock price responds sensitively to earnings news for that firm and claim that investor sentiment is essential to explaining the relationship between stock prices and firm-level information. Additionally, Bouteska (2019) shows that investor sentiment significantly affects the market reaction when bad news is released, implying that sentiment causes asymmetric market reactions to analyst recommendation changes. This finding is consistent with Tang and Yao's (2019) finding that investors rely more on analyst reports when sentiment is higher. These previous studies collectively indicate that stock returns' reactions to public news are significantly affected by investor sentiment, suggesting that both sentiment and information uncertainty must be considered when analyzing the stock market response to analyst recommendation changes.

Furthermore, investors tend to be more overconfident, and their sentiment may be higher when information about firm value is imperfect (Jiang, Lee, and Zhang, 2005; Loh, 2010; Zhang, 2006; Zhu and Niu, 2016). Brown, Christensen, Elliott, and Mergenthaler (2011) observe that pro forma earnings per share are greater under high investor sentiment than under low investor sentiment, implying that managers disclose adjusted (pro forma) financial statements, such as statements that exclude expenses or emphasize earnings figures, under high investor sentiment. In other words, financial statements, which are a type of information about firm value, are more likely to be manipulated under high investor sentiment, suggesting that investor sentiment is related to information uncertainty. Based on this logic, we conjecture that sentiment affects stocks with higher information uncertainty and examine whether the effect of sentiment on the relationship between analyst recommendation changes and stock returns varies depending on the degree of information uncertainty, implying that a lack of information on stocks may lead to sentiment affecting stock returns.

Based on these arguments and referring to previous findings that investor sentiment significantly influences the reaction of the stock market to firm-specific news, we hypothesize that the stock market reaction to investor sentiment is greater when information uncertainty is higher. If the sentiment significantly affects stock returns only under high information uncertainty, then the effect of investor sentiment on stock returns is likely to be limited, implying that a lack of information about firms can lead investors to become irrational and behaviorally biased. In contrast, if investor sentiment significantly affects stock returns regardless of the level of information uncertainty, then we can conclude that the effect of investor sentiment is distinct from that of information uncertainty.

H2: The effect of investor sentiment on the market reaction to analyst recommendation changes is greater for the stocks of firms with higher information uncertainty.

Although some recent studies analyze the role of investor sentiment in the market's reaction to public information (Chen and Lien, 2017; Keshk and Wang, 2018; Seok, Cho, and Ryu, 2019a), to the best of our knowledge, our study is the first to use the concept of information uncertainty to explain the relationships among investor sentiment, stock market reactions, and public information. In this study, we incorporate the degree of market competition and firm size to analyze the effects of information uncertainty (Haw, Hu, and Lee, 2015; Tookes, 2008; Zhang, 2006).

3. Sample Data and Methodology

3.1 Analyst recommendation changes

The samples on analyst recommendations for the Korean stock market are collected from DataGuide. Our sample period extends from January 2010 to December 2018.[2] We refine our dataset as follows. First, we classify the grades of analyst recommendations based on guidelines from the Financial Supervisory Service. The rating is given a score from Grade 1 to Grade 5, based on the level of the analyst's target returns. Here, Grade 1 denotes a "Sell" recommendation, Grade 2 denotes "Reduce/Underperform," Grade 3 denotes "Neutral/Hold/Market Perform," Grade 4 denotes "Buy/Outperform/Trading Buy/Overweight," and Grade 5 denotes "Strong Buy." "Strong Buy" is the strongest buy-side recommendation, and "Sell" is the strongest sell-side recommendation. Second, if an analyst releases multiple recommendations for the same company within 25 trading days, we include only his/her initial recommendation (i.e., his/her first recommendation during the 25 trading days) in the sample and exclude his/her other recommendations from the sample (Barber, Lehavy, McNichols, and Trueman, 2001; Lin and Lu, 2015).

Next, we use analyst recommendation changes rather than levels to eliminate upward bias from our sample (Moshirian, Ng, and Wu, 2009). Thus, we define analyst recommendations changes as follows. An analyst changing his/her recommendation to a stronger buy-side recommendation (e.g., from "Reduce" (Grade 2) at time t-1 to "Hold" (Grade 3) at time t) is classified as an upgrade, and an analyst changing his/her recommendation to a stronger sell-side recommendation (e.g., from "Buy" (Grade 4) at time t-1 to "Hold" (Grade 3) at time t) is classified as a downgrade. If an analyst's recommendation does not change, the event is classified as neutral. Finally, if multiple analysts change their recommendations for a company over a 25-trading-day period, we consider only the first recommendation change.

[2] The dataset of Korean analyst reports is inaccurate before 2010 owing to frequent mergers and acquisitions among the houses. Further, before 2010, only a handful of analysts cover the Korean market, and the dataset includes only a few observations.

Finally, we exclude recommendation changes that fall within three days of quarterly earnings announcement dates because earning announcements may affect analyst recommendations, investor sentiment, and stock returns (Ivkoviç and Jegadeesh, 2004; Mian and Sankaraguruswamy, 2012). Table 1 shows the distribution of analyst recommendation changes in our final sample, which contains 662 upgrades, 2,743 neutral events, and 779 downgrades.

[Table 1 Here]

3.2 Investor sentiment

By extending the firm-specific sentiment indices proposed by Yang and Zhou (2015, 2016), we construct the sentiment proxies that capture individual firm characteristics by processing daily price and transaction data for all manufacturing firms whose stocks are traded on the KOSPI equity market.[3] Our dataset runs from January 2010 to December 2018, the period when analyst coverage is well-defined in this market. In order to avoid ambiguity, stocks are excluded from the final sample if their trading is temporarily suspended or if they experience administrative issues.

We construct the firm-specific sentiment indicator by combining five sentiment proxies that are used in previous studies (for each stock *i* on trading day *t*). The first proxy is the relative strength index (*RSI*). We calculate the relative strength as the sum of positive stock returns divided by the sum of negative stock returns over the past 14-trading-day period as of day *t* (Chen, Chong, and Duan, 2010; Zhou and Yang, 2020). In this study, we employ *RSI*, which is an adjusted index for the relative strength that is designed to range from 0 to 100. In Equation (1), $P_{i,t-k}$ denotes the stock price of firm *i* on trading day *t-k*. $RS_{i,t}$ is the relative strength of firm *i* on trading day *t*. $RSI_{i,t}$ equals 100 when the denominator of $RS_{i,t}$ equals 0. If the *RSI* is greater (less) than 80 (20), investor sentiment is optimistic (pessimistic).

$$RSI_{i,t} = \frac{RS_{i,t}}{(1+RS_{i,t})} \cdot 100, \textit{ where } RS_{i,t} = \frac{\sum_{k=0}^{13} \max\,(P_{i,t-k}-P_{i,t-k-1},0)}{\sum_{k=0}^{13} \max\,(P_{i,t-k-1}-P_{i,t-k},0)}. \tag{1}$$

The second proxy is the psychological line index (*PLI*), which captures investors' psychological stability by measuring short-term price reversals. It reflects investors' psychological changes by counting how many of the past 12 trading days have price increases (Yang and Gao, 2014; Gao and Liu, 2020). $PLI_{i,t}$ equals 100 when its denominator equals 0. If *PLI* is greater (less) than 75 (25), we conclude that investor sentiment is optimistic (pessimistic).

[3] Similar proxies for sentiment are also used in other recent behavioral finance studies that focus on the Korean market (Ryu, Kim, and Yang, 2017; Seok, Cho, and Ryu, 2019a, 2019b; Yang, Ryu, and Ryu, 2017).

$$PLI_{i,t} = \left[\sum_{k=0}^{11}\left\{\frac{\max\left(P_{i,t-k}-P_{i,t-k-1},0\right)}{P_{i,t-k}-P_{i,t-k-1}}\right\}/12\right]\cdot 100. \tag{2}$$

The third proxy is the buy-sell imbalance (*BSI*) of individual investors, which captures the trading behavior of domestic individual investors (Kumar and Lee, 2006). These investors are perceived as uninformed and noisy because they tend to behave more irrationally and sentimentally than their institutional counterparts do. $BSI_{i,t}$ is the ratio of the net buying volume to the total trading volume of firm *i* on trading day *t*, as shown in Equation (3).

$$BSI_{i,\mathrm{t}} = \frac{BV_{i,t}-SV_{i,t}}{BV_{i,t}+SV_{i,t}}, \tag{3}$$

where $BV_{i,t}$ and $SV_{i,t}$ denote the buy and sell volumes of domestic individual investors, respectively, of firm *i* on trading day *t*. Here, a positive (negative) value of *BSI* for a particular stock indicates that investors are optimistic (pessimistic) about that stock.

The fourth proxy is the logarithm of the trading volume ($LVOL$). In Equation (4), $VOL_{i,t}$ is the trading volume of stock *i* on trading day *t*. A high trading volume normally indicates that investors trading the stock have high sentiment.

$$LVOL_{i.t} = ln(VOL_{i,t}). \tag{4}$$

Lastly, the adjusted turnover ratio (*ATR*) is adopted as a proxy for sentiment, considering that Baker and Stein (2004) reveal that investor sentiment is higher when the turnover ratio is greater. In Equation (5), $R_{i,t}$ denotes the stock returns and $\#\ of\ outstanding\ stocks_{i,t}$ denotes the number of outstanding shares, respectively, of stock *i* on trading day *t*. A positive (negative) value of *ATR* when stock returns are positive (negative) implies that the stock market is bullish (bearish).

$$ATR_{i,t} = \frac{VOL_{i,t}}{\#\ of\ outstanding\ stocks_{i,t}}\cdot\frac{R_{i,t}}{|R_{i,t}|}. \tag{5}$$

We obtain the first principal component of each proxy *j* for firm *i* ($F_{i,j}$) by implementing principal component analysis. Equation (6) shows that the common sentiment factor ($CS_{i,t}$) is the linear sum of the product of each proxy (*RSI*, *PLI*, *BSI*, $LVOL$, and *ATR*) and its corresponding $F_{i,j}$.[4] Because

[4] For robustness check, we also construct the firm-level sentiment index employing the partial least squares method instead of the principal component analysis method. We confirm that overall findings are consistent irrespective of the use of the sentiment index. We thank the anonymous referee for

$CS_{i,t}$ may include a common market factor, we perform the regression given by Equation (7) to extract only firm-level sentiment (Yang, Ryu, and Ryu, 2017; Yang and Zhou, 2016). Here, the excess market return (MKT_t) is defined as the difference between the KOSPI index return and the risk-free rate of return, which is proxied by the 91-day certificate of deposit rate. Firm-level investor sentiment is the residual ($Senti_{i,t}$) in Equation (7).[5]

$$CS_{i,t} = F_{i,RSI} \cdot RSI_{i,t} + F_{i,PLI} \cdot PLI_{i,t} + F_{i,BSI} \cdot BSI_{i,t} + F_{i,LVOL} \cdot LVOL_{i,t} + F_{i,ATR} \cdot ATR_{i,t}, \tag{6}$$

$$CS_{i,t} = \alpha_0 + \alpha_1 \cdot MKT_t + Senti_{i,t}. \tag{7}$$

Table 2 provides summary statistics for the proxies and sentiment indicators. The mean of *Senti* is zero because it is the residual term shown in Equation (7).

[Table 2 Here]

3.3 Information uncertainty

Each study defines information uncertainty slightly differently. Some studies try to measure information uncertainty using various firm-level variables, such as firm age, stock return volatility, and the number of analyst followings (Hou, 2007; Lu, Chen, and Liao, 2010; Zhang, 2006). In this study, we use the degree of market competition and firm size as the primary proxies for information uncertainty. Datt, Iskandar-Datt, and Singh (2013) argue that the firms in highly competitive markets generally have weaker pricing power and higher uncertainty regarding their values because their future cash flows are more challenging to predict. If an industry has low barriers to entry, then it includes many competitors and exhibits high market competition. In this case, firms have difficulty securing their market shares and settling cash flows (Ghosal and Loungani, 1996; Hou and Robinson, 2006; Ryu, Ryu, and Yang, 2020). Conversely, if an industry has high barriers to entry, the industry has few competitors and low

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commenting on this.

[5] To further control for the effects of macroeconomic variables, we also employ the options-implied volatility index (VKOSPI) as a control variable when constructing the sentiment indicator, as shown in the following equation: $CS_{i,t} = \alpha_0 + \alpha_1 \cdot MKT_t + \alpha_2 \cdot VKOSPI_t + Senti_{i,t}$. Here, $Senti_{i,t}$ is the error term of this equation, as in Equation (7). $VKOSPI_t$ denotes the first-differenced implied volatility series. The additional results considering the VKOSPI are consistent with the results of this study, and we do not report these additional results for brevity. For more details on the VKOSPI, which is the representative implied volatility index in the Korean market, refer to previous studies, including those of Park, Kutan, and Ryu (2019) and Song, Ryu, and Webb (2018). We appreciate an anonymous referee for providing this valuable suggestion.

market competition. Irvine and Pontiff (2009) also claim that the degree of market competition can measure information uncertainty because the volatility of a firm's fundamental value is higher when market competition is higher.

We employ the HHI, which directly captures the degree of market competition (Bustamante and Donangelo, 2017; Giroud and Mueller, 2011; Luo, Homburg, and Wieseke, 2010), as a proxy for information uncertainty. As in Equation (8), we calculate the HHI for industry *j* at time *t*. $s_{i,j,t}$ denotes the market share of a company *i* operating in industry *j* at time *t*. *N* denotes the number of companies in industry j. High (low) HHI values represent low (high) market competition and low (high) information uncertainty.

$$HHI_{j,t} = \sum_{i=1}^{N} s_{i,j,t}^2. \tag{8}$$

We also note that smaller firms generally have higher information uncertainty as they are usually younger and riskier. Namely, smaller firms have more volatile future cash flows. Although firm size has been widely used as a risk (pricing) factor in the finance literature (Fama and French, 1993; Herskovic, Kelly, Lustig, and Van Nieuwerburgh, 2016), Zhang (2006) suggests that firm size captures information uncertainty because investors underreact more to new information for small firms than to that for large firms. This approach can explain the size anomaly well. Hong, Lim, and Stein (2000) find that information about small firms spreads slowly through the market, implying that investors must make an effort to gather information about these stocks under high information uncertainty. Lu, Chen, and Liao (2010) find that smaller firms tend to be younger and have higher yield spreads, indicating higher information uncertainty. Thus, we use the aggregate market capitalization of each firm as a measure of information uncertainty. A high (low) aggregate market capitalization indicates a large (small) firm size and a low (high) level of information uncertainty (Asness, Frazzini, Israel, Moskowitz, and Pedersen, 2018; Liu, Stambaugh, and Yuan, 2019; You and Zhang, 2009).

3.4 Methodology

We use an event study approach to investigate whether stock returns react significantly to analyst recommendation changes. The event study analyses are performed considering three degrees of information uncertainty (i.e., $High$, $Medium$, and Low). We calculate the abnormal return ($AR_{i,t}$) on stock i at time *t,* as shown in Equation (9). $Return_{i,t}$ denotes the return on stock *i*, and $Return_{market,t}$ denotes the KOSPI index return, which represents the market portfolio return. We calculate $CAR[t_1, t_2]$, the cumulative abnormal return (CAR) from t_1 to t_2, following Equation (10). If the market reaction to analyst recommendation changes varies with the degree of information uncertainty, then the CAR should be greater and more significant under high information uncertainty than under low information uncertainty.

$$AR_{i,t} = Return_{i,t} - Return_{market,t}, \tag{9}$$

$$CAR[t_1,t_2] = \sum_{t=t_1}^{t_2} AR_{i,t}. \tag{10}$$

We use the cross-sectional regression given by Equation (11) to investigate whether the effect of sentiment on the reaction of stock returns to analyst recommendation changes varies depending on the degree of information uncertainty. The regressions are performed for three degrees of information uncertainty (i.e., high, medium, and low). *CAR*[0,2], the dependent variable, represents the CAR from the event day (t=0) to two days after the event (t=2). $Senti_{i,t-1}$ reflects investor sentiment one day before event day t. If uninformed investors are overconfident prior to analyst recommendation changes, then the coefficient of $Senti_{i,t-1}$ should be greater and more significantly positive under high information uncertainty than under low information uncertainty.[6] *Up* (*Down*) equals one when the analyst recommendation is an upgrade (downgrade) and zero otherwise. We use firm size (*ln_Size*), the ratio of book equity to market equity (*BM*), the return on assets (*ROA*), leverage ratio (*LEV*), cash flows (*CF*), and return volatility (*Volatility*) as control variables. *ln_Size* is the logarithm of total assets. *BM* is the book value divided by the market value. *ROA*, *LEV*, and *CF* are net income, total debt, and cash flows, respectively, divided by total assets. *Volatility* is the average of the 52-week standard deviations of daily stock returns. We measure these control variables at time t-1.

$$\begin{aligned} CAR[0,2]_{i,t} = \beta_0 + \beta_1 \cdot Senti_{i,t-1} + \beta_2 \cdot Up_{i,t} + \beta_3 \cdot Down_{i,t} + \beta_4 \cdot ln\_Size_{i,t-1} + \beta_5 \cdot BM_{i,t-1} \\ + \beta_6 \cdot ROA_{i,t-1} + \beta_7 \cdot LEV_{i,t-1} + \beta_8 \cdot CF_{i,t-1} + \beta_9 \cdot Volatility_{i,t-1} + \epsilon_{i,t}. \end{aligned} \tag{11}$$

We also estimate the regression given by Equation (12) to examine whether the sentiment effect on the reaction of stock price dynamics varies with the direction of analyst recommendation changes when information uncertainty is high. *Up×Senti* (*Down×Senti*) is the interaction variable used to examine whether the reaction of stock returns to upgrades (downgrades) is more sensitive when investor sentiment is high. If the sentiment effect on the reaction of stock returns to an analyst's upgrade

[6] Following Baker and Wurgler (2006, 2007), many previous studies show that investor sentiment can forecast stock returns (Hengelbrock, Theissen, and Westheide, 2013; Kim, Ryu, and Seo, 2014; Smales, 2016, 2017). Furthermore, Mian and Sankaraguruswamy (2012) and Kim, Ryu, and Yang (2019) investigate the relationships among investor sentiment, stock returns, and firm-specific news and find that prior sentiment significantly predicts the stock return response to firm-specific news around announcement dates (t=0). We find that sentiment forecasts stock returns within our sample period. In addition, we employ a bootstrap simulation to check the robustness of this result and find consistent results. We thank an anonymous referee for this helpful suggestion.

(downgrade) is greater under high information uncertainty, then the coefficient of $Up \times Senti$ ($Down \times Senti$) should be significantly positive. We use the same control variables as in Equation (11).

$$CAR[0,2]_{i,t} = \beta_0 + \beta_1 \cdot Up_{i,t} + \beta_2 \cdot Down_{i,t} + \beta_3 \cdot Up \times Senti_{i,t-1} + \beta_4 \cdot Down \times Senti_{i,t-1}$$
$$+\beta_5 \cdot ln\_Size_{i,t-1} + \beta_6 \cdot BM_{i,t-1} + \beta_7 \cdot ROA_{i,t-1} + \beta_8 \cdot LEV_{i,t-1} + \beta_9 \cdot CF_{i,t-1}$$
$$+\beta_{10} \cdot Volatility_{i,t-1} + \epsilon_{i,t}. \tag{12}$$

4. Empirical Results

4.1 Analyst recommendation changes and information uncertainty

Figure 1 presents average abnormal returns (AAR) for the period [-25,25] depending on the level of information uncertainty. Panel A (Panel B) shows the market reaction to analysts' upgrades and downgrades depending on the degree of market competition (firm size). We classify our sample into three groups according to the level of information uncertainty: firms below the 33rd percentile, firms between the 33rd and 77th percentiles, and firms above the 77th percentile. The firms below the 33rd (above the 77th) percentile are the firms with the highest (lowest) levels of information uncertainty. We observe that the market reaction to analysts' upgrades is more sensitive under high information uncertainty than under low information uncertainty. Furthermore, these graphs show that the reactions of the AAR series are most evident from day 0 to day 2, implying that in the event window [0,2], the announcement effect of analyst recommendation changes on stock returns is greater. In addition, during the event window [0,2], the reaction of the AAR series is more apparent for the high market competition group than for the low market competition group.

[Figure 1 Here]

Figure 2 displays the CARs for the event window [-25,25] according to the level of information uncertainty. Panel A (Panel B) shows the market reaction to analysts' upgrades and downgrades depending on the degree of market competition (firm size). We observe that the market reactions to analyst recommendation changes are more sensitive in the case of high information uncertainty (i.e., high market competition and small firms) than in the case of low information uncertainty (i.e., low market competition and large firms), which supports the hypothesis that the market reaction differs depending on the level of information uncertainty. Furthermore, regardless of the proxy for information uncertainty, the market reaction is always greater under high information uncertainty irrespective of the direction of the analyst recommendation change.

[Figure 2 Here]

However, the results in Panels A and B are slightly different. When the firm size is used as a proxy for information uncertainty, the market reaction to analyst's upgrades exhibits similar patterns under both high and low information uncertainty. Thus, we argue that the size effect is present in the stock market. Investors with inferior information and behavioral biases sell small stocks and buy large stocks (Cai, Han, Li, and Li, 2019; Nofsinger and Sias, 1999; Sias, 2004), and their trading behavior results in the asymmetric reaction of stock returns to analyst recommendation changes (Brown, Wei, and Wermers, 2014). We, therefore, interpret this finding to mean that the stock return reaction is significantly positive for large firms before analyst recommendations are announced and that the announcement effect on stock returns is smaller for upgrades than for downgrades.

In addition, Table 3 shows the stock return reaction to analyst recommendation changes around analyst reports' announcement dates. We compare the CARs for the event windows [-1,1], [0,2], and [-1,2] across different levels of information uncertainty to select the main event window to use to examine the announcement effects of analyst recommendation changes. Panel A (Panel B) shows the stock return reaction around the dates of analyst recommendation changes depending on the level of the market competition (firm size), where *High*, *Medium*, and *Low* indicate high, medium, and low levels of market competition, respectively, and *Small*, *Medium*, and *Large* indicate small, medium, and large firms, respectively. In Panel A, the absolute difference between the CARs of *High* and *Low* groups is 1.3138 (1.2067) for recommendation upgrades (downgrades) when we use the event window [0,2]. In Panel B, the absolute difference between the CARs of the *Small* and *Large* groups is 1.0677 (0.094) for recommendation upgrades (downgrades) when we use the event window [0,2]. Panels A and B both show that the absolute differences between the CARs of firms with high and low information uncertainty are greater for the event window [0,2] than for the event windows [-1,1] and [-1,2]. Thus, we use CAR[0,2] as the main event window for our study.[7]

[Table 3 Here]

Table 4 shows how stock returns respond to analyst recommendation changes depending on the degree of market competition (i.e., the HHI), which directly captures the degree of information uncertainty. Panel A (Panel B) of Table 4 shows the stock market reaction to analysts' upgrades (downgrades). CAR[0,2], which reflects post-event returns (up to two days after an event), is more

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[7] We also divide our sample into five groups according to HHI levels. The absolute difference between the CARs of the bottom (i.e., *High*) and top quintiles (i.e., *Low*) for market competition is 0.7763 (0.6219) for recommendation upgrades (downgrades), and that between the bottom (i.e., *Small*) and top quintiles (i.e., *Large*) for firm size is 0.4237 (0.0667) for recommendation upgrades (downgrades). These CAR differences are greater for the event window [0,2] than for the event windows [-1,1] and [-1,2]. These results are consistent with those in Table 3.

sensitive to analyst recommendation changes under high market competition (i.e., low HHI), implying that analyst reports are more (less) informative for stocks with higher (lower) information uncertainty after the reports are announced. We can conclude that investors tend to react tardily to analyst recommendation changes, implying that investors that lack information about firm value prefer to trade a firm's stock after analyst reports about that firm are announced. Hence, a high level of information uncertainty can make the reactions of stock returns to analyst recommendation changes more sensitive and longer-lasting (Chen and Lu, 2017; Chen and Zhao, 2012; Hou, 2007).

[Table 4 Here]

Table 5 shows the stock return reactions to analyst recommendation changes depending on firm size, another proxy for information uncertainty. Specifically, a smaller (larger) firm has more (less) information uncertainty regarding its value. We classify firms as *Small*, *Medium*, or *Large* depending on their market capitalizations, where *Small* (*Large*) indicates firms with small (large) market capitalizations. Panel A (Panel B) of Table 5 shows the stock return reactions to analysts' upgrades (downgrades). The post-event return, CAR[0,2], responds more sensitively to analyst recommendation changes when firms are smaller, implying that analyst reports play an essential role in explaining the reactions of stocks when information uncertainty is high (Devos, Hao, Prevost, and Wongchoti, 2015; Womack, 1996).

[Table 5 Here]

In sum, Tables 4 and 5 suggest that the stock market reactions to analyst recommendation changes vary with the degree of information uncertainty, implying that analyst reports play a more important role in the stock market when information uncertainty is higher. The results in Tables 4 and 5 support the hypothesis that the stock returns respond more sensitively to analyst recommendation changes under greater information uncertainty (*H1*).

4.2 Sentiment effect versus information uncertainty

In this section, we investigate whether the effect of investor sentiment on the market reaction varies with the degree of information uncertainty. The post-event returns are more significant and longer-lasting because informed and uninformed investors underreact when analyst reports are publicly announced. However, Chen and Zhao (2012) find that informed trading does not vary with the degree of information uncertainty. We presume that the market reaction to analyst recommendation changes is greater and more significant under high information uncertainty because uninformed or noise traders behave more irrationally when information uncertainty is higher (Hribar and McInnis, 2012; Jiang, Lee, and Zhang, 2005; Zhang, 2006). The investor sentiment created by uninformed investors may induce greater market reactions to analyst recommendation changes when information uncertainty is more severe. Thus, we need to investigate both whether the effect of sentiment on stock market reactions to analyst recommendation changes varies with the degree of information uncertainty and whether our previous finding that the effect of analyst reports on the stock market is greater under high information uncertainty still holds when we jointly consider the sentiment effect.

The results of estimating Equation (11), as shown in Table 6, show the effect of investor sentiment or information uncertainty on post-event stock return movements (i.e., CARs) in response to analyst recommendation changes. Considering that the control variable for firm size (*ln_Size*) cannot control for the high return volatility of small firms when upgrades and downgrades are combined with the rest of the recommendations, we separately examine *Up* and *Down* variables. The coefficients of *ln_Size* are significantly negative in models with the *Up* variable when information uncertainty is high or moderate. These results imply that smaller firms tend to have larger *CAR*[0,2] values after recommendation upgrades and smaller *CAR*[0,2] values after recommendation downgrades, relative to larger firms.[8] When information uncertainty is high, we observe that the coefficient of *Senti* is significantly positive. This result remains the same irrespective of whether information uncertainty is measured by market competition or firm size. Investor sentiment explains stock market reactions to analyst recommendation changes under high information uncertainty (i.e., for high market competition or small firms), but it loses its explanatory power under low information uncertainty (i.e., for low market competition or large firms). The results indicate that the effect of sentiment on the stock return reaction to analyst recommendation changes significantly varies with the degree of information uncertainty; uninformed investors underreact more when information uncertainty is higher (Epstein and Schneider, 2008; Jiang, Lee, and Zhang, 2005). Caskey (2009) and Hong, Lim, and Stein (2000) suggest that risk-averse and uninformed investors prefer to reduce information uncertainty and, thus, participate in the market after public information is released. Under high information uncertainty, investors may have incentives to wait for analyst reports to be released. If so, investor sentiment affects stock return reactions to analyst recommendation changes more significantly under high information uncertainty, meaning that information uncertainty alters the sentiment effect on post-event stock return movements.[9]

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[8] We are grateful to an anonymous referee for this comment.

[9] Because the effects of analyst reports may differ across analysts, we add two variables reflecting analyst characteristics as control variables. One variable is a dummy variable that equals one if an analyst is awarded as one of the best analysts and zero otherwise, and the other variable is a dummy variable that equals one if the house is awarded as one of the best houses and zero otherwise. The data on analyst characteristics are manually collected from the official website that announces the best analysts and houses (http://beta.fnguide.com/Analyst/analyst_main.asp). We confirm that the estimation results are consistent with those in Tables 6 and 7.

[Table 6 Here]

Table 6 also shows whether the market reaction to changes in analyst recommendations remains significant after controlling for the sentiment effect. The coefficient of *Up* is significant and positive when information uncertainty is high. Analysts' upgrades explain post-event stock movements under high information uncertainty, but they lose their explanatory power under low information uncertainty. The coefficient of *Down* is significantly negative regardless of the degree of information uncertainty, but the absolute value of the coefficient of *Down* is greater under high information uncertainty than under low information uncertainty. These results indicate the following conclusions. First, the effect of analyst recommendation changes on the stock market is greater under high information uncertainty, implying that analyst reports are more informative under high information uncertainty even after considering the effect of sentiment owing to the lack of information. Second, the absolute value of the coefficient of *Down* is greater than the coefficient of *Up*, implying that the effect of analysts' downgrades on post-event stock return movements is greater than that of analysts' upgrades. Because Savor (2012) suggests that stock return reactions to bad news are more sensitive and long-lasting than those to good news are in the case of informational events, we propose that analyst reports contain significant information content.

Additionally, we investigate whether the effect of sentiment on the reactions of stock returns to analysts' upgrades or downgrades is greater under high information uncertainty. Estimating the regression given by Equation (12), as shown in Table 7, shows the variation in the effect of the interaction between investor sentiment and analyst recommendation changes on post-event stock return movements according to the degree of information uncertainty. The coefficient of *Up*×*Senti* is not significant regardless of the degree of information uncertainty, indicating that the stock market reaction to analysts' upgrades is not greater when investor sentiment is higher. Conversely, the coefficient of *Down*×*Senti* is significantly positive under higher information uncertainty (i.e., higher market competition or smaller firms). The effect of the interaction between investor sentiment and analysts' downgrades explains the stock market reaction under high information uncertainty and implies that the effect of sentiment on the stock market dominates the effect of bad news in the case of high information uncertainty. Karpoff, Koester, Lee, and Martin (2017) suggest that conservative and pessimistic investors underreact to bad news. Li and You (2015) show that the stock market reacts more sensitively to analysts' downgrades because of investor sentiment. Thus, we argue that trading by uninformed investors reflects the effect of analysts' downgrades on stocks more slowly under higher information uncertainty.

[Table 7 Here]

In addition, the coefficient of *Down×Senti* is significantly negative for large firms, implying that the effect of bad news on post-event stock movements dominates the effect of sentiment when firm size is large. We suggest that trading of informed investors offsets the effect of investor sentiment for the stocks of large firms. Baker and Wurgler (2006) propose that the sentiment effect exists when short-selling or arbitrage trading is constrained. The sentiment effect on the stocks of small firms is greater than that on the stocks of large firms because short-selling and arbitrage trading are often more regulated for small stocks than for large stocks. Thus, the sentiment effect dominates the effect of bad news on small stocks, whereas it is offset in the case of large stocks. Furthermore, the trading behavior of investors with inferior information and behavioral biases affects the stock market's asymmetric reaction to analysts' downgrades depending on firm size because such investors sell small stocks and buy large stocks (Brown, Wei, and Wermers, 2014; Cai, Han, Li, and Li, 2019; Nofsinger and Sias, 1999; Sias, 2004). Thus, the interaction effect between investor sentiment and analysts' downgrades on the reaction of stock returns is negatively significant for large stocks.[10]

Moreover, we conduct a subsample analysis to estimate the effect of *Senti* separately for different groups to confirm the robustness of our findings. The sample is divided into two groups: upgrades and downgrades. We find that investor sentiment has a significantly positive effect for the downgrade subsample when the level of information uncertainty is high. This result is consistent with our previous findings, implying that our estimation models are correctly and adequately constructed.

In sum, Tables 6 and 7 suggest that information uncertainty should be considered when investigating the relationships among investor sentiment, changes in analyst recommendations, and stock returns. They support the significant role of information uncertainty in explaining these relationships. The results in Tables 6 and 7 indicate that the effect of investor sentiment on the reaction of stock returns to analyst recommendation changes is stronger for stocks with higher information uncertainty (*H2*).

4.3 Robustness checks

To examine the robustness of our empirical results, we adopt different measures of abnormal returns

[10] We think that including the variable $Senti_{i,t-1}$ is inappropriate for this type of analysis for the following reasons. First, the near-multicollinearity problem is suspected to arise when *Senti* is included. Models for investigating the interaction between one continuous variable (X) and one dummy variable (D) usually include both variables along with the interaction terms, that is, the models include X, D, and X×D. However, our models include two dummy variables, *Up* and *Down*, and their interaction terms with *Senti*, *Up×Senti*, and *Down×Senti*. In this case, the sum of *Up×Senti* and *Down×Senti* is highly likely to be similar to the variable *Senti*, possibly leading to the near-multicollinearity problem. If "*Up×Senti+Down×Senti*" is too closely related to *Senti*, then the estimation results may be distorted and invalid. In addition, the estimation models may be too heavy when the *Senti* is included, leading to spurious regression results, especially when our analyses use subsamples classified according to the level of information uncertainty, which have smaller sample sizes.

constructed using market and factor-adjusted models, as in Equations (13) and (14), respectively. We estimate the regression given by Equation (13) to calculate abnormal returns in the market model. $Return_{i,t}$ is the dependent variable, $Return_{market,t}$ is the independent variable, and $AR_{i,t}$ is the residual. We also run the regression given by Equation (14) to construct abnormal returns using the factor-adjusted model. We use Carhart's four factors, that is, the market (*MKT*), size (*SMB*), value (*HML*), and momentum (*MOM*) factors, as control variables.

$$AR_{i,t} = Return_{i,t} - \hat{\alpha} - \hat{\beta} \cdot Return_{market,t}. \tag{13}$$

$$AR_{i,t} = Return_{i,t} - \hat{\alpha} - \hat{\beta}_1 \cdot MKT_t - \hat{\beta}_2 \cdot SMB_t + \hat{\beta}_3 \cdot HML_t - \hat{\beta}_4 \cdot MOM_t. \tag{14}$$

Panel A (Panel B) of Table 8 provides the results of estimating this regression for three groups classified by the level of market competition (firm size). The left three columns (*Market Excess Return*) in Table 8 show the results using the abnormal returns of the market model, and the right three columns (*Factor-adjusted Return*) show the results using the abnormal returns of the factor-adjusted model. Both sets of results suggest that the market reacts more significantly to analysts' downgrades in the case of stocks with greater information uncertainty when investor sentiment is more pessimistic. These results are similar to those in Table 7, indicating that our empirical test is suitable.[11] Even though we control for the size effect in the factor-adjusted model, we confirm that the stock return reaction varies with firm size. This result supports Zhang's (2006) study, which argues that firm size explains information uncertainty rather than the size anomaly.

[Table 8 Here]

5. Conclusion

In this study, we aim to determine whether investor sentiment or information uncertainty drives the link between analyst recommendation changes and stock market reactions. We examine the effects of analyst reports and investor sentiment on post-event returns, depending on the levels of information uncertainty. Our empirical findings are as follows. *i*) The reaction of stock returns to analyst recommendation changes is greater for firms with high information uncertainty, indicating that analyst reports are more informative regarding the firms about which investors have little information. *ii*) The stock return

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[11] We also adopt the measures of abnormal returns from Equations (13) and (14) and estimate the regression in Equation (11) to check robustness. The results are not significantly different from those in Table 6.

reaction to recommendation downgrades is greater than the reaction to recommendation upgrades, suggesting that analyst reports reflecting bad news are more informative than those reflecting good news. *iii*) Investor sentiment significantly impacts the reaction of stock returns to analyst reports only when information uncertainty is high. *iv*) Analyst recommendation downgrades significantly affect stock returns regardless of the information uncertainty level. *v*) The effect of investor sentiment on the stock return reaction to analyst recommendation downgrades is greater when information uncertainty is higher. In sum, we conclude that information uncertainty explains the relationship between analyst recommendation changes and the stock market dynamics by inducing noisy and sentiment trading.

We contribute to the literature on investor sentiment, which is the field that has been rather unexplored in the context of emerging markets, by providing some novel contributions and implications in the Korean financial market. First, we introduce a daily measure for firm-specific investor sentiment, which is specifically applicable to the Korean and other emerging markets. Our study employs the sentiment proxies that are easily accessible in emerging markets and constructs a sentiment index that reflects the characteristics of the Korean stock market, such as the active participation of individual investors in the market. Second, we investigate the relationship between analyst reports and investor sentiment in the representative emerging market. Analyst reports play a role of mitigating information asymmetry in the market, and this role is more evident in emerging markets where information asymmetry is severer owing to the active participation of uninformed investors than that in advanced markets (Lim, Brooks, and Kim, 2008). Lastly, and most importantly, our study further analyzes the relationship between investor sentiment and the effect of analyst reports in the stock market, employing the concept of information uncertainty. This is particularly more meaningful because we investigate the leading and emerging stock market in Korea that is characterized by evident differences in information asymmetry levels across firms.

Furthermore, our study proposes some implications for various types of market participants, such as investors, managers, and regulators. First, we find that stock returns react more sensitively to recommendation upgrades and downgrades when information uncertainty is high, indicating that investors make better decisions by referencing analyst reports when they are less informed. Second, investors irrationally behave when they have insufficient information about firm value. We find that the effect of investor sentiment on stock returns is stronger for firms with higher information uncertainty, implying that investor irrationality is more prevalent when investors are less informed. Third, investors' irrational behavior causes the overreaction of the stock market to analyst recommendation changes. The stock market is expected to become more efficient when analyst reports are announced, considering that these reports provide investors with useful information. However, investor irrationality may introduce confusion to the association among the stock market dynamics, analyst reports, and investment decisions by leading stock prices to diverge from their fundamental values in the financial market. Specifically, the effect of investor irrationality is easily offset by arbitrage trading for firms with low information uncertainty, but it is hardly offset for firms with high information uncertainty. This result is because it is difficult to estimate fundamental values and exploit arbitrage opportunities for stocks with high information uncertainty. For this reason, investors tend to be more overconfident about their own trading abilities, leading the stock market to overreact or underreact to analyst reports. Fourth, our results imply that fund or asset managers tend to disclose only good news to the market prior to analyst report announcements. We find that the effect of recommendation downgrades on stock returns is more significant than that of recommendation upgrades, and this relationship remains even after controlling for the effect of investor sentiment. This result implies that firm managers disclose good news about their firms to the market before analyst report announcements, whereas they tend to conceal bad news until the information is conveyed to the public by analyst reports, as suggested by Chambers and Penman (1984). Last, our study reveals that analyst coverage helps to reduce information uncertainty in the market, as the effects of recommendation changes on stock returns become more significant when information uncertainty is higher. Therefore, regulators should encourage analyst activities and strengthen regulations regarding fair disclosure to resolve information uncertainty within the market.

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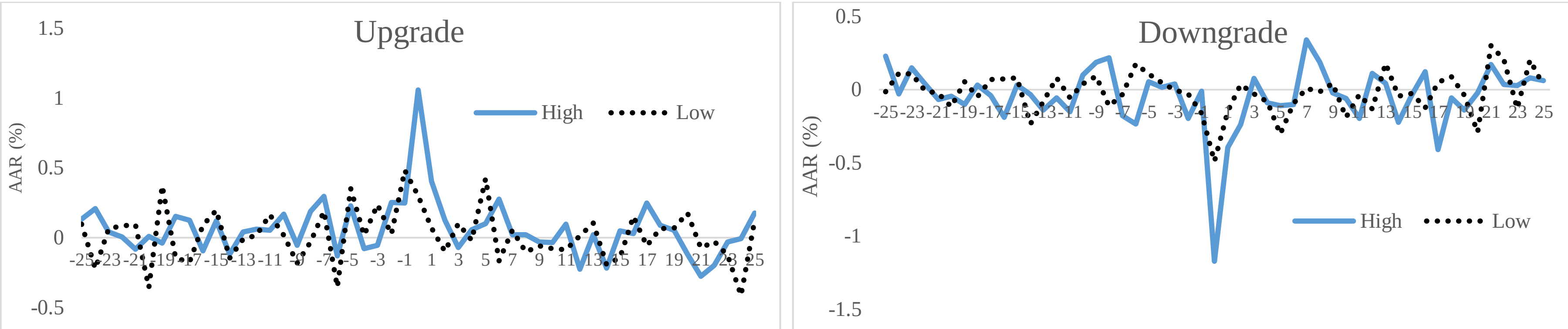
Fig. 1. Stock market reactions to analyst recommendation changes.

Note: Panel A (Panel B) shows average abnormal returns (*AAR*) for the event window from day -25 to day 25 according to the degree of market competition (firm size). The graphs labeled *Upgrade* (*Downgrade*) show AAR trends when the analyst recommendation is an upgrade (downgrade). *High* (*Small*), shown as a solid line, indicates high market competition (small firm size) and, thus, high information uncertainty. *Low* (*Large*), shown as a dotted line, indicates low market competition (large firm size) and, thus, low information uncertainty.

Panel A. Market competition



Panel B. Firm size

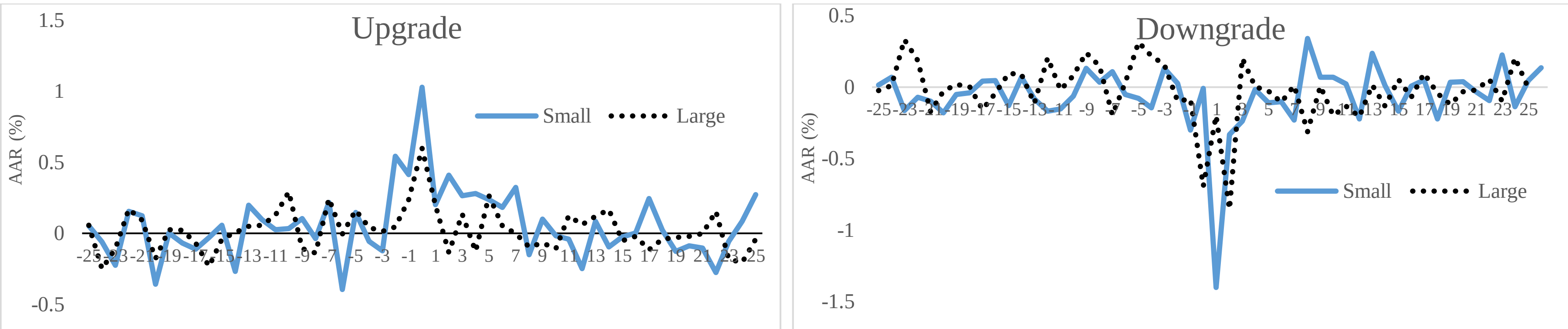
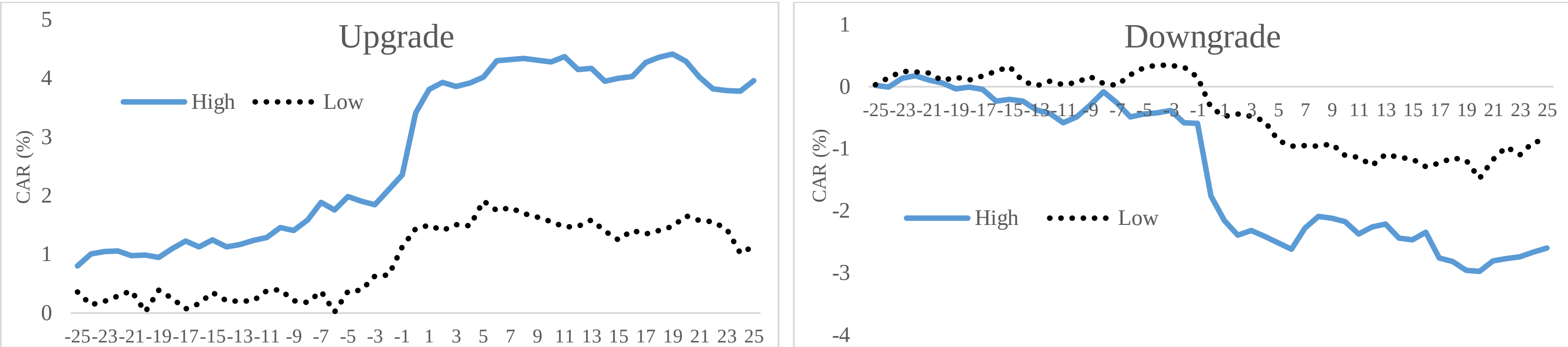


Fig. 2. Cumulative market reactions to analyst recommendation changes.

Note: Panel A (Panel B) shows cumulative abnormal returns (CAR) for the event window from day -25 to day 25 according to the degree of market competition (firm size). The graphs labeled *Upgrade* (*Downgrade*) show CAR trends when the analyst recommendation is an upgrade (downgrade). *High* (*Small*), shown as a solid line, indicates high market competition (small firm size) and, thus, high information uncertainty. *Low* (*Large*), shown as a dotted line, indicates low market competition (large firm size) and, thus, low information uncertainty.

Panel A. Market competition



Panel B. Firm size

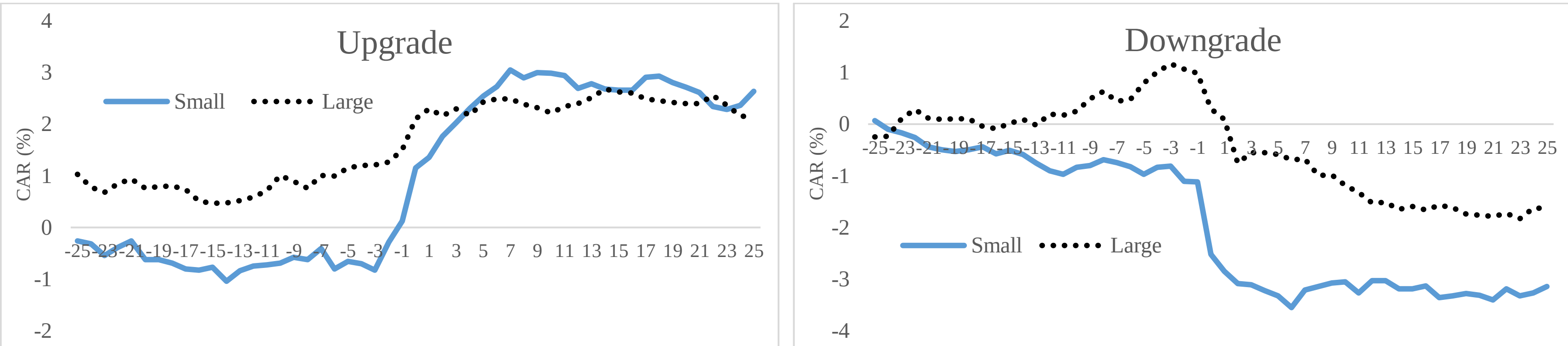


Table 1. Distribution of changes in analyst recommendations by year.

Note: This table shows the distribution of changes in analyst recommendations for each year. *Upgrade* denotes an upward change in an analyst's recommendation (e.g., from Grade 1 to Grade 3). *Neutral* means no change in an analyst's recommendation. *Downgrade* means a downward change in an analyst's recommendation (e.g., from *Grade 4* to *Grade 2*). The numbers in the table are the numbers of events.

	Upgrade	Neutral	Downgrade
2010	8	27	7
2011	19	127	32
2012	53	166	65
2013	63	268	107
2014	88	375	105
2015	103	426	119
2016	108	474	111
2017	123	447	144
2018	97	433	89
Total	662	2,743	779

Table 2. Summary statistics.
Note: This table presents summary statistics for the five investor sentiment proxies and the sentiment indicator based on data from 2010 to 2018. The summary statistics include the mean (*Mean*), standard deviation (*Std*), minimum (*Min*), 25th percentile (*P25*), 50th percentile (*P50*), 75th percentile (*P75*), and maximum (*Max*) of the sentiment proxies (*RSI*, *PLI*, *BSI*, *LVOL*, and *ATR*) and the residual sentiment indicator (*Senti*).

	Mean	Std	Min	P25	P50	P75	Max
RSI	49.310	17.117	0.000	37.126	49.098	61.364	99.852
PLI	44.024	14.894	0.000	33.333	41.667	50.000	100.000
BSI	-0.012	0.210	-1.000	-0.075	0.000	0.061	1.000
LVOL	11.010	2.255	0.000	9.659	11.219	12.536	20.403
ATR	0.001	0.039	-3.155	-0.003	0.000	0.003	3.617
Senti	0.000	17.000	-67.060	-11.806	-0.403	11.521	71.179

Table 3. Stock return reactions around the dates of analyst recommendation changes.
Note: This table describes the market reactions around the dates of analyst recommendation upgrades and downgrades for event windows [t_1, t_2] across different levels of information uncertainty. Panel A (Panel B) shows the results when the market competition (firm size) is used as a proxy for information uncertainty. The columns labeled *Upgrades* (*Downgrades*) show the stock return reactions around the dates of analysts' recommendation upgrades (downgrades). The sample data are classified into three groups according to the levels of information uncertainty: firms below the 33rd percentile, firms between the 33rd and 77th percentiles, and firms above the 77th percentile. The firms below the 33rd (above the 77th) percentile are the group with the highest (lowest) information uncertainty. In Panel A, *High*, *Medium*, and *Low* indicate high, medium, and low levels of market competition, respectively. In Panel B, *Small*, *Medium*, and *Large* indicate small, medium, and large firms, respectively. The figures in parentheses are *t*-statistics. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Market competition

	Upgrades			Downgrades		
Event Window	High	Medium	Low	High	Medium	Low
[-1,1]	1.7095***	1.2544***	0.8525***	-1.5778***	-1.2886***	-0.7979**
	(5.23)	(3.94)	(2.76)	(-4.70)	(-3.96)	(-2.38)
[0,2]	**1.5850*****	**1.3038*****	**0.2712**	**-1.8059*****	**-2.1558*****	**-0.5992***
	(5.02)	**(4.06)**	**(0.92)**	**(-5.78)**	**(-4.14)**	**(-1.65)**
[-1,2]	1.8330***	1.6133***	0.7535**	-1.8171***	-2.2007***	-0.7609**
	(4.93)	(4.48)	(2.20)	(-4.92)	(-4.01)	(-2.00)

Panel B. Firm size

	Upgrades			Downgrades		
Event Window	Small	Medium	Large	Small	Medium	Large
[-1,1]	1.8253***	1.4839***	1.1866***	-1.8017***	-1.5619***	-1.0876***
	(4.42)	(3.51)	(3.27)	(-4.15)	(-3.89)	(-2.94)
[0,2]	**1.8232*****	**1.2902*****	**0.7565****	**-2.0398*****	**-1.4650*****	**-1.9458*****
	(4.49)	**(3.28)**	**(2.50)**	**(-5.31)**	**(-3.70)**	**(-3.19)**
[-1,2]	2.2804***	1.6368***	1.0290***	-2.0476***	-1.5651***	-2.0392***
	(4.94)	(3.48)	(2.73)	(-4.37)	(-3.46)	(-3.38)

Table 4. Stock return reactions to analyst recommendation changes by market competition level.
Note: This table shows the market reactions to changes in analyst recommendations for event windows [t_1, t_2] across different HHI levels. *High* indicates a low HHI and, thus, high market competition. *Medium* indicates a medium HHI and, thus, moderate market competition. *Low* indicates a high HHI and, thus, low market competition. Panel A (Panel B) shows the results for upgrade (downgrade) news. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Upgrades

	High		Medium		Low	
Event Window	CAR	*t*-stat	CAR	*t*-stat	CAR	*t*-stat
[-25,-1]	1.6793**	2.35	0.6011	0.91	0.8697	1.17
[0,2]	**1.5850*****	**5.02**	**1.3038*****	**4.06**	**0.2712**	**0.92**
[3,25]	0.0222	0.03	0.4201	0.61	-0.2642	-0.41

Panel B. Downgrades

	High		Medium		Low	
Event Window	CAR	*t*-stat	CAR	*t*-stat	CAR	*t*-stat
[-25,-1]	-0.3710	-0.51	1.0184	1.56	0.2679	0.35
[0,2]	**-1.8059*****	**-5.78**	**-2.1558*****	**-4.14**	**-0.5992***	**-1.65**
[3,25]	-0.2051	-0.32	-0.3977	-0.59	-0.4236	-0.70

Table 5. Stock return reactions to changes in analyst recommendations by firm size.

Note: This table shows the market reactions to changes in analyst recommendations for each event window [t_1, t_2] by firm size. *Small* indicates small market capitalizations and small firms. *Medium* indicates medium market capitalizations and medium firms. *Large* indicates large market capitalizations and large firms. Panel A (Panel B) shows the results for upgrade (downgrade) news. ***and * indicate statistical significance at the 1% and 10% levels, respectively.

Panel A. Upgrades

	Small		Medium		Large	
Event Window	CAR	*t*-stat	CAR	*t*-stat	CAR	*t*-stat
[-25,-1]	0.4910	0.54	1.7627*	1.96	0.6028	0.91
[0,2]	**1.8232*****	**4.49**	**1.2902*****	**3.28**	**0.7565*****	**2.50**
[3,25]	0.9761	0.99	-0.7709	-0.64	-0.0519	-0.07

Panel B. Downgrades

	Small		Medium		Large	
Event Window	CAR	*t*-stat	CAR	*t*-stat	CAR	*t*-stat
[-25,-1]	-1.1495	-1.48	1.4382	1.35	1.3178*	1.75
[0,2]	**-2.0398*****	**-5.31**	**-1.4650*****	**-3.70**	**-1.9458*****	**-3.19**
[3,25]	-0.0489	-0.07	-0.7226	-0.95	-0.9712	-1.34

Table 6. Sentiment effect depending on information uncertainty.

Note: This table shows the estimation results for the regression given by the equation: $CAR[0,2]_{i,t} = \beta_0 + \beta_1 \cdot Senti_{i,t-1} + \beta_2 \cdot Up_{i,t} + \beta_3 \cdot Down_{i,t} + \beta_4 \cdot ln\_Size_{i,t-1} + \beta_5 \cdot BM_{i,t-1} + \beta_6 \cdot ROA_{i,t-1} + \beta_7 \cdot LEV_{i,t-1} + \beta_8 \cdot CF_{i,t-1} + \beta_9 \cdot Volatility_{i,t-1} + \epsilon_{i,t}$. Panels A and B provide the results using market competition (*High*, *Medium*, and *Low*) and firm size (*Small*, *Medium*, and *Large*), respectively, as proxies for information uncertainty. The dependent variable, *CAR*[0,2], denotes the stock market reaction to changes in analyst recommendations. *ln_Size*, *BM*, *ROA*, *LEV*, *CF*, and *Volatility* capture firm characteristics. The figures in parentheses are *t*-statistics. *Adj.* R^2 denotes the adjusted *R*-squared value. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Market competition

	High			Medium			Low		
Intercept	0.04487	-0.03831	-0.01255	0.1078***	0.0287	0.05053	0.1073	-0.00327	-0.0017
	(1.59)	(-1.38)	(-0.42)	(3.42)	(0.93)	(1.55)	(0.52)	(-0.16)	(-0.01)
Senti	0.0278***	0.0274***	0.0266***	-0.0044	-0.0011	-0.0024	0.0035	0.0024	0.0022
	(3.09)	(3.07)	(2.98)	(-0.41)	(-0.10)	(-0.22)	(0.43)	(0.29)	(0.28)
Up	1.7768***		0.9638**	2.0578***		1.0422**	0.5236		0.2610
	(4.27)		(2.17)	(4.20)		(2.03)	(1.52)		(0.72)
Down		-2.4307***	-2.0928***		-3.0464***	-2.7270***		-0.9176***	-0.8403**
		(-6.19)	(-4.96)		(-6.94)	(-5.85)		(-2.74)	(-2.39)
ln_Size	-0.2578*	0.1751	0.0370	-0.6539***	-0.2491*	-0.3587**	-0.1444	-0.0589	-0.0780
	(-1.82)	(1.26)	(0.24)	(-4.45)	(-1.73)	(-2.33)	(-1.60)	(-0.65)	(-0.83)
BM	0.0032	0.0026	0.0031	0.0088***	0.0074**	0.0079***	0.0013	0.0002	0.0004
	(1.06)	(0.86)	(1.02)	(2.91)	(2.47)	(2.64)	(0.69)	(0.08)	(0.21)
ROA	0.0023***	0.0016*	0.0018**	-0.0008	-0.0005	-0.0005	0.0001	0.0001	0.00004
	(2.66)	(1.86)	(2.12)	(-1.37)	(-0.86)	(-0.91)	(0.16)	(0.06)	(0.06)
LEV	0.0137	0.0091	0.0114	0.0342***	0.0410***	0.0391***	0.0118	0.0111	0.0114
	(1.21)	(0.81)	(1.01)	(2.99)	(3.63)	(3.45)	(1.37)	(1.29)	(1.32)
CF	-0.0019**	-0.0013*	-0.0015*	0.0013**	0.0011**	0.0011**	0.0002	0.0002	0.0002
	(-2.42)	(-1.65)	(-1.86)	(2.32)	(2.04)	(2.07)	(0.31)	(0.35)	(0.37)
Volatility	0.1969	0.2407	0.2290	-0.4368	-0.5713	-0.6260	0.5429***	0.5170**	0.5205**
	(0.83)	(1.03)	(0.98)	(-0.14)	(-0.19)	(-0.21)	(2.62)	(2.50)	(2.51)
Adj. R^2	0.0222	0.0373	0.0402	0.0247	0.0475	0.0499	0.0075	0.0115	0.0111

Panel B. Firm size

	Small			Medium			Large		
Intercept	0.1257***	-0.0355	0.0011	0.1478	0.0162	0.0836*	0.0239	-0.0415	-0.0300
	(3.15)	(-0.91)	(0.02)	(3.77)	(0.42)	(1.73)	(0.69)	(-1.21)	(-0.82)
Senti	0.0208**	0.0200**	0.0196**	0.0031	0.0034	0.0027	0.0046	0.0042	0.0039
	(2.29)	(2.23)	(2.19)	(0.34)	(0.38)	(0.29)	(0.47)	(0.44)	(0.40)
Up	0.0203***		0.0768	0.0184***		0.0118**	0.0113***		0.0042
	(4.54)		(1.54)	(4.22)		(2.27)	(2.61)		(0.91)
Down		-0.0286***	-0.0253***		-0.0169***	-0.1088**		-0.0202***	-0.0188***
		(-6.98)	(-5.49)		(-4.22)	(-2.26)		(-5.01)	(-4.35)
ln_Size	-0.7408***	0.1631	-0.0439	-0.8016***	-0.1157	-0.4684*	-0.2437	0.0940	0.0358
	(-3.50)	(0.80)	(-0.18)	(-4.09)	(-0.61)	(-1.91)	(-1.58)	(0.61)	(0.22)
BM	0.0051*	-0.0020	-0.0002	0.0057**	0.0004	0.0032	0.0070**	0.0038	0.0043
	(1.72)	(-0.71)	(-0.06)	(1.98)	(0.15)	(1.04)	(2.31)	(1.25)	(1.40)
ROA	0.0011	0.0013*	0.0012	-0.0014*	-0.0014*	-0.0014*	0.0006	0.0005	0.0005
	(1.36)	(1.66)	(1.57)	(-1.88)	(-1.88)	(-1.85)	(0.97)	(0.77)	(0.81)
LEV	0.0312***	0.0182*	0.0213*	0.0115	0.0048	0.0090	0.0272**	0.0205*	0.0216**
	(2.84)	(1.68)	(1.94)	(1.07)	(0.45)	(0.83)	(2.57)	(1.95)	(2.04)
CF	-0.0004	-0.0006	-0.0005	0.0011	0.0010	0.0010	0.0001	0.0002	0.0002
	(-0.51)	(-0.76)	(-0.68)	(1.46)	(1.37)	(1.40)	(0.11)	(0.35)	(0.30)
Volatility	0.1783	0.1787	0.1806	0.4282*	0.4327*	0.4275*	0.2986	0.2959	0.2891
	(0.78)	(0.79)	(0.79)	(1.75)	(1.77)	(1.75)	(1.15)	(1.15)	(1.12)
Adj. R^2	0.0265	0.0488	0.0499	0.0189	0.0189	0.022	0.0094	0.0226	0.0225

Table 7. Interaction effects of analyst recommendation changes and sentiment depending on information uncertainty.

Note: This table shows the estimation results for the regression given by the equation: $CAR[0,2]_{i,t} = \beta_0 + \beta_1 \cdot Up_{i,t} + \beta_2 \cdot Down_{i,t} + \beta_3 \cdot Up_{i,t} \times Senti_{i,t-1} + \beta_4 \cdot Down_{i,t} \times Senti_{i,t-1} + \beta_5 \cdot ln\_Size_{i,t-1} + \beta_6 \cdot BM_{i,t-1} + \beta_7 \cdot ROA_{i,t-1} + \beta_8 \cdot LEV_{i,t-1} + \beta_9 \cdot CF_{i,t-1} + \beta_{10} \cdot Volatility_{i,t-1} + \epsilon_{i,t}$. The columns labeled *Market Competition* provide the regression results for three subgroups (*High*, *Medium*, and *Low*) defined according to the level of market competition. The columns labeled *Firm Size* provide the regression results for three subgroups (*Small*, *Medium*, and *Large*) defined according to firm size. The dependent variable, $CAR[0,2]$, denotes the stock market reaction to changes in analyst recommendations. *ln_Size*, *BM*, *ROA*, *LEV*, *CF*, and *Volatility* capture firm characteristics. The figures in parentheses are t-statistics. *Adj.* R^2 denotes the adjusted R-squared value. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Market Competition			Firm Size		
	High	Medium	Low	Small	Medium	Large
Intercept	-0.065*	-0.0262	-0.0194	-0.0148	-0.0341	-0.0654*
	(-1.89)	(-0.67)	(-0.92)	(-0.44)	(-1.32)	(-1.71)
Up	0.0089*	0.0072	0.0017	0.0094**	0.0053	0.0024
	(2.04)	(0.95)	(0.44)	(2.11)	(1.20)	(0.34)
Down	-0.0187***	-0.0373***	-0.0088**	-0.0252***	-0.0152***	-0.0245***
	(-4.58)	(-5.23)	(-2.33)	(-5.96)	(-3.59)	(-3.58)
UP×Senti	0.0363	-0.0282	-0.0055	-0.0191	0.0184	0.0087
	(1.52)	(-0.68)	(-0.27)	(-0.84)	(0.74)	(0.23)
Down×Senti	0.0342*	-0.0468	-0.0001	0.051**	0.0167	-0.074**
	(1.71)	(-1.29)	(0.00)	(2.38)	(0.78)	(-2.30)
ln_Size	0.0032	0.0009	0.0006	0.0008	0.0018	0.0032
	(1.60)	(0.40)	(0.54)	(0.39)	(1.17)	(1.54)
BM	0.0036	0.007	0.0011	0.002	0.001	0.0058
	(1.17)	(1.52)	(0.58)	(0.73)	(0.39)	(1.41)
ROA	-0.0014	0.0021	-0.0003	-0.0049	-0.006	-0.0023
	(-0.73)	(0.72)	(-0.33)	(-1.18)	(-1.36)	(-0.42)
LEV	0.4046*	0.3808	0.6457**	0.0019	-0.0013	-0.0014
	(1.84)	(0.98)	(3.32)	(1.31)	(-1.19)	(-0.67)
CF	0.0099	0.0189	0.0083	0.0202**	0.0113	-0.0073
	(1.05)	(1.58)	(1.14)	(2.50)	(1.54)	(-0.50)
Volatility	0.0025	-0.0051	-0.0056*	0.2409	0.5917**	0.4769
	(0.50)	(-0.75)	(-1.84)	(1.13)	(2.58)	(1.29)
Adj. R^2	0.0323	0.0262	0.016	0.0477	0.026	0.0145

Table 8. Robustness check.

Note: This table shows the estimation results for the regression given by the equation: $CAR[0,2]_{i,t} = \beta_0 + \beta_1 \cdot Up_{i,t} + \beta_2 \cdot Down_{i,t} + \beta_3 \cdot Up_{i,t} \times Senti_{i,t-1} + \beta_4 \cdot Down_{i,t} \times Senti_{i,t-1} + \beta_5 \cdot ln\_Size_{i,t-1} + \beta_6 \cdot BM_{i,t-1} + \beta_7 \cdot ROA_{i,t-1} + \beta_8 \cdot LEV_{i,t-1} + \beta_9 \cdot CF_{i,t-1} + \beta_{10} \cdot Volatility_{i,t-1} + \epsilon_{i,t}$. Panel A shows the results for three groups defined according to the level of market competition (*High*, *Medium*, and *Low*). Panel B shows the results for three groups defined according to firm size (*Small*, *Medium*, and *Large*). The columns labeled *Market Excess Return* and *Factor-adjusted Return* provide the results using the CARs after controlling for market excess returns and Carhart's four factors, respectively. The CARs used in the *Market Excess Return* (*Factor-adjusted Return*) column are calculated, as shown in Equation (13) (Equation (14)). The dependent variable, *CAR*[0,2], denotes the stock market reaction to changes in analyst recommendations. *ln_Size*, *BM*, *ROA*, *LEV*, *CF*, and *Volatility* capture firm characteristics. The figures in parentheses are *t*-statistics. *Adj.* R^2 denotes the adjusted *R*-squared value. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Interaction effects depending on the level of market competition

	Market Excess Return			Factor-adjusted Return		
	High	Medium	Low	High	Medium	Low
Intercept	-0.0648*	-0.0275	-0.0195	-0.0698*	-0.0319	-0.0089
	(-1.88)	(-0.70)	(-0.92)	(-1.91)	(-0.74)	(-0.42)
Up	0.009**	0.0069	0.0017	0.0091*	0.0077	0.0018
	(2.06)	(0.93)	(0.43)	(1.96)	(0.95)	(0.45)
Down	-0.0187***	-0.0366***	-0.009**	-0.0183***	-0.0388***	-0.0085**
	(-4.58)	(-5.19)	(-2.37)	(-4.25)	(-5.00)	(-2.23)
UP×Senti	0.036	-0.0289	-0.0049	0.0362	-0.0279	-0.0029
	(1.51)	(-0.70)	(-0.24)	(1.40)	(-0.62)	(-0.14)
Down×Senti	0.0345*	-0.0415	-0.0025	0.0391*	-0.0658	-0.0024
	(1.72)	(-1.16)	(-0.13)	(1.86)	(-1.64)	(-0.12)
ln_Size	0.0032	0.001	0.0006	0.0035	0.0012	0.0001
	(1.60)	(0.45)	(0.54)	(1.62)	(0.47)	(0.05)
BM	0.0036	0.0068	0.0012	0.0044	0.0072	0.0014
	(1.16)	(1.49)	(0.58)	(1.34)	(1.43)	(0.70)
ROA	0.0025	-0.0054	-0.0055*	0.0052	-0.003	-0.0053*
	(0.49)	(-0.80)	(-1.82)	(0.95)	(-0.40)	(-1.77)
LEV	-0.0014	0.0023	-0.0003	-0.0013	0.003	-0.0003
	(-0.73)	(0.79)	(-0.35)	(-0.66)	(0.91)	(-0.36)
CF	0.0098	0.0192	0.0082	0.0094	0.019	0.0094
	(1.04)	(1.60)	(1.11)	(0.97)	(1.50)	(1.30)
Volatility	0.3985*	0.3668	0.6445***	0.3455	0.3177	0.6362***
	(1.82)	(0.95)	(3.31)	(1.50)	(0.74)	(3.29)
Adj. R^2	0.0324	0.0255	0.016	0.0327	0.0263	0.0181

Panel B. Interaction effects depending on firm size

	Market Excess Return			Factor-adjusted Return		
	Small	Medium	Large	Small	Medium	Large
Intercept	-0.0147	-0.0338	-0.0654*	-0.0126	-0.0194	-0.0682
	(-0.44)	(-1.31)	(-1.71)	(-0.36)	(-0.73)	(-1.63)
Up	0.0094**	0.0053	0.0025	0.0097**	0.0056	0.002
	(2.13)	(1.19)	(0.35)	(2.06)	(1.20)	(0.25)
Down	-0.0252***	-0.0152***	-0.0246***	-0.0244***	-0.0169***	-0.0259***
	(-5.96)	(-3.60)	(-3.58)	(-5.55)	(-3.84)	(-3.47)
UP×Senti	-0.0189	0.0179	0.0088	-0.0045	0.0005	0.0076
	(-0.83)	(0.72)	(0.23)	(-0.19)	(0.02)	(0.18)
Down×Senti	0.051**	0.0172	-0.0738**	0.0392*	0.0237	-0.0873**

	(2.38)	(0.80)	(-2.30)	(1.73)	(1.06)	(-2.45)
ln_Size	0.0008	0.0017	0.0032	0.0007	0.001	0.0032
	(0.39)	(1.16)	(1.54)	(0.37)	(0.67)	(1.41)
BM	0.002	0.001	0.0058	0.0028	0.0002	0.0066
	(0.73)	(0.38)	(1.41)	(0.97)	(0.06)	(1.49)
ROA	-0.0049	-0.0061	-0.0023	-0.002	-0.0081*	-0.0001
	(-1.18)	(-1.38)	(-0.41)	(-0.46)	(-1.75)	(-0.02)
LEV	0.0019	-0.0013	-0.0014	0.0014	-0.0013	-0.0011
	(1.32)	(-1.19)	(-0.67)	(0.96)	(-1.07)	(-0.52)
CF	0.0201**	0.0113	-0.0073	0.0155*	0.015*	-0.0056
	(2.48)	(1.54)	(-0.50)	(1.91)	(1.90)	(-0.37)
Volatility	0.2428	0.592**	0.47	0.0962	0.6244**	0.4924
	(1.14)	(2.58)	(1.27)	(0.43)	(2.59)	(1.23)
Adj. R^2	0.0477	0.026	0.0145	0.0409	0.0323	0.014