경영학석사 학위논문

Does Single Stock Futures alleviate Post-Earnings-Announcement Drift?

개별주식선물이 이익공시 후 주가지연반응에 미치는 영향에 관한 연구

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서울대학교 대학원
경영학과 재무금융전공
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Abstract

Does Single Stock Futures alleviate Post-Earnings-Announcement Drift?

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This paper investigates whether single stock futures (SSF) alleviates post-earnings-announcement drift (PEAD) by facilitating arbitrage activity. Using quarterly earnings announcement of KOSPI composite stocks, I find a statistically significant reduction in PEAD of SSF-listed stocks. This reduction remains after controlling the firm size and foreign ownership rates. Moreover, PEAD tends to decrease as SSF is traded more actively and as the Financial Institutions' fraction in the total SSF trade volumes increases. Also, it seems that arbitrage activities using SSF are done prior to the earnings announcement. Overall, these findings support the mispricing explanation of PEAD and that the availability of SSF mitigates PEAD, the market inefficiency.

Keywords: post-earnings-announcement drift, single stock futures, limit of arbitrage, market inefficiency, derivatives market

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1. Introduction

Post-Earnings-Announcement Drift (PEAD) is one of the most famous and robust anomalies in the financial market. Since 1968 when Ball and Brown presented PEAD, this drift has not been disappeared over 50 years. It is extraordinary, considering many anomalies in the market were exploited and diminished by arbitrage activities soon after they are discussed in the academy. Also, in Korea, many papers have reported the drift repeatedly (Nah, C., 2008; Nah, C. and Lee, E., 2009; Lee, H. and Choe, H., 2012; Lee, B. et al., 2018). One explanation of PEAD is that the market friction prevents investors from reacting to the news quickly enough, so investors' under-reaction occurs after earnings surprises or shocks. Based on this explanation, the limitations in arbitrage activities have not been completely eliminated yet, and the market needs to expand arbitrage opportunities. Consequently, PEAD has been a useful measure of market inefficiency. The purpose of this paper is to investigate whether the availability of Single Stock Futures (SSF) alleviates the level of market inefficiency in the spot market measured by PEAD. Under the assumption that the limit of arbitrage is a reason for PEAD, the negative relationship between SSF and PEAD implies that an additional channel promoting arbitrage activity reduces PEAD and improves market efficiency.

Derivatives markets have been studied as the means for price discovery, leading indicators in transmitting new information (Pizzi et al., 1998). According to Statista, the number of futures and options contracts worldwide has grown to 19.24 and 15.23 billion, from 12.13 and 9.42 billion in 2013, and the statistics support that they are useful products that stimulate investors' trades. Especially in the Korean market, many experts, investors, and politicians consider derivatives as alternatives for the short position on underlying stocks under the strict regulations on short-selling. When investors exploit derivatives as substitutes for the short-selling position, derivatives can have the potentials to improve price discovery in the spot market, considering Miller (1977) and Diamond and Verrechia (1987) argued that short-selling improves price discovery. Moreover, single stock derivatives allow investors to arbitrage or hedge precisely than index derivatives, so I narrow down the focus to single stock derivatives. There are three major single stock derivatives in the Korean market; SSF, ELW, and single stock option. However, there are considerable differences in their total trade value. According to the Korean Exchange, the 2020 1st quarter daily average trade values of SSF, ELW, and single stock options are 2544.2 billion, 12.15 billion, and 0.609 billion won, respectively. Thus, I find SSF is a better proxy for new arbitrage opportunities, and I examine whether the availability of SSF dissolves the limit of arbitrage.

In the market where SSF is available, investors will exploit it as follows. If the stock is overpriced after bad earnings news, then arbitrageurs want to sell that stock immediately, no matter whether they actually hold that stock at the moment, and shorting the SSF can help with it. Under the selling pressure in the SSF market, the negative information would be incorporated into the overpriced stock until the price will set right on its fundamental value. In this way, the SSF market can bring the stock price down to its fundamental value. On the other hand, the availability of SSF may also affect the underpriced stocks, as short-selling mentioned in Wang, S. and Lee H. (2017) and Hwang et al. (2019). If the stock is underpriced after positive earnings news, then arbitrageurs want to buy that stock immediately and sell it back when the stock price meets its fundamental value. When taking a short position with SSF is possible for the underpriced stock, the arbitrageurs will buy the stock more aggressively because they can hedge their long position by shorting SSF. Therefore, even the underpriced stock can find a way to its fundamental value faster with SSF under fewer arbitrage constraints.

Furthermore, there are unique participants in the SSF market called liquidity providers. Since September 2014, the Korean Exchange has designated 18 Financial Institutions as liquidity providers in the SSF market. Due to this unique position, these Financial Institutions have a different trading opportunity and motivation from other types of investors, as Goldstein et al. (2013) modeled. Trades of liquidity providers can go either strengthen or weaken the correction of mispricing depending on the situation. When arbitrageurs believe a stock is overpriced, Liquidity providers have to take in excessive short orders in the SSF market. In this case, they are more likely to take a short position in the spot market to hedge their long position in SSF because liquidity providers can benefit from more flexible short-selling policies and security transaction tax exemption applying to liquidity providers. Therefore, with liquidity providers' hedging trading, the price can be brought down quickly to the fundamental value. In other circumstances where the arbitrageurs believe the stock price is under its fundamental value, liquidity providers might weaken the price correction. Liquidity providers may absorb the selling orders in the SSF market made by arbitrageurs who want to hedge their long position in the spot market. Consequently, liquidity providers also need to hedge their position by selling the stock in the spot market, so the price might not be corrected well in this segmented spot market. Thus, in this paper, I examine whether the availability of SSF influences PEAD and if and how the trading of Financial Institutions affects PEAD.

This paper takes advantage of the listing pattern of SSF in the Korean market, which allows me to compare the magnitude of PEAD at the firm level between SSF-listed stocks and non-SSF-listed stocks. In 2008, KRX listed 15 SSFs on KOSPI composites and kept adding the number of single stock futures once in a year from 2014 to 2019. Today, in 2020, 120 single stock futures on KOSPI composites are in the market. In this paper, the total sample consists of 11,544 firm-quarter panel data (481 firms and 24 quarters from 2014 to 2019). I also restrict the sample period from 2014, when Korean Exchange endeavored to kick-start the SSF market, to 2019 to avoid confounding events like the short-sale ban. Among the data, 1,417 firm-quarter data (73 firms) holds SSF, and 10,127 firm-quarter data (408 firms) does not hold SSF.

I use cumulative abnormal return (CAR) with windows of 3 to 60 days and standardized unexpected earnings (SUE) to measure PEAD. The portfolio analyses in this paper show that market-adjusted abnormal returns from buying the highest SUE quintile portfolio and selling the lowest SUE quintile portfolio reach 2.22% (t = 4.08) over 60 days. This finding provides evidence of PEAD in KOSPI composite stocks. However, the drifts vanish after restricting the sample to SSF-listed stocks, and even the sign of abnormal returns from the buy-sell portfolios are negative. These findings are consistent with the prediction that SSF activates arbitrage trades, which reduces PEAD. A similar pattern is presented when I adjust the abnormal returns with the total sample value-weighted average return. I also test the hypothesis with multivariate regression, and it shows that the availability of SSF diminishes the positive linear relationship between CAR and SUE. With 20 days window, SSF-listed stocks generate 0.56% lower (t = -2.17) CAR comparing to non-SSF-listed stocks. This result is consistent with the hypothesis that SSF plays the role of mitigating PEAD. However, the potential concerns regarding confounding factors in the effect of SSF on PEAD should be abated. Firm size and foreign ownership rates are known to affect PEAD (Foster et al., 1984; Nah, C. and Shin, H., 2012), so I conduct robustness tests for the effects of SSF by combining multiple interaction terms of them. Even after controlling for the effects of size and foreign ownership rates, SSF reduces 0.93% (t = -2.74) of CAR generated over 20 days after earnings news. This result implies that the effect of SSF on PEAD is independent of that of firm size and foreign ownership rate. To mitigate further concerns, I match the mean values of control variables between SSF-listed stocks subsample and non-SSF-listed stock subsample by exploiting the propensity scores matching method. With this matched sample, I again find the regression results remain collectively similar in supporting the hypothesis.

To understand the result further, I perform additional analyses with two continuous variables of SSF; trade volume and the change in the rate of Financial Institutions in the total SSF trade volume. I find a decrease of 0.07% (t = -2.33) of CAR over 20 days as one unit SSF trade volume increases. This finding suggests that as more investors use SSF, the stock price reverts to its fundamental value quicker. I test the change in the fraction of Financial Institutions in the total SSF trade volume to investigate the transaction of liquidity providers in the SSF market. Since liquidity providers should keep trading SSF and demand a hedging position in the stock market, SSF trading of

Financial Institutions might also influence PEAD in the stock market. I conduct multivariate regression to support this prediction, and I also compare the change before and after earnings news to see when arbitrage activities occur. The result shows that the increase in the fraction before earnings news reduces PEAD by 2.69% (t = -2.13), but the change in the fraction after earnings news does not affect PEAD (t = -0.03). This result supports the idea that Financial Institutions' SSF trading negatively affects PEAD, and this trading occurs before the event day. However, it is hard to confirm that the primary role of Financial Institutions in the SSF market is a liquidity provider. Financial Institutions also trade like arbitrageurs considering that Institutional investors usually have better information even before the earnings announcement (Park, J. and Kim, J, 2012). Besides, Chae, J. et al. (2013) presented empirical evidence that the one who provides liquidity in the Korean ELW market is algorithmic traders, not liquidity providers. Therefore, further data on trading motivations is needed to clarify the primary role that Financial Institutions play in the SSF market and how their trades affect PEAD in the spot market.

In sum, this paper supports the idea that PEAD is due to the limit of arbitrage, which can be alleviated by adopting an additional arbitrage channel. This study contributes to the literature in three ways. First, this paper extends the literature on PEAD in the Korean market, supporting PEAD's behavioral explanation by using SSF. With the empirical findings, the availability of SSF has negative effects on PEAD, market inefficiency, independent of considerable factors (firm size and foreign ownership rates). Second, the result provides a hint that Financial Institutions have an important position in the channel where the availability of SSF mitigates PEAD. They could affect

PEAD in the stock market by either hedge activities or taking advantage of the information asymmetry. This finding throws another research question on liquidity provider policy. Lastly, this paper highlights the importance of financial derivatives for single stocks so that it suggests an implication to the policymakers in Korea. The result supports the effectiveness of the SSF market and offers the Korean Exchange and the government to stimulate the SSF market for the sake of entire market efficiency.

The rest of the paper is organized as follows. Section 2 presents the literature on PEAD. Section 3 describes the data and methodology. Section 4 shows the empirical result of the analyses. Section 5 concludes.

2. Literature Review

Ball and Brown (1968) first reported the drifts of stock prices after firms disclose their earnings performance. If a firm announces higher earnings than the market expected, its price tends to drift upward and, in turn, results in a cumulated abnormal return over 60 days after the announcement. There is also a downward drift when a firm announces unexpected negative news. This drift is called post-earnings-announcement drift (PEAD) and becomes one of the most famous and robust anomalies in the market. Foster et al. (1984) also reported the drift using quarterly earnings data, and they established fundamental measures for unexpected earnings adopting a seasonal random walk with trend.

Since then, contentious debates on why PEAD occurs have been going on; unknown risk premium or investors' underreaction. Dyckman and Morse

(1986) and Ball et al. (1993) mainly attributes PEAD to incomplete pricing models calculating the cumulated abnormal return after earnings announcements. Thus, many works have been done to find this unknown risk providing compensation for the abnormal returns after earnings news (Kim, D. and Kim, M., 2003; Sadka, 2006). On the other hand, there are efforts to find market frictions that can explain PEAD. Bernard and Thomas (1989) suggested the drift is due to transaction costs, which impede reactions to earnings news. Wurgler and Zhuravkaya (2002) mentioned the limit of arbitrage as a reason for PEAD. Francis et al. (2007) examined the information uncertainty in the earnings announcement and claimed it might cause the underreaction of investors. In Korean literature, Nah, C. (2008) suggested that investors do not fully exploit the serial correlation in accounting information.

Academics also have studied whether the firm characteristics or external change affects PEAD. For example, Foster et al. (1984) empirically showed the smaller the firm size, the larger the absolute magnitude of CAR, and earnings forecast error and firm size are highly correlated. Also, Hung et al. (2015) tested whether the introduction of IFRS, which is expected to improve accounting information quality, had influenced market efficiency by using PEAD. This external information shock resulted in reducing CAR. There are also many studies in Korea investigating features of PEAD. Nah, C. and Lee, E. (2009) related the drift with the audit quality. Lee, K. and Lee, Y. (2008) found a negative relationship between PEAD and firms' information environment. Nah, C. and Shin, H. (2012) focused on foreign investors who are considered to be informed traders and found the negative relationship between the drift and foreign ownership rates. Song, J. and Woo, Y. (2015) reported a similar result of introducing IFRS in Korea to Hung et al. (2015). Lee, B. et al. (2018) examined the effect of six proxies of the limit of arbitrage on PEAD and supported the idea that PEAD is the outcome of underreaction and mispricing.

Under the hypothesis that PEAD is due to the limit of arbitrage, much literature has used events of the short-selling constraints as a proxy for the intensive limit of arbitrage since Miller (1977) claimed that the short-sale constraints delay the market to incorporate negative information by obstructing pessimistic informed traders. Diamond and Verrechia (1987) suggested that restriction on short-sale induces overpricing of stocks that display negative drift after earnings shock. Furthermore, Wang, S. and Lee H. (2017) and Hwang et al. (2019) argued that short sales also encourage correction of the underpricing stocks. Wang, S. and Lee H. (2017) suggested that the positive PEAD is lower for stocks in the easy-to-short industry than stocks in the difficult-to-short industry with empirical evidence in Korea. Hwang et al. (2019) provided empirical evidence in Hong Kong, saying that the relaxation of short-sale constraints allows investors to hedge their long position in seemingly underpriced stocks.

Based on the relationship between PEAD and short-selling constraints, derivatives can be a factor relaxing the level of the limit of arbitrage and mispricing not only because of their contribution to price discovery but also because of their usage of synthetic short positions (Danielsen et al., 2007). Wang, S. and Lee, H. (2017) examined that the negative relationship between short-selling constraints and PEAD becomes more robust during the inactive ELW trade period and weaker during the active ELW trade period, implying that ELWs worked as a substitute for short-sales. However, the effect of options on short-sale constraints is puzzling. Under the short-sale constraints, the synthetic shorting in the options market might also be costly since the liquidity in the options market relies on the ability of market makers to short underlying stocks as a hedge against bearish options activity (Evans et al., 2009; Battalio and Stultz, 2011; Gagnon, 2018). Therefore, Gagnon (2018) suggested that single stock futures might further relax the constraints, even if options are already traded on the stocks. He investigated the impact of single stock futures (SSF) introductions on the short-sale constraints facing their underlying stocks and supported the view that SSF is a viable alternative for short-selling and relaxes short-selling constraints.

This paper examines whether single stock futures alleviate PEAD. This prediction is based on the idea that single stock futures of KOSPI composite stocks are substitutes for short-selling and dissolve the limit of arbitrage in the stock market.

3. Data and Methodology

3.1. Data

This paper compares the magnitude of PEAD between single stock futures (SSF) listed stocks and non-SSF-listed stocks. Using the quarterly earnings announcement dates of KOSPI composite stocks between January 2014 and December 2019, I compute the cumulated abnormal return (CAR). During this period, there were no bans or restrictions on short-sale trades and SSF trades that might perplex the effects of SSF. I restricted the sample to the KOSPI composites that have been listed during the entire sample period, straight twenty-four quarters. I also exclude the firms in other than manufacturing industry; the firms not providing data to calculate standardized unexpected earnings (SUE) and CAR for the sample period; and non-December year-end firms. There are 481 stocks and 24 quarters, which produces 11,544 firm-quarter data, in the total sample. Among 120 SSFs' underlying stocks, 73 are included in the total sample. I collect the financial data from the DataGuide (a database provided by FnGuide).

Since the KOSPI firms announce their tentative quarter earnings via various types of disclosures, the event day of the first earnings announcement needs to be manually selected from three types of disclosures dates; the fair disclosure on business performance in each quarter, the quarterly/annual report disclosure, and the public notice of general meetings of shareholders. I collect dates of these disclosures for 24 quarters from the KIND (Korean Investor's Network for Disclosure system). Among these types of disclosures, I select the earliest date for each firm and quarter, and define the event day of the earnings announcement according to the selected calendar date and time stamp of each disclosure since trade cannot occur after 2:50 PM of the day in KRX. Therefore, if a firm announced its quarterly earnings for the first time on October 15th at 4:00 PM, I changed its event day to the next trading day, like October 16th.

3.2. Key Variables

I define *SUE* as the standardized unexpected earnings, the forecast error scaled by its standard deviation, estimated by equation (1) and (2).

$$\boldsymbol{SUE_{i,q}} = \frac{\boldsymbol{Q_{i,q} - E[Q_{i,q}]}}{\boldsymbol{\sigma[Q_{i,q} - E[Q_{i,q}]]}} \tag{1}$$

$$E[Q_{i,q}] = Q_{i,q-4} + \varphi\left(Q_{i,q-1} - Q_{i,q-5}\right) + \delta \tag{2}$$

where $Q_{i,q}$ is a stock i's EPS in quarter q. $E[Q_{i,q}]$ is an expectation of $Q_{i,q}$ based on a seasonal random walk model using φ and δ computed by the last twenty-four quarterly EPS, suggested by Foster, Olsen, and Shevlin (1984) and Bernard and Thomas (1989). As Wang, S. and Lee, H. (2017) mentioned, some studies define the forecast errors with analysts' forecasts, but this has the disadvantage of reducing the sample size since analyst reports generally cover a limited number of stocks. Therefore, I estimate SUE with the accounting numbers to save the number or data.

To measure PEAD, I also calculate *CAR* with abnormal returns after two trading days from the event day.

$$\boldsymbol{CAR_{i,q}(2,n) = \sum_{2}^{n} AR_{i,t}\ ,\ AR_{i,t} = R_{i,t} - R_{m,t}} \tag{3}$$

where $AR_{i,t}$ refers to the abnormal return of stock *i* at day *t*, adjusted for value-weighted KOSPI return including dividend yield. I compute *CAR* by adding the abnormal returns from two days after the earnings disclosure of quarter q to n days. In this paper, I examine CAR over 3 days, 10 days, 20 days, and 60 days to see the patterns of PEAD.

To examine the effect of SSF on the change in the magnitude of PEAD, I use a dummy variable $Avail._{i,q}$, which equals one when SSF of stock i is trading at quarter q, and zero otherwise.

3.3. Main Regression

I first model the multivariate regression with key variables for the firm-quarter panel data and then change the terms to check the robustness of its result.

$$\boldsymbol{CAR} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 SUE} + \boldsymbol{\beta_2 SUE} \times \boldsymbol{Avail.} + \boldsymbol{\beta_3 Avail.} + \sum \boldsymbol{\beta_k}(\boldsymbol{Firm\ characteristics, firm\&quarter\ fixed\ effect}) + \boldsymbol{\varepsilon} \tag{4}$$

where firm characteristics are *ln(size), FOR, MTB,* and *beta*. *ln(size)* is the natural logarithm of the total market value of the stock. *FOR* is the ratio of foreign ownership. *MTB* is the ratio of the market value of equity to book value of equity. These characteristics are measured by accounting numbers at the end of quarter q. *beta* is the market beta of stock estimated from daily stock returns on daily market returns during the one-year period before the earnings announcement. This regression also includes firm and quarter fixed effects. In this regression, β_1 captures the relationship between SUE and CAR, which represents PEAD. If PEAD exists in the Korean market, β_1 would be positive and statistically significant. Also, the interaction term, β_2, captures the change in PEAD for the availability of SSF. If the SSF alleviates PEAD, I expect a negative and statistically significant coefficient on the interaction term.

Table 1 presents the descriptive statistics for the variables used in the regression. Panel A reports descriptive statistics for the total sample; Panel B reports descriptive statistics for the sample with Single Stock Futures, which means *Avail.* dummy variable equals one; and Panel C reports descriptive statistics for the sample without Single Stock Futures, which means *Avail.* dummy variable equals zero. This data shows that the absolute value of mean CAR is generally bigger in stocks without SSF, comparing to stocks with SSF. On average, stocks with SSF hold a bigger size, 15.5177 to 12.1340, higher foreign ownership rate, 28.3774 to 8.0589, higher market to book ratio, 0.0971

<Table 1>
Descriptive Statistics.
Panel A reports descriptive statistics for the full sample. Panel B reports descriptive statistics for the sample with Single Stock Futures: *Avail.* dummy variable equals one. Panel C reports descriptive statistics for the sample without Single Stock Futures: *Avail.* dummy variable equals zero. *CAR* is the cumulated abnormal return after the two-day event period, adjusted for value-weighted KOSPI return. *SUE* is the standardized unexpected earnings based on the seasonal random walk model. *ln(size)* is the natural logarithm of the total market value of the stock. *FOR* is the ratio of foreign ownership. *MTB* is the ratio of the market value of equity to the book value of equity. *beta* is the market beta of stock estimated one year before the earnings announcement.

	Mean	*St.Div.*	*Min*	*Max*	*Median*
Panel A. total sample (n=11,544)					
CAR(2,4)	-0.0011	0.0509	-0.6061	0.6162	-0.0029
CAR(2,11)	-0.0013	0.0849	-0.4787	1.1985	-0.0072
CAR(2,21)	0.0106	0.1217	-0.7422	1.8624	-0.0037
CAR(2,61)	0.0141	0.2101	-1.5236	2.3867	-0.0092
SUE	-0.4979	1.3182	-7.9574	4.4618	-0.3082
Avail.	0.1227	0.3282	0	1	0
ln(size)	12.5493	1.6264	8.8058	19.7683	12.2023
FOR	10.5530	13.0953	0	91.6073	5.2021
MTB	0.0287	0.0986	0.0002	1.6947	0.0080
beta	0.7808	0.4393	-1.1633	2.4276	0.7523
Panel B. Avail.=1 sample (n=1,417)					
CAR(2,4)	-0.0003	0.0351	-0.1808	0.3354	-0.0016
CAR(2,11)	0.0005	0.0591	-0.3036	0.3572	-0.0031
CAR(2,21)	0.0018	0.0793	-0.3380	0.4963	-0.0022
CAR(2,61)	-0.0035	0.1422	-0.7683	0.5665	-0.0058
SUE	-0.8415	1.5199	-7.9574	4.4374	-0.5700
Avail.	1	0.0000	1	1	1
ln(size)	15.5177	1.1261	13.1395	19.7683	15.4042
FOR	28.3774	15.1514	2.0703	79.9844	24.8723
MTB	0.0971	0.2493	0.0009	1.6947	0.0175
beta	0.9882	0.4209	-0.0843	2.3394	0.9803
Panel C. Avail.=0 sample (n=10,127)					
CAR(2,4)	-0.0012	0.0527	-0.6061	0.6162	-0.0032
CAR(2,11)	-0.0015	0.0879	-0.4787	1.1985	-0.0078
CAR(2,21)	0.0118	0.1265	-0.7422	1.8624	-0.0038
CAR(2,61)	0.0166	0.2178	-1.5236	2.3867	-0.0096
SUE	-0.4498	1.2802	-7.6997	4.4618	-0.2767
Avail.	0	0.0000	0	0	0
ln(size)	12.1340	1.1969	8.8058	17.1888	11.9769
FOR	8.0589	10.6161	0.0000	91.6073	4.0229
MTB	0.0191	0.0406	0.0002	0.7870	0.0073
beta	0.7518	0.4340	-1.1633	2.4276	0.7205

<Table 2>
Pearson Correlation matrix for the total sample
This table presents the Pearson correlations of each variable of the total sample. All numerical variables are winsorized at the first and 99th percentile. Pearson correlation coefficients are reported below the diagonal. p-values for correlation are reported in parentheses.

	CAR(2,4)	*CAR(2,11)*	*CAR(2,21)*	*CAR(2,61)*	*SUE*	*Avail.*	*ln(size)*	*FOR*	*MTB*	*beta*
CAR(2,4)	1.0000									
CAR(2,11)	0.5498 (<.0001)	1.0000								
CAR(2,21)	0.3855 (<.0001)	0.6622 (<.0001)	1.0000							
CAR(2,61)	0.2280 (<.0001)	0.3813 (<.0001)	0.5546 (<.0001)	1.0000						
SUE	0.0115 (0.2172)	0.0276 (0.0030)	0.0344 (0.0002)	0.0429 (<.0001)	1.0000					
Avail.	0.0083 (0.3717)	0.0127 (0.1719)	-0.0260 (0.0053)	-0.0309 (0.0009)	-0.0924 (<.0001)	1.0000				
ln(size)	-0.0016 (0.8657)	-0.0032 (0.7313)	-0.0654 (<.0001)	-0.0897 (<.0001)	-0.1992 (<.0001)	0.6823 (<.0001)	1.0000			
FOR	0.0043 (0.6466)	-0.0001 (0.9879)	-0.0389 (<.0001)	-0.0398 (<.0001)	-0.2112 (<.0001)	0.5240 (<.0001)	0.6415 (<.0001)	1.0000		
MTB	-0.0052 (0.5767)	-0.0024 (0.7986)	-0.0233 (0.0125)	-0.0258 (0.0055)	-0.1645 (<.0001)	0.2683 (<.0001)	0.4784 (<.0001)	0.3970 (<.0001)	1.0000	
beta	0.0038 (0.6834)	-0.0567 (<.0001)	-0.0364 (<.0001)	-0.0615 (<.0001)	0.0963 (<.0001)	0.1778 (<.0001)	0.1633 (<.0001)	0.0377 (<.0001)	-0.0329 (0.0004)	1.0000

to 0.0191, and closer to one in market beta, 0.9882 to 0.7518, than those of stocks without SSF.

Pearson correlations between the variables are reported in Table 2. From this table, all variables are winsorized at the first and 99th percentile. The positive correlation between CARs and SUE implies that PEAD exists in the Korean market, but it needs to be checked with portfolio analysis and multivariate regression. As shown in Table 1, *Avail.* variable is highly correlated to *ln(size)* and *FOR*, with Pearson correlation coefficients of 0.6415 and 0.5240, respectively. Since *ln(size)* and *FOR* are known to be variables that reduce PEAD, the effect of SSF should be evaluated separately from these two variables.

4. Empirical Results

4.1. Portfolio analysis

Table 3 presents the result of portfolio analyses of PEAD in the Korean market. Each panel, A, B, and C, shows the result from the total sample, subsample with SSF, and subsample without SSF, respectively. I partition the samples into 5 quintiles based on *SUE*, applying the cutoff point in the distribution of *SUE*s in the previous quarter. The *SUE5* group refers to the most positive earnings surprise and *the SUE1* group refers to the most negative earnings shock. The results in Panel A show that PEAD exists in KOSPI composites since it presents bigger and positive differences between SUE5 and SUE1 portfolios as more abnormal returns are cumulated. To be specific, when the abnormal returns are cumulated over 3 days, the difference is 0.0005 and statistically insignificant. However, the difference is 0.0222 and significant at the 0.1% levels when I expand the *CAR* window to 60 days. Although the total sample presents PEAD, a subsample with SSF does not. In Panel B, the sign of differences between top and bottom portfolios is reversed to negative, and t-statistics of mean CAR varies between -1.84 and -1.04. Besides, Panel C implies that PEAD gets stronger when portfolios are composed only with stocks without SSF. Overall, this finding suggests that SSF-listed stocks experience

<Table 3>
Post-earnings-announcement drift (PEAD) in SUE quintiles
PEAD is measured as the cumulative abnormal return (*CAR*), adjusted for value-weighted KOSPI return, two days later from the event day. This table shows the value-weighted average *CAR* of each SUE quintile portfolio. Panel A reports portfolio analysis with total sample. Panel B reports portfolios with stocks which have Single Stock Futures (*Avail.*= 1). Panel C reports portfolios with stocks which does not have Single Stock Futures (*Avail.*= 0). See Appendix A for the results of *CAR* adjusted for the total sample value-weighted average return. *SUE quintiles* are based on the cutoff point in the distribution of SUEs in the previous quarter.

	CAR(2,4)		*CAR(2,11)*		*CAR(2,21)*		*CAR(2,61)*		
Panel A. total sample	Mean	t-stat.	Mean	t-stat.	Mean	t-stat.	Mean	t-stat.	*No. of Obs.*
SUE5 (Good)	-0.0017	(-1.71)	0.0006	(0.36)	0.0158	(6.43)	0.0261	(5.96)	2324
SUE4	0.0014	(1.46)	-0.0009	(-0.51)	0.0078	(3.31)	0.0125	(2.88)	2310
SUE3	-0.0020	(-2.16)	-0.0022	(-1.45)	0.0069	(3.31)	0.0008	(0.20)	2251
SUE2	-0.0024	(-2.82)	-0.0031	(-2.15)	0.0077	(3.72)	0.0103	(2.85)	2210
SUE1 (Bad)	-0.0022	(-2.86)	-0.0046	(-3.53)	0.0045	(2.48)	0.0039	(1.20)	2449
SUE5 - SUE1	0.0005	(0.42)	0.0052	(2.38)	0.0113	(3.71)	0.0222	(4.08)	
Panel B. Avail.= 1 subsample									
SUE5 (Good)	-0.0027	(-1.38)	-0.0030	(-0.85)	-0.0032	(-0.66)	-0.0115	(-1.36)	270
SUE4	0.0001	(0.03)	-0.0037	(-1.01)	-0.0061	(-1.34)	-0.0161	(-1.92)	264
SUE3	-0.0003	(-0.13)	0.0028	(0.78)	0.0115	(2.56)	0.0088	(1.02)	282
SUE2	-0.0020	(-1.02)	0.0003	(0.11)	0.0032	(0.67)	0.0043	(0.53)	277
SUE1 (Bad)	0.0024	(1.23)	0.0058	(1.79)	0.0045	(0.99)	0.0004	(0.05)	294
SUE5 - SUE1	-0.0052	(-1.84)	-0.0088	(-1.83)	-0.0077	(-1.16)	-0.0119	(-1.04)	
Panel C. Avail.= 0 subsample									
SUE5 (Good)	-0.0015	(-1.38)	0.0007	(0.36)	0.0185	(6.79)	0.0307	(6.32)	2038
SUE4	0.0016	(1.52)	0.0008	(0.42)	0.0111	(4.35)	0.0182	(3.93)	2147
SUE3	-0.0022	(-2.27)	-0.0025	(-1.55)	0.0069	(3.00)	0.0018	(0.42)	1936
SUE2	-0.0025	(-2.61)	-0.0045	(-2.28)	0.0075	(3.27)	0.0073	(1.84)	1906
SUE1 (Bad)	-0.0032	(-3.74)	-0.0071	(-4.85)	0.0042	(2.06)	0.0063	(1.72)	2100
SUE5 - SUE1	0.0017	(1.21)	0.0078	(3.19)	0.0143	(4.19)	0.0244	(4.01)	

no or even reversed drift pattern in *CAR* after the earnings announcement. The same analyses with abnormal returns adjusted for value-weighted average returns of the total sample, instead of value-weighted KOSPI returns, are presented in Appendix A, and they also show similar patterns.

4.2. Multivariate analysis

The main question of this paper is whether SSF help to resolve PEAD by promoting arbitrage trading. To answer this question, I estimate the equation (4). Table 4 shows the results of equation (4) with the total sample and four different periods of *CAR* as dependent variables. I found that *SUE* holds a positive coefficient in every column in Table 4, and its significance increases as *the CAR* window expanded from 3 days to 60 days. This result is consistent with the portfolio analysis, Table 3. Coefficient estimates of equation (4) for the total sample are presented in Columns (2), (4), (6), and (8) of Table 4. All these Columns show a negative coefficient (-0.0017, -0.0032, -0.0056, -0.0064, respectively) on the interaction term, $SUE \times Avail.$, after controlling for firm characteristics and fixed effects. Especially in Column (6), the interaction term yields a negative and statistically significant at the 5% level. This coefficient in Column (8) becomes insignificant, but it is still negative. This finding suggests that the availability of SSF plays a role in reducing PEAD.

4.3. Robustness check of the main results

Avail. variable shows high correlations with firm characteristics since stocks need to have enough trade values, size, and the number of outstanding shares and shareholders to list its SSF. To confirm that the estimated effect on PEAD is associated with SSF, not with other firm characteristics like size and foreign ownership rates, I also conduct robustness tests with these variables. Table 5 presents the robustness check for the effect of SSF on PEAD, including additional interaction terms, $SUE \times ln(size)$ and $SUE \times FOR$. For brevity, I only use *CAR(2,21)* as a dependent variable. Columns (1) and (2) in Table 5

<Table 4>

The effects of the availability of Single Stock Futures on PEAD

The dependent variable is *CAR* with four different window. Fixed effects for firm and quarter are included. Coefficients of independent variables are reported and t-statistics are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

Variable	*CAR(2,4)*		*CAR(2,11)*		*CAR(2,21)*		*CAR(2,61)*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercept	0.0330*	0.0326*	0.1628***	0.1601***	0.3763***	0.3714***	1.3120***	1.3094***
	(1.95)	(1.92)	(5.54)	(5.45)	(9.22)	(9.10)	(18.65)	(18.60)
SUE	0.0004	0.0006	0.0017**	0.0021***	0.0021**	0.0029***	0.0050***	0.0059***
	(0.98)	(1.50)	(2.52)	(2.98)	(2.29)	(2.92)	(3.10)	(3.42)
SUE×Avail.		-0.0017*		-0.0032*		-0.0056**		-0.0064
		(-1.64)		(-1.75)		(-2.17)		(-1.45)
Avail.		-0.0021		0.0073		0.01416*		-0.0021
		(-0.63)		(1.28)		(1.81)		(-0.16)
ln(size)	-0.0027**	-0.0026*	-0.0146***	-0.0144***	-0.0267***	-0.0264***	-0.1087***	-0.1085***
	(-1.97)	(-1.95)	(-6.26)	(-6.18)	(-8.28)	(-8.17)	(-19.52)	(-19.47)
FOR	-0.0002*	-0.0002*	-0.0003	-0.0003	-0.0006*	-0.0005*	-0.0004	-0.0003
	(-1.82)	(-1.79)	(-1.43)	(-1.42)	(-1.70)	(-1.69)	(-0.63)	(-0.61)
MTB	-0.0469	-0.0469	-0.0217	-0.0233	-0.1002	-0.1032	-0.0246	-0.0256
	(-1.38)	(-1.38)	(-0.37)	(-0.40)	(-1.23)	(-1.26)	(-0.17)	(-0.18)
beta	0.0006	0.0006	-0.0094***	-0.0091***	-0.0029	-0.0024	-0.0011	-0.0014
	(0.40)	(0.42)	(-3.83)	(-3.71)	(-0.86)	(-0.69)	(0.19)	(0.23)
Fixed effect	*firm, quarter*							
adjusted R^2	0.0788	0.0790	0.0783	0.0788	0.0917	0.0926	0.1674	0.1675

include the interaction between *SUE* and *ln(size)*. The coefficients on the interactions (-0.0002 and 0.0011) are insignificantly different from zero. However, the coefficient on $SUE \times Avail.$ presents a much stronger significance (t = -2.60) after controlling effect of firm size in Column (2).

<Table 5>

Robustness tests for the effects of Single Stock Futures

The dependent variable is *CAR* over 20 days. Fixed effects for firm and quarter are included. Coefficients of independent variables are reported, and t-statistics are reported in parentheses. See Appendix B for the results of the regression with SUE decile numbers. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

Variable	CAR(2,21)				
	(1)	(2)	(3)	(4)	(5)
intercept	0.3760***	0.3719***	0.3772***	0.3736***	0.3735***
	(9.21)	(9.11)	(9.24)	(9.15)	(9.15)
SUE	0.0044	-0.0104	0.0016	0.0015	-0.0044
	(0.61)	(-1.14)	(1.31)	(1.23)	(-0.44)
SUE×Avail.		-0.0088***		-0.0083***	-0.0093***
		(-2.60)		(-2.84)	(-2.74)
SUE×ln(size)	-0.0002	0.0011			0.0005
	(-0.32)	(1.46)			(0.59)
SUE×FOR			0.0001	0.0002**	0.0001
			(0.63)	(1.93)	(1.40)
Avail.		0.0113		0.0117	0.0108
		(1.41)		(1.47)	(1.34)
ln(size)	-0.0267***	-0.0264***	-0.0268***	-0.0266***	-0.0266***
	(-8.27)	(-8.18)	(-8.29)	(-8.23)	(-8.22)
FOR	-0.0006*	-0.0005*	-0.0005	-0.0005	-0.0005
	(-1.70)	(-1.66)	(-1.61)	(-1.36)	(-1.40)
MTB	-0.1021	-0.0920	-0.0927	-0.0983	-0.0939
	(-1.25)	(-1.12)	(-1.21)	(-1.20)	(-1.15)
beta	-0.0029	-0.0023	-0.0030	-0.0025	-0.0024
	(-0.86)	(-0.68)	(-0.87)	(-0.73)	(-0.71)
Fixed effects			*firm, quarter*		
adjusted R^2	0.0917	0.0928	0.0917	0.0929	0.0929

Columns (3) and (4) show the interaction between SUE and FOR. The coefficients on $SUE \times FOR$ is positive (0.0001 and 0.0002), and become significant at the 5% level in Column (4). The interaction $SUE \times Avail.$ in Column (4) is similar to that in Column (2), presenting a negative and significant (t = -2.84) coefficient. Most importantly, the coefficient on $SUE \times Avail.$ remains negative and statistically significant at the 1% level even after controlling both effects of firm size and foreign ownership rates on PEAD. This finding suggests that the effect of SSF on PEAD is independent of the effects of firm size and foreign ownership.

In addition, the results of the same analyses with *SUE* decile numbers are reported in Appendix B. Beaver et al. (1979), Kothari (2001), Lee, K. and Lee, Y. (2008), and Nah, C. and Lee, E. (2009) used decile number of SUE instead of continuous variable SUE, because the linear relationship between CAR and SUE marginalized when the volatility of return is high. Therefore, to intensify the linear relationship between CAR and SUE, I also conduct the same analyses with SUE decile numbers, *DUE*. In Appendix B, the coefficient on DUE increases in value and significance and estimates of interaction terms are consistent with Table 5, supporting the negative effect of SSF on PEAD.

To mitigate potential concerns that the findings in Table 4, I also conduct a robustness check by using a matched sample. I match each data of stocks with SSF (*Avail.* = 1) to data of stocks without SSF (*Avail.* = 0) using propensity scores. I use the logistic regression model with a treatment indicator variable, *Avail.*, and explanatory variables, *ln(size), FOR, MTB,* and *beta*, for computing propensity scores. Based on the propensity scores, I match each data with the one-to-one greedy nearest neighbor matching method[1] with caliper[2]

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[1] In the greedy nearest neighbor matching method, one control unit is matched with each unit in the treated group, and this method produces the smallest within-pair difference among all available pairs with this treated unit.
[2] The caliper in the propensity score matching process means the maximum level of the difference in the pooled estimate of the standard deviation between pairs of units from the two groups.

<Table 6>

Propensity Score Matching test

This table shows the mean values of variables used in the calculation for logistic propensity score. I match SSF-listed stock (Avail. = 1) to non-SSF-listed stock (Avail. = 0) using the propensity scores through the greedy 1:1 method with 0.1 caliper. Panel A reports the mean values of the full sample, before the matching. Panel B reports the mean values of the matched sample. Panel C reports the results of regressions with the matched sample. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

	ln(size)	*FOR*	*MTB*	*beta*
Panel A. Sample before Matching				
Avail.=0 (n=10,127)	12.1369	7.9723	0.0189	0.7529
Avail.=1 (n=1,417)	15.4590	28.0890	0.0620	0.9859
Diff.	-3.3222	-20.1167	-0.0431	-0.2330
t-value	(-115.20)	(-50.96)	(-15.81)	(-19.41)
Panel B. Sample after Matching				
Avail.=0 (n=652)	14.6699	19.8913	0.0482	0.9705
Avail.=1 (n=652)	14.7276	21.0436	0.0515	0.9826
Diff.	-0.0577	-1.1523	-0.0033	-0.0121
t-value	(-1.48)	(-1.67)	(-0.77)	(-0.58)
Panel C. Regression with Matched Sample (n = 1,304)				
	CAR(2,4)	*CAR(2,11)*	*CAR(2,21)*	*CAR(2,61)*
intercept	0.0813	0.1894	0.4000**	2.268***
	(0.99)	(1.39)	(2.18)	(7.18)
SUE	-0.0009	0.0037	0.0045	0.0126**
	(-0.68)	(1.57)	(1.45)	(2.34)
SUE×Avail.	-0.0034*	-0.0041	-0.0101**	-0.0136*
	(-1.86)	(-1.36)	(-2.50)	(-1.94)
Avail.	-0.0014	-0.0097	-0.0038	-0.0240
	(-0.30)	(-1.26)	(-0.37)	(-1.34)
ln(size)	-0.0055	-0.0128	-0.0264**	-0.1455***
	(-0.98)	(-1.37)	(-2.12)	(-6.76)
FOR	-0.0003	-0.0001	-0.0005	-0.0015*
	(-1.25)	(-0.35)	(-1.01)	(-1.86)
MTB	-0.1944***	-0.0679	-0.0811	-0.0049
	(-2.65)	(-0.55)	(-0.49)	(-0.02)
beta	-0.0201**	-0.0242***	-0.0199*	-0.0101
	(-2.10)	(-3.01)	(-1.84)	(-0.54)
Fixed effect	*firm, quarter*			
adjusted R^2	0.1517	0.1465	0.1629	0.2258

of 0.1. I drop the data if there are no pairs under this restriction.

Panel A in Table 6 shows the mean values of variables used in the calculation for propensity scores. The differences in mean values between SSF-listed stocks and non-SSF-listed stocks are significantly different from zero, which needs to be matched for accurate comparison. Therefore, by using the propensity score matching method, Panel B in Table 6 reports matched sample descriptions. The mean values between matching samples are insignificantly different except for *FOR*. Due to strict matching requirements, a loss in the number of samples, from 1,417 to 652, already occurs, so it was hard to scarify more samples to match the level of *FOR*. With this matched sample (n = 1304), I regress the main equation (4), and the estimates are reported in Panel C in Table 6. The coefficients on interaction term $SUE \times Avail.$ are negative. Also, the estimate on $SUE \times Avail.$ with *CAR(2,21)* remains significant at the 5% level as in total sample. This result confirms the findings of previous tables in this paper, where SSF takes part in mitigating market efficiency independently of firm size or foreign ownerships.

4.4. Analyses with continuous variable of SSF

This section presents the results of the main regression with different key variables instead of *Avail.* dummy variable. I use the daily average trade volume of SSF and change in Financial Institutions' trade volume rate.

Table 7 shows analyses with the daily average trade volume of SSF. The variable *SSFtv* is the natural logarithm of the daily average SSF trade volume of stock *i* in each quarter *q*. If a stock does not have SSF in a quarter,

<Table 7>

Single Stock Futures Trade volume and PEAD

The dependent variable is *CAR* with four different windows. *SSFtv* is the natural logarithm of the daily average SSF trade volume of stock *i* in each quarter *q*. If a stock does not have SSF in a quarter, then *SSFtv* equals zero. Fixed effects for firm and quarter are included. Coefficients of independent variables are reported and t-statistics are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

variables	*CAR(2,4)*	*CAR(2,11)*	*CAR(2,21)*	*CAR(2,61)*
	(1)	(2)	(3)	(4)
intercept	0.0325*	0.1560***	0.3710***	1.3097***
	(1.91)	(5.44)	(9.09)	(18.60)
SUE	0.0006	0.0021***	0.0029***	0.0061***
	(1.39)	(2.96)	(2.92)	(3.56)
SUE×SSFtv	-0.0002	-0.0004*	-0.0007**	-0.0010*
	(-1.35)	(-1.72)	(-2.33)	(-1.87)
SSFtv	-0.0000	-0.0010	0.0019*	-0.0007
	(-0.10)	(-1.37)	(1.92)	(-0.41)
ln(size)	-0.0026*	-0.0144***	-0.0263***	-0.1085***
	(-1.95)	(-6.18)	(-8.16)	(-19.48)
FOR	-0.0002*	-0.0003	-0.0006*	-0.0003
	(-1.79)	(-1.45)	(-1.72)	(-0.59)
MTB	-0.0469	-0.0234	-0.1036	-0.0242
	(-1.38)	(-0.40)	(-1.27)	(-0.17)
beta	0.0006	-0.0091***	-0.0024	-0.0014
	(0.44)	(-3.71)	(-0.70)	(0.24)
Fixed effect	*firm, quarter*			
adjusted R^2	0.0790	0.0788	0.0927	0.1676

then *SSFtv* equals zero. I collect the daily trade volume of SSF from DataGuide and compute *SSFtv* for each stock *i* and quarter *q*.

$$\boldsymbol{CAR = \beta_0 + \beta_1 SUE + \beta_2 SUE \times SSFtv + \beta_3 SSFtv + \sum \beta_k (Firm\ characteristics, firm\&quarter\ fixed\ effect) + \varepsilon} \quad (5)$$

where other variables are defined in the same way as equation (4). By estimating this regression (5), I find that the negative effect of SSF on PEAD intensifies as SSF is actively traded. The coefficient of $SUE \times SSFtv$ is negative and significant when using *CAR(2,11)*, *CAR(2,21)*, and *CAR(2,61)* as dependent variables. Comparing to Columns (6) and (8) in Table 4, t-statistics of the interaction terms are greater in Columns (3) and (4). This finding supports the idea that PEAD is negatively related to the trade volume of SSF.

In addition, I examine the fraction of Financial Institutions in the total SSF trade volume. Financial Institutions are supposed to play a unique role in the Korean SSF market as designated liquidity providers from September 2014. If Financial Institutions more actively trade around the unexpected earnings announcement in the SSF market reacting to short orders made by arbitrageurs, they also demand more hedge transactions with underlying stocks. Thus, the PEAD of stocks with SSF can be either decrease or increase as Financial Institutions take more parts in SSF trade volume around the event day. I also examine when arbitrage trades using SSF are executed. If the arbitrage activity has been done by informed traders who hold information a few days earlier than the announcement date, the change in rates of Financial Institutions measured before the event day would show a negative and statistically significant sign.

To see the relationship between PEAD and the change in Financial Institutions participation in the SSF market, I modify the equation (4).

$$\boldsymbol{CAR} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 SUE} + \boldsymbol{\beta_2 SUE} \times \Delta \boldsymbol{FI} + \boldsymbol{\beta_3} \Delta \boldsymbol{FI} + \sum \boldsymbol{\beta_k}(\boldsymbol{Firm\ characteristics, firm\&quarter\ fixed\ effect}) + \boldsymbol{\varepsilon} \tag{6}$$

where ΔFI is the quarterly change in daily average Financial Institutions fraction in trade volumes during the three day period before, ΔFI*(-4, -2)*, and after, $\Delta FI(+2, +4)$, the event date. To be specific, I compute $\Delta FI(-4, -2)$ of quarter q by subtracting $FI(-4, -2)$ of quarter $q-1$ from $FI(-4, -2)$ of quarter q. If a stock does not have SSF in a quarter, then ΔFI equals zero. Other variables are the same as equation (4). I use daily trade volumes of each type of investor provided by the Korean Exchange but there are missing values in some stocks, which change their KRX codes due to M&A or transition to a holding company system. Also, I exclude the disclosure for the 4th quarter in 2019 since the 2020 daily trade volume data of each investor type is not available at this point. Thus, the number of data used for this regression is different from other tables.

Table 8 reports the estimates of equation (6). Panel A in Table 8 covers total sample (n = 11,063). Column (1) shows the quarterly change in the average rate of Financial Institutions before the announcement. The coefficient on $SUE \times \Delta FI$ is negative but not significant. Column (2) reports the ΔFI after the announcement date, and the coefficient on the interaction term is also negative and not significant. This may result due to the lack of variation in ΔFI distribution. Therefore, I narrow down the sample to stocks with SSF as Panel B (n = 1,344), the coefficient on $SUE \times \Delta FI$ becomes negative and significant at the 5% level (-0.0269, t = -2.13) in Column (3). However, when ΔFI is measured as the quarterly change after the announcement, it reports no relationship with PEAD as ascertained in Column (4). Since Panel B reports the results of stocks with SSF, the linear relationship between *CAR* and *SUE* is negative and insignificant as presented in Table 3, but other control variables are stable given the smaller number of data. The result in Column (3) supports the idea that increment of Financial Institutions' rate in the total SSF trade volume ahead of the earnings disclosure is related to decreasing PEAD. To see

< Table 8>

Financial Institutions trading in Single Stock Futures market and PEAD

The dependent variable is CAR over 20 days. ΔFI is the quarterly change in daily average Financial Institutions' fraction in trade volumes during three day period before $\Delta FI(-4, -2)$ and after $\Delta FI(+2, +4)$ the event date. If a stock does not have SSF in a quarter, then ΔFI equals zero. Fixed effects for firm and quarter are included. Coefficients of independent variables are reported and t-statistics are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

	CAR(2,21)			
	Panel A. total sample (n = 11,063)		Panel B. Avail.=1 sample (n = 1,344)	
variables	(1) *ΔFI(-4, -2)*	(2) *ΔFI (+2, +4)*	(3) *ΔFI(-4, -2)*	(4) *ΔFI (+2, +4)*
intercept	0.3370*** (8.22)	0.3370*** (8.22)	0.6631*** (3.91)	0.6686*** (3.94)
SUE	0.0023** (2.43)	0.0023** (2.38)	-0.0021 (-1.10)	-0.0024 (-1.30)
SUE×ΔFI	-0.0191 (-1.27)	-0.0010 (-0.06)	-0.0269** (-2.13)	-0.0004 (-0.03)
ΔFI	-0.0403 (-1.46)	-0.0220 (-0.80)	-0.0466** (-2.06)	-0.0220 (-0.93)
ln(size)	-0.0289*** (-8.87)	-0.0289*** (-8.87)	-0.0436*** (-3.61)	-0.0442*** (-3.65)
FOR	-0.0006* (-1.68)	-0.0006* (-1.70)	-0.0008 (-1.21)	-0.0008 (-1.25)
MTB	-0.0925 (-1.12)	-0.0909 (-1.10)	-0.1369 (-0.86)	-0.1261 (-0.79)
beta	-0.0028 (-0.80)	-0.0027 (-0.80)	0.0008 (0.09)	0.0008 (0.09)
Fixed effect	*firm, quarter*			
adjusted R^2	0.0929	0.0928	0.1396	0.1363

this relationship is also independent of firm size, I combine equation (6) with $SUE \times ln(size)$ and found that the effect of ΔFI on PEAD is not related to the effect of firm size with the coefficient of -0.0251 (t = -2.15).

Therefore, it seems that Financial Institutions in the SSF market affect PEAD in the way of facilitating the correction of mispriced stocks on average, under the assumption that Financial Institutions are liquidity providers. However, it is hard to clarify the primary role of Financial Institutions in the SSF market at this point. Financial Institutions are one of Institutional investors who are considered as informed traders in the Korean market and successfully predict the direction of unexpected earnings and earn abnormal returns around earnings announcement. Thus, the primary role of Financial Institutions might be an arbitrageur, not a liquidity provider. Therefore, further research on trading motivations of Financial Institutions is needed to clarify the primary role of them and how their trades affect PEAD in the spot market.

5. Conclusion

This paper examines whether single stock futures (SSF) alleviates PEAD by using quarterly earnings announcements of KOSPI composite stocks from 2014 to 2019. Since SSF can be an effective alternative for short-sale constraints in Korea, investors can react to earnings news more quickly and adequately by exploiting the SSF market. Therefore, on average, I expect that price drifts after the earnings announcement decrease in its magnitude as their SSF are traded. This has a significant meaning, especially in the Korean market, where the short-selling constraints for individual investors are accused of limiting informed trading activities.

Using the quasi-experimental setting created by introducing SSFs on the Korean Exchange between 2014 and 2019, I compare SSF-listed stocks to non-SSF-listed stocks. I find that there is a statistically significant reduction in PEAD of SSF-listed stocks comparing to non-SSF-listed stocks. After controlling for firm size and foreign ownerships, SSF maintains the percentage reducing PEAD and its statistical significance level. The result supports the prediction that SSF alleviates the limit of arbitrage and PEAD. Furthermore, I find that PEAD tends to be mitigated when SSF is more actively traded, and Financial Institutions consume more fractions in SSF trade volume prior to the earnings announcement. This finding implies Financial Institutions can be a potential channel of reducing PEAD through the SSF market. However, this paper has limitations in distinguishing the effects of SSF on PEAD. In this research, I assume that other derivatives do not have enough trade values to affect PEAD, so additional investigation in the Korean derivatives market is required to provide further evidence. Also, the examination of a potential channel between SSF and PEAD should be taken further. I focused on Financial Institutions as liquidity providers, but they might play as arbitrageurs, so the question of who reduces PEAD using SSF remains.

This study has contributed to extending the literature on PEAD in the Korean market. Empirical results using the availability of SSF are supporting behavioral explanations of PEAD. The availability of SSF has negative effects on PEAD independent of firm size and foreign ownership rates. Moreover, the result provides marginal evidence of Financial Institutions' role in improving market efficiency. They could affect PEAD in the stock market by either hedge activities or taking advantage of the information asymmetry. This finding throws another research question on liquidity provider policy. Lastly, this paper demonstrates the benefits of the SSF markets, and it has important policy implications. As the market improves its efficiency with the existence of the SSF market stimulating arbitrage activities, it is apparent that Korea's regulatory authorities should give more attention to the SSF market to allow it to grow to its full potential.

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<Appendix A>

Portfolio analyses with a different CAR adjustment

PEAD is measured as the cumulative abnormal return (*CAR*) after the two day event period, adjusted for value-weighted average return of total sample. *SUE quintiles* are based on the cutoff point in the distribution of SUEs in the previous quarter.

	CAR(2,4)		*CAR(2,11)*		*CAR(2,21)*		*CAR(2,61)*		
Panel A. Full sample	Mean	t-stat.	Mean	t-stat.	Mean	t-stat.	Mean	t-stat.	*No.of Obs.*
SUE5 (Good)	-0.0005	(-0.54)	0.0014	(0.82)	0.0067	(2.81)	0.0118	(2.84)	2324
SUE4	0.0012	(1.35)	-0.0026	(-1.61)	-0.0019	(-0.81)	0.0014	(0.33)	2310
SUE3	-0.0017	(-2.00)	-0.0035	(-2.37)	-0.0028	(-1.37)	-0.0089	(-2.41)	2251
SUE2	-0.0023	(-2.80)	-0.0040	(-2.89)	-0.0014	(-0.71)	-0.0038	(-1.09)	2210
SUE1 (Bad)	-0.0019	(-2.53)	-0.0043	(-3.47)	-0.0051	(-2.90)	-0.0153	(-4.92)	2449
SUE5 - SUE1	0.0014	(1.15)	0.0057	(2.71)	0.0118	(3.98)	0.0271	(5.22)	
Panel B. *Avail.*.= 1 subsample									
SUE5 (Good)	-0.0023	(-1.20)	-0.0069	(-1.92)	-0.0109	(-2.26)	-0.0247	(-2.83)	270
SUE4	0.0003	(0.14)	-0.0097	(-2.60)	-0.0132	(-2.93)	-0.0237	(-2.69)	294
SUE3	-0.0002	(-0.10)	-0.0013	(-0.35)	0.0032	(0.71)	-0.0005	(-0.05)	282
SUE2	-0.0024	(-1.17)	-0.0032	(-0.92)	-0.0033	(-0.68)	-0.0031	(-0.37)	277
SUE1 (Bad)	0.0021	(1.02)	0.0029	(0.85)	-0.0004	(-0.09)	-0.0146	(-1.81)	294
SUE5 - SUE1	-0.0045	(-1.56)	-0.0097	(-1.98)	-0.0104	(-1.54)	-0.0101	(-0.85)	
Panel C. *Avail.*.= 0 subsample									
SUE5 (Good)	-0.0003	(-0.25)	0.0019	(1.03)	0.0088	(3.34)	0.0156	(3.39)	2038
SUE4	0.0014	(1.46)	-0.0002	(-0.13)	0.0018	(0.74)	0.0086	(1.95)	2147
SUE3	-0.0020	(-2.17)	-0.0035	(-2.23)	-0.0034	(-1.52)	-0.0090	(-2.23)	1936
SUE2	-0.0023	(-2.49)	-0.0046	(-2.99)	-0.0018	(-0.81)	-0.0078	(-2.08)	1906
SUE1 (Bad)	-0.0028	(-3.40)	-0.0060	(-4.38)	-0.0067	(-3.43)	-0.0146	(-4.16)	2100
SUE5 - SUE1	-0.0025	(1.90)	0.0080	(3.43)	0.0155	(4.73)	0.0302	(5.22)	

<Appendix B>

Robustness tests with SUE decile numbers

This table shows the results of the regression with SUE decile numbers (*DUE*). The dependent variable is *CAR*. Fixed effects for firm and year are included. Coefficients of independent variables are reported, and t-statistics are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

Variable	*CAR(2,21)*					
	(1)	(2)	(3)	(4)	(5)	(6)
intercept	0.3673***	0.3476***	0.3847***	0.3665***	0.3631***	0.3760***
	(8.99)	(7.68)	(8.08)	(8.94)	(8.86)	(7.75)
DUE	0.0011**	0.0044	-0.0028	0.0012**	0.0012**	-0.0011
	(2.76)	(1.35)	(-0.67)	(2.28)	(2.15)	(-0.24)
DUE×Avail.			-0.0392***		-0.0375***	-0.0411***
			(-2.74)		(-3.01)	(-2.85)
DUE×ln(size)		-0.0024	0.0032			0.0017
		(-1.01)	(1.04)			(0.50)
DUE×FOR				-0.0001	0.0005	0.0004
				(-0.24)	(1.30)	(0.93)
Avail.			0.0328***		0.0321***	0.0336***
			(3.46)		(3.55)	(3.53)
ln(size)	-0.0265***	-0.0250***	-0.0282***	-0.0265***	-0.0263***	-0.0274***
	(-8.24)	(-6.98)	(-7.44)	(-8.23)	(-8.15)	(-7.01)
FOR	-0.0005*	-0.0005*	-0.0005	-0.0005	-0.0007**	-0.0007*
	(-1.66)	(-1.66)	(-1.59)	(-1.40)	(-2.03)	(-1.84)
MTB	-0.1009	-0.1077	-0.0970	-0.1014	-0.1033	-0.0988
	(-1.24)	(-1.32)	(-1.18)	(-1.24)	(-1.27)	(-1.20)
beta	-0.0029	-0.0029	-0.0024	-0.0029	-0.0025	-0.0024
	(-0.86)	(-0.85)	(-0.70)	(-0.85)	(-0.73)	(-0.72)
Fixed effects	*Firm, quarter*					
R^2	0.0921	0.0922	0.0932	0.0921	0.0933	0.0933

국문 초록

본 논문은 한국 주식시장의 개별주식선물이 이익공시 후 주가지연반응에 미치는 영향을 실증적으로 분석하였다. 개별주식선물은 공매도 제한이 있는 한국시장에서 새로운 차익거래 기회로 작용할 수 있으므로, 개별주식선물이 거래되는 주식은 차익거래 제한이 일부 해소되어 이익공시 후 주가지연반응이 줄어들 것으로 예상할 수 있다. 따라서 본 논문에서는 다중회귀모형을 이용하여 개별주식선물이 상장된 주식은 개별주식선물이 없는 주식에 비해 이익공시 이후 누적초과수익률이 감소함을 실증적으로 확인하였다. 또한 일반적으로 주가지연반응을 해소하는 것으로 알려진 주식의 시장가치와 외국인 보유 비율을 통제한 이후에도 개별주식선물과 주가지연반응 사이의 음의 관계는 통계적으로 유의미하게 나타나, 개별주식선물은 시장가치와 외국인 보유 비율과는 별개의 영향을 끼치는 것으로 보인다. 개별주식선물의 거래량이 늘어날수록 주가지연반응이 감소함을 추가적으로 확인하였으며, 이익공시일 이전에 이루어지는 시장조성자의 개별주식선물 거래가 주식시장에서 이익공시 후 주가지연반응을 줄이는 요인으로 작용함을 간접적으로 보였다. 본 논문은 이익공시 후 주가지연반응이 시장 마찰요인으로 인한 투자자들의 과소반응에 기인한다는 설명을 지지하며, 개별주식선물이 주식시장의 효율성을 개선함을 시사한다.

주요어: 이익공시 후 주가지연반응, 개별주식선물, 차익거래제한, 시장비효율성, 파생상품시장

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