# Can Short-Selling Alleviate the Underpricing?:

# Evidence from the positive PEAD in the Korean Stock Market

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## Abstract

This paper investigates whether short-selling facilitates arbitrage activity and mitigates the positive post-earnings announcement drift (PEAD), the well-known underpricing anomaly. Using the quarterly earnings announcement of the Korean Stock Exchange KOSPI200 composite stocks, we find that positive earnings stock in a difficult-to-short industry experiences larger and more persistent underpricing after earnings announcement than those in an easy-to-short industry; and that the observed larger underpricing in a difficult-to-short industry is associated with the short-sale constraint, not with their illiquidity or information inefficiency. Moreover, this inverse relation between the positive PEAD and its industry's short-ability is stronger during the inactive equity linked warrant (ELW) trade period, thereby suggesting that short-selling alleviates the mispricing by facilitating arbitrage activities (not by the other channels); and ELW actually play roles as an alternative of short trade.

**Keywords**: Short-selling, Underpricing, Post-earnings announcement drift, Arbitrage, ELW.

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## 1. Introduction

One of the contentious debates on the financial stock market is whether the short sales improves market efficiency versus generates market instability. One group of academics argues that the short-selling leads the overpriced stocks to revert to their fundamental value quickly, thereby improving price discovery (Miller, 1977; Diamond and Verrechia, 1987). The other group insists that short-selling increases the stock return volatility, thus destabilizing the stock market. Without much consensus about this issue, whenever a financial crisis arose, short sellers were blamed for the collapse of stock market and as a result, the regulators of various countries imposed a temporary restriction on short-selling.

The primary question considered by previous researches is whether the short-sellers make overpriced stocks revert to their fundamental value by their intensive selling activities based on their private information. Some researches (Rubinstein, 2004; Boehmer, Jones, and Zhang, 2008) examined the impact of short-selling on the price of the shorted stocks and showed that short-selling allows negative information to be incorporated into the stock prices. However, short-selling need not only affect the stocks being shorted. We examine the impact of short-selling on the pricing of stocks other than the shorted stocks and investigate whether short-selling help the underpriced stock to revert back to its fundamental value.

The issue is as follows. If a stock in a given industry is underpriced, then arbitrageurs buy that stock and sell it back when its price reverts to the fundamental value. In this case, they generally sell short other stocks in the same industry to hedge the industry risk. Accordingly, if the industry has a large pool of stocks available to short-selling and there is no limit to arbitrage, then the

underpriced stocks can return to its fundamental value in a very short time owing to the aggressive arbitrage. However, if short-selling activity of the industry is constrained for some reason, stocks in that industry cannot revert back to fundamental value as quickly as those in an easy-to-short industry (Delong et al., 1990; Shleifer and Vishny, 1997; Shleifer, 2000) because the difficult hedging via the substitute stocks increases the industry risk, thereby causing arbitrageurs to trade less aggressively. In other words, short-selling can alleviate the mispricing of underpriced stock by facilitating arbitrage activities.

This paper investigates this question by analyzing the positive post-earnings announcement drift (PEAD), the well-known underpricing anomaly. The scholars supporting behavior finance argue that positive PEAD attributes to some irrational trading and the limit of arbitrage. According to this view, uninformed traders tend to misinterpret the earnings information and impatiently sell the stocks with earnings surprise, thereby causing the underreaction. In addition, the constraints on short sales limit the arbitrage activity and the underpricing is further exacerbated. That is, the positive PEAD seems to be the underpricing anomaly caused owing to the constraints on short sales.

This phenomenon provides the best test set for investigating whether short-selling can alleviate the mispricing of underpriced stock by facilitating arbitrage activities. Since in the easy-to-short industry, the ability to short stocks allows arbitrageurs to exploit temporarily underpriced stocks aggressively, the positive PEAD in this industry should be weaker and less persistent. However, in the difficult-to-short industries, since hedging via substitute is difficult, arbitrageurs trade less aggressively. This should slow down the price response to good news and the elimination of underpricing. We predict that the underpriced stocks with

earnings surprise in the easy-to-short industry have less delayed price response, in both magnitude and persistence, than stocks in the difficult-to-short industry.

Using the quarterly earnings announcement of KOSPI200 composite stocks between January 2006 and December 2013, we examine the average *CAR* of 20 trading days following the positive earnings announcement in both an easy-to-short and difficult-to-short industry. The results show that the average $CAR_{[0,19]}$ in a difficult-to-short industry is significantly higher than that in an easy-to-short industry, 1.95% and 0.71%, respectively. Moreover, in a difficult-to-short industry, 32.73% and 40.97% of the total underpricing disappeared during 1 and 10 days following earnings announcement, respectively. However, an easy-to-short industry, 70.49% and 83.81% get resolved during the same period. The results are robust to control the other variables that potentially affect the stock returns following earnings announcements.

To confirm that the observed underpricing in difficult-to-short industry is associated with the short-sale constraint, not with their illiquidity or information inefficiency, we also examine firms' reaction to negative earnings announcement. If the underpricing comes from their illiquidity or information inefficiency, then we should also observe more sluggish stock price reversals in a difficult-to-short industry for the negative earnings sample (overpriced stocks), as well. We cannot find a greater negative PEAD in a difficult-to-short industry than in an easy-to-short industry, thereby suggesting that the stock illiquidity or information inefficiency hypotheses may not be the case.

Lastly, we divide the entire sample periods into three groups, active, normal, and inactive ELW trade period, and examine in which period the inverse relation between the positive PEAD and its industry's short-ability is stronger. During the

active ELW trade period, arbitrageurs can freely use the put-ELWs instead of actual short sales, so the difference of the positive PEAD between difficult-to-short and easy-to-short industry could be small. During the inactive ELW trade period, however, arbitrageurs cannot use put-ELWs as substitutes of short sales, so the difference of the positive PEAD between two groups should be large. Expectedly, during the active ELW trade period, the difference in the magnitude of PEAD between two groups gets blurred, compared with the other two periods. And during the inactive ELW trade period, the difference in the speed of alleviation of underpricing between the two groups tends to be the most prominent. This result suggests that short-selling alleviate the mispricing of underpriced stock by facilitating arbitrage activities (not by the other channels), also it implies that ELWs act as alternatives for short trade when short-selling constrained.

The contributions of this paper to the literature are as follow. First, this paper examines the impact of shorting on the pricing of industry's peer stocks, rather than the stock being shorted itself.[1] By using this new approach, we shed light on a different dimension of short-selling, that is, short-selling induces not only overpriced stocks but also underpriced stocks to revert back to their fundamentals. Second, this paper directly shows how arbitrageurs use long-short strategies to exploit the positive PEAD phenomenon. In particular, this paper provides new information on the arbitraging behavior of the South Korean hedge funds, which were introduced in the late 2011. Third, the result provides a hint that the cross-country difference in the PEAD phenomenon could be related to the stock market

[1] A large body of literature examines the effect of shorting on the shorted stock, except one paper (Hwang et al., 2013).

system regarding the short restriction of each country. Lastly, this paper suggests an insight to the policy makers who formulate and implement the ELW regulations in South Korea.[2] The evidence, supporting the argument that ELWs have been actively used in hedging as a substitute of short sales, suggests that the regulation restricting ELW trading strictly can limit the hedging and arbitraging activities (as well as speculating) and interrupt the overall function of the stock market.

The rest of this paper is organized as follows. In section 2, there is a summary of the previous studies on short-selling. Section 3 describes the dataset and methodology for investigating the issue raised. Section 4 provides the empirical results for the hypotheses in this study. Section 5 is the conclusion.

## 2. The Literature

The main question of previous studies is whether short-selling makes the overpriced stocks revert to their fundamental values. The empirical studies showed that the increases in short interest or short volume lead to the declines in stock returns (Diether et al., 2009a; Dehow et al., 2001; Asquith and Meulbroek, 1996; Conrad, 1994; Figlewski and Webb, 1993). Using 414 stocks in the S&P500, Figlewski (1981) formed a portfolio based on six months short interest and calculated the portfolio return in the next twelve months. He found that short interests were negatively related with the following stock returns. Senchack and

[2] The ELW market started in 2005 with a daily average trading volume of 21 billion KRW. But, after only 5 years, the market experienced a hundred-fold growth and recorded a daily average trading volume of 2.1 trillion KRW in October 2010. However, many unfair market practices, such as large losses of individual investors, lawsuit against scalpers (professional high frequency traders), and large spread offered by a liquidity provider caused the financial regulatory body to enact control measures, which in turn significantly reduced the trading volume. After April 2012, the daily average market trading volume dropped to 70–110 billion KRW, recording a 90% decrease in a year-to-year comparison (Capital market weekly, No 44, 2012).

Starks (1993) showed that the stocks with unexpected increase in short interests experienced negative CARs following the announcement of monthly short interest. These papers presented that short sales have the return predictability, that is, shorting activities can lead the overpriced stocks to revert to fundamental value.

Academics also have studied the effect of the short-selling constraints on the asset prices. Miller (1977) theoretically suggested that the short constraints impeded negative information from being incorporated into the stock price. He argued that since the price of the stocks under the short constraints reflected only optimistic opinions, those experienced considerable overpricing. Diamond and Verrechia (1987) showed that short-selling constraints could impede efficient price discovery by eliminating certain informed traders. They argued that if the investors had the rational expectations, then short constraints would not lead to the overpricing of stocks. All of these theoretical models assumed short sellers are better informed about the firm's fundamental values.

There are also many studies investigating how the short-selling ban affects the stock market. Diether et al. (2009b) examine how the SHO regulation affects the market quality. Boulton and Braga-Alves (2009), and Boehmer et al. (2009) examined the impact of the short-ban during 2008 global financial crisis and found that the ban on short-selling worsens the market's liquidity and price discovery. Kolasinksi et al. (2010) studied whether the short restriction and the short ban would influence on stock market differently and found that the ban decreased the liquidity and increased the informativeness of trades much more, compared with the restriction.

Hwang et al. (2014) provided an alternative perspective on short-selling, by

arguing that short sales may help to correct the underpricing of stocks. Utilizing the institutional feature of the Hong Kong market where only the stocks on the designated short-sale list announced quarterly can be shorted, Hwang et al. (2014) found that when stock *i* is designated as the shortable stocks, other stocks that exist in the same industry as stock *i* earned positive abnormal returns. Based on these results, they state that short-selling also helps other undervalued stocks to find their fundamental value.

Similar to Hwang et al. (2014), this paper examines whether the short-selling facilitates the arbitrage activities and mitigates the positive PEAD, the well-known underpricing anomaly, by using the quarterly earnings announcement of KOSPI200 composite stocks. In particular, we investigate the channel, through which its industry's short-ability alleviates the underpricing of the stocks, by using the South Korean ELW market.

## 3. Data and Methodology

Using the quarterly earnings announcements of KOSPI200 composite stocks between January 2006 and December 2013, we examine the average *CAR* of 20 trading days, following the positive earnings announcement in an easy-to-short and difficult-to-short industry. We restrict the sample to the KOSPI200 stocks because arbitrage trades are mostly performed by institutional and foreign investors who usually trade the stocks with large market capitalization. To alleviate survivorship bias, we include the stocks dropped from KOSPI200 during the sample period in our sample.[3] We exclude the global financial crisis period (Oct. 1, 2008–May 31, 2009) and the European financial crisis period (Aug 10,

[3] The total number of sample stocks is 275.

2011–Nov. 10, 2011) from the sample period because the South Korean financial authority banned short sales during these periods.

We collect the short sales data for each sample stock from the Korea Stock Exchange (KSE) and extract the financial and market information of each stock from TS-2000 (a database operated by Korea Listed Companies Association (KLCA). We resort to DataGuide (a database maintained by FnGuide, one of the biggest data vendor in Korea) to collect the daily trading volumes of ELWs. We identify the earnings announcement day for each stock-earnings sample by using KIND (Korea Investor's Network for Disclosure System), which is an electronic disclosure platform operated by KSE.

Because the firms usually announce their tentative earnings via various types of disclosure before the final annual report disclosure, we manually collect the date of the first time when the earnings-related information is substantially announced in a given quarter. For $4^{TH}$ quarter earnings announcements, we pick the calendar date of earliest one among five announcements: the fair disclosure on business performance, the report of sales change greater than 30%, the report of audit, the notice for convocation of meeting of shareholders, and the annual stockholders' meeting. For $1^{st}$, $2^{nd}$, and $3^{rd}$ quarter earnings announcements, we pick the calendar date of the earlier one of two events: the temporary earnings announcement and the quarterly report disclosure.[4]

To secure the accuracy of the earnings information, we should use the calendar date of the quarterly report disclosure as the event days. However, we cannot

[4] We do not regard the tentative earnings disclosure, without the full contents of quarterly earnings including net income, as the quarterly earnings announcement.

exactly measure the announcement effect in this way, since stock prices have already reflected the tentative earnings information revealed through other type of disclosures, such as the fair disclosure on business performance, the report of audit, etc. Thus, we select the substantial first day when the firms announce their quarterly earnings, irrespective of whether they are tentative or definitive, as the earnings announcement day.[5] We change the event day of the earnings announcement revealed after the official market-closing time (2:50 PM) to the next trading day.[6]

We define the samples with *SUE* (standardized unexpected earning) values greater than 1 as positive earnings stocks, and those with *SUE* less than -1 as negative earnings stocks. The *SUE* is the forecast error from a seasonal random walk with trend, scaled by its standard deviation within the trend estimation period.[7] The numerator of *SUE* is an actual earnings minus an expectation based on a seasonal random walk with trend, which is estimated by equation (1). In equation (1), $Q_{i,q}$ ($Q_{i,q-4}$) is a stock *i*'s net income in quarter *q* (*q*-4) and $\delta_{i,q}$ is a stock *i*'s trend. The denominator of *SUE* is a standard deviation of the unexpected earnings over the estimation period.

$$Q_{i,q} = \delta_{i,q} + Q_{i,q-4} + \varepsilon_{i,q} \qquad (1)$$

We can compute the SUE for 7,144 stock-earnings observations out of our total

[5] According to previous studies, earnings expectations released through corporate fair disclosures are quite close to the actual earnings to be reported in annual reports and elicit strong stock market reactions.

[6] The KIND provides a time stamp for each announcement, so we can identify the exact time of each information disclosure. In South Korea, since trade cannot occur during the last 10 minutes for each trading day, 14:50–15:00, the information about earnings announcement cannot be reflected during the last 10 minutes.

[7] Our definition of SUEs is same as that in Foster et al. (1984), Bernard and Thomas (1989, 1990).

sample.[8] Of these, positive earnings stocks with *SUEs* greater than 1 are 1,184 and negative earnings stocks with *SUE* less than -1 are 1,469.

Some studies define the earnings surprise measure as the difference between an actual earnings and an average analysts' forecast before the earnings announcement for each stock. This measure has the advantage of eliminating the noises caused by business structural change but it has the disadvantage of reducing the sample size, since the Koreanbroker firms generally cover less than 100 stocks and sometimes present yearly basis forecasts, rather than quarterly basis forecasts. Thus, we use the *SUE*, estimated by the accounting information, as the earnings surprise measure.

## 4. Empirical Analysis

### 4.1. Summary statistics of sample firms

To examine the effect of short sales on the underpriced stock, we divide total samples into two groups: stocks belonging to a difficult-to-short industry and stocks belonging to an easy-to-short industry, and investigate the difference in the positive PEAD between these two groups. We categorize our sample stocks into fifteen industries based on KSIC (Korean Standard Industrial Classification) and compute the each industry's *shorted firm ratio* for each quarter, which is the number of stocks with nonzero shorting volumes during the quarter divided by the total number of stocks in a given industry. Stock *i* is categorized as being in a

[8] Because we require the 16 quarterly earnings information prior to the earnings announcement in order to estimate the earnings trend, the number of samples decreases. Also, we trim the samples with SUE values greater than +5 or less than -5, to reduce the influence of outliers.

difficult-to-short industry if it belongs to the bottom 50% group based on its industry's *shorted firm ratio*; otherwise, it is categorized as coming from an easy-to-short industry

Table 1[9] presents the details of the industry classification and the time-series distribution for the *shorted firm ratios* of 15 industries. The number of stocks for each industry varies from 3 (telecommunication) to 60 (material manufacturing). The average *shorted firm ratio* ranges between 0.7 and 1 across 15 industries. Media, utility, and wholesale and retail exhibit the low average *shorted firm ratio*, whereas telecommunications, construction, and education and leisure exhibit the high average *shorted firm ratio*. Almost all of industries exhibit large gaps between the minimum and maximum, thereby suggesting that there were considerable variations in the *shorted firm ratio* of each industry across 32 quarters. For each industry, we also calculate the number of quarters in which that industry belongs to the bottom 50% group, based on the quarterly *shorted firm ratio*, that is, the difficult-to-short group. Industrial goods manufacturing, material manufacturing, utility, and media belonged to the difficult-to-short group in more than 25 quarters of 32 quarters. However, telecommunications and construction never belonged to the difficult-to-short during the sample periods.

We calculate the cross-sectional average and standard deviation of the *shorted firm ratio* of 15 industries for each quarter, and examine their historical trends. The average *shorted firm ratio* increased steadily and the standard deviation of that decreased consistently during the sample period, except for the 2008 global

[9] In Table 1 and Figure 1, we do not exclude the global financial crisis period (Oct. 1, 2008–May 31, 2009) and the European financial crisis period (Aug. 10, 2011–Nov. 10, 2011) from the sample period to provide the whole picture of the short-selling activities in our sample.

financial crisis period, as can be seen in Figure 1. We also examine the historical trends of the total shorting volumes and the proportion of the shorted stocks. The total shorting volumes have shown an overall increase over the sample period, accompanied by some fluctuations, depending on the stock market condition. The proportion of the shorted stocks increased consistently during the sample period except for the 2008 global financial crisis period[10], similar to the average shorted firm ratio.

Table 2 presents the summary statistics of *SUE* and firm characteristics for a difficult-to-short and easy-to-short industry. As shown in Panel A, about 63% (4,499 observations) and 37% (2,645 observations) of the stock-earnings sample belong to a difficult-to-short and easy-to-short industry, respectively. The stocks in a difficult-to-short industry have a lower book-to-market ratio, a smaller size, and a lower turnover than those in an easy-to-short industry, thereby suggesting that there exist some differences in other firm characteristics (as well as short sales restriction) between the two groups. We calculate the summary statistics in the same way for the positive earnings sample and the negative earnings sample. The results (Panels B–C) are similar to that of total sample. The stocks in difficult-to-short industry are more growth-oriented, small-sized, and illiquid, compared with those in easy-to-short industry, for both subsamples.

[10] The South Korean financial authority banned short sales during the global financial crisis period (Oct. 1, 2008–May 31, 2009) except for the market making activities for ELW, ETF, individual stock future and option. Thus, during this period, the total shorting volumes and the proportion of the shorted stocks did not decrease to zero. We find no changes in the quarterly short activity during the European financial crisis period (Aug 10, 2011–Nov. 10, 2011) because the European financial period did not cover any quarters entirely.

### 4.2. Delayed price response for positive earnings announcement

The main question of this paper is whether short sales help to resolve the underpricing anomaly by facilitating the long-short arbitrage trading. To answer this question, we examine the difference in the degree and the persistency of the positive PEAD between a difficult-to-short and easy-to-short industry. We measure the degree of the positive PEAD by the average *CAR* of 20 trading days following (including) the positive earnings announcement day ($CAR_{[0,19]}$). We decompose $CAR_{[0,19]}$ into $CAR_{[0,0],}$ which is the immediate price response to earnings information and $CAR_{[1,19],}$ which is the delayed price response.[11] It seems that the positive earnings stocks with larger $CAR_{[0,19]}$ (especially larger $CAR_{[1,19]}$ ) suffer more severe underpricing. We measure the persistency of the drift by $Frac_n$, which is the proportion of the drift resolved during *n* days adjacent the earnings announcement day in the total PEAD. ($Frac_n = \frac{CAR_{[0,n]}}{CAR_{[0,19]}}, n = 1, 3, 5, 10$). The higher $Frac_n$ means that the large parts of the delayed price response (the drift) are observed within the *n* days just after earnings announcement. Hence, if the underpricing of stock *i* has quickly disappeared, then the stock reports a higher $Frac_n$.

We compare the degree and the persistency of the positive PEAD across the two groups of stocks: those in a difficult-to-short industry and those in an easy-to-short industry. We hypothesize that the stocks in a difficult-to-short industry suffer a larger and more persistent positive PEAD because of the limited long-

[11]The *CARs* are calculated by accumulating the market-adjusted returns during each specified period following the earnings announcement day (day0). The market-adjusted returns are computed by subtracting the return on the market portfolio, which is the equal-weighted portfolio of all sample stocks, from the raw return on each stock.

short arbitrage activities. If the hypothesis is correct, then we should observe a higher average $CAR_{[0,19]}$ and a lower average $Frac_n$ in a difficult-to-short industry than in an easy-to-short industry. For the analysis of *CARs*, we use the total positive earnings stocks (stocks with *SUE* greater than 1), however, for the analysis of *Fracs*, we limit the sample to the positive earnings stocks with a positive PEAD (stocks with *SUE* larger than 1 and positive $CAR_{[0,19]}$). Since the persistency analysis is valid only for the stocks experiencing positive PEADs after their positive earnings announcement, we add this restriction when investigating the persistency of the positive PEAD ($Frac_n$).

For positive earnings stocks, the average $CAR_{[0,19]}$ in a difficult-to-short industry (1.95%) is higher than that in easy-to-short industry (0.71%), as can be ascertained from Panel A of Table 3. This difference is derived from $CAR_{[1,19]}$, rather than $CAR_{[0,0]}$. The average $CAR_{[1,19]}$ is significantly higher in difficult-to-short industry (1.36%) than in easy-to-short industry (0.15%). However, there is no difference in the average $CAR_{[0,0]}$ between two groups. This result suggests that the positive earnings stocks in difficult-to-short industry experience the greater delayed price response than those in easy-to-short industry. The average $Frac_1$ and $Frac_{10}$ in a difficult-to-short industry are 32.73% and 40.97%, respectively, but those in an easy-to-short industry are 70.49% and 83.81%, respectively, as can be seen in Panel B. It means that the large part of the total positive PEAD is resolved in the initial stage after the earnings announcement in an easy-to-short industry, but only small part is mitigated in the same period in a difficult-to-short industry. However, the differences of $Frac_1$, $Frac_3$, $Frac_5$, and $Frac_{10}$ between the two industry groups are not statistically significant in this

univariate analysis. Overall, the result implies that the positive PEAD, which is the underpricing phenomenon of positive earnings stocks, is larger and more persistent in a difficult-to-short industry. It is the evidence supporting our hypothesis that short-selling can alleviate the mispricing of underpriced stock by facilitating arbitrage activities.

To confirm that the observed underpricing in a difficult-to-short industry is associated with a short-sale constraint, not with their illiquidity or information inefficiency, we also examine the firms' reaction to negative earnings announcement.[12] If the larger underpricing in a difficult-to-short industry comes from its illiquidity or information inefficiency, then for the negative earnings stocks, that is, "overpriced stocks", we should find a more sluggish stock price correction in a difficult-to-short industry. That is, we should observe the lower average $CAR_{[0,19]}$ and $Frac_n$ in a difficult-to-short industry than in an easy-to-short industry for the negative earnings sample. However, as reported in Table 3, for negative earnings stocks, there are no differences in both $CAR_{[0,19]}$ and $Frac_n$ between the two groups, thereby suggesting that there exists no greater delayed price response after a negative earnings announcement (negative PEAD) in a difficult-to-short industry than in an easy-to-short industry. Therefore, the illiquidity and information inefficiency hypotheses are not supported in this study.

Figure 2 presents *CARs* around earnings announcement day under the assumption that the earnings are announced on day 0. For the positive earnings stocks (Panels A–B), the average *CARs* in difficult-to-short industry increase

[12] In general, stocks with less liquidity and less information efficiency tend to revert back to their fundamental values more slowly. Since the stocks in a difficult-to-short industry would be smaller, and less liquid, as shown in Table 1, it is possible that the more underpricing in a difficult-to-short-industry comes from their illiquidity or information inefficiency, not from short-sales constraints.

gradually after earnings announcement day, the average $CAR_{[0,19]}$ reaching 1.95%, whereas the average *CARs* in an easy-to-short industry increase over 3 days following earnings announcement and moves at random afterwards, average $CAR_{[0,19]}$ being 0.71%. The *Fracs* in a difficult-to-short industry gradually increases and reaches 1 at 20 trading days, whereas the *Fracs* in an easy-to-short industry reaches 1 at 12 trading days, thereby suggesting that underpricing gets resolved in a shorter time in an easy-to-short industry. For the negative earnings stocks (Panels C–D), we cannot find any different patterns between the two groups. The results of Figure 2 suggest that short-selling activities within each industry mitigate the positive PEAD that is an underpricing anomaly.

To confirm that the results are robust even after controlling other variables that may affect the stock returns following earnings announcement, we run multiple regressions where dependent variables are *CARs* and *Fracs*, controlling for a variety of firm characteristics. We transform *CARs* and *Fracs* into a decile rank between 0 and 1 to facilitate the interpretation and to reduce the influence of outliers. The main explanatory variable is $Difficult_{i,q-1}$, which equals one when stock *i* belongs to a difficult-to-short industry in the quarter *q-1*, and zero otherwise.[13] We include $Shorted_{i,q-1}$, which equals one if stock *i* itself has a nonzero shorting volume in the quarter *q-1*, otherwise zero. The coefficients of *Difficult* and *Shorted* present the impact of its affiliated industry's short-ability and its own short-ability on the PEAD, respectively. In order to control the price pressure[14] of short trading, we include the *SS.Vol*, which is shorted volume to

[13] To eliminate the reverse causality effect, we defined the difficult-to-short industry based on the ranks of previous quarter. This methodology is similar to Hwang et al. (2014).

[14] Generally, a high fraction of shares shorted precedes low future returns, implying that short

total trading volume ratio during each period corresponding with each dependent variable ($CAR_{[0,19]}$, $CAR_{[0,0],}$ $CAR_{[1,19]}$, and $\text{Frac}_n$s). We control firm's book-to-market ratio (*ln(BM)*), size (*ln(Size)*), return volatility (*Vol*), turnover (*Turn*), and lagged return (*Mom*)[15]. These variables have been considered in the previous literature as relevant factors that can affect the firms' PEAD. To control for the differences across industries, we also include the volatility ($Vol_{ind}$) and the turnover ($Turn_{ind}$) of the industry that each stock belongs to. We add a year-quarter dummy to control for possible variation in the degree of a PEAD phenomenon over time. Standard errors are adjusted by considering the clustering in year-quarter. Specifically, we estimate the following specification.[16]

$$CARs_{i,q} =$$

$$\beta_0 + \beta_1 Difficult_{i,q-1} + \beta_2 Shorted_{i,q-1} + \beta_3 SS.Vol_{i,q} + \beta_4 \ln(BM)_i + \beta_5 \ln(Size)_i +$$

$$\beta_6 Vol_{i,q-1} + \beta_7 Turn_{i,q-1} + \beta_8 Mom_{i,q-1} + \beta_9 Vol_{ind_{i,q-1}} + \beta_{10} Turn_{ind_{i,q-1}} + \varepsilon_{i,q} \qquad (2)$$

$$Fracs_{i,q} =$$

$$\beta_0 + \beta_1 Difficult_{i,q-1} + \beta_2 Shorted_{i,q-1} + \beta_3 SS.Vol_{i,q} + \beta_4 \ln(BM)_i + \beta_5 \ln(Size)_i +$$

$$\beta_6 Vol_{i,q-1} + \beta_7 Turn_{i,q-1} + \beta_8 Mom_{i,q-1} + \beta_9 Vol_{ind_{i,q-1}} + \beta_{10} Turn_{ind_{i,q-1}} + \varepsilon_{i,q} \qquad (3)$$

$$CARs \in \{CAR_{[0,19]}, CAR_{[0,0],} CAR_{[1,19]}\}$$

$$Fracs \in \{Frac_1, Frac_3, Frac_5, Frac_{10}\}$$

$$SS.Vol \in \{SS.Vol_{[0,0]}, SS.Vol_{[0,1],} SS.Vol_{[0,3]}, SS.Vol_{[0,5]}, SS.Vol_{[0,10]}, SS.Vol_{[0,19]}, SS.Vol_{[1,19]}\}$$

As expected, if the more severe underpricing phenomenon emerges in a difficult-to-short industry than in an easy-to-short industry, then $\beta_1$ in equation

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sellers are informer traders. (Figlewski, 1981; Desai et al., 2005)

[15] Generally, if an industry currently experiences an upward trend, short volume in the industry should be naturally lower and the high stock returns will be observed in the industry due to its bullish trend. In order to eliminate this possibility, we include the lagged return (*Mom*).

[16] This regression model is similar to Hwang et al. (2014)

(2) should be positive. If the underpricing is more persistent in a difficult-to-short industry, then $\beta_1$ in equation (3) should be significantly negative.

There is a weak positive relationship between $CAR_{[0,19]}$ and *Difficult*, as shown in Panel A of Table 4. When using $CAR_{[1,19]}$ instead of $CAR_{[0,19]}$ as the dependent variable, the positive relation becomes more significant. However, when using $CAR_{[0,0]}$ as dependent variable, *Difficult* does not have a meaningful coefficient any longer. Since $CAR_{[1,19]}$, trimmed the immediate price response to an earnings announcement, measures the delayed price response more exactly than $CAR_{[0,19]}$, this result strongly support our hypothesis, which is that the positive earnings stocks in a difficult-to-short industry experience a greater delayed price response than those in an easy-to-short industry. When using *Fracs* as dependent variables (Panel B), *Difficult* exhibit significantly negative coefficients. The results suggest that positive PEADs of stocks in a difficult-to-short industry tend to be resolved more slowly than those in an easy-to-short industry. This result is consistent with the findings of Hwang et al. (2014), who show that short-selling can help to correct the underpricing in the Hong Kong stock market. The coefficients of *Shorted* and *SS.Vol* are mostly insignificant, implying that the stocks' own short-ability and the price pressure of shorting activity do not influence the positive PEAD phenomenon.

As discussed in Table 3, there exists a possibility that the severe underpricing phenomenon observed in a difficult-to-short industry is associated with their illiquidity or information inefficiency, rather than their short-sales constraints. To confirm this possibility, we run the same regression using the negative earnings sample. If the underpricing is owing to stocks' illiquidity or information

inefficiency, then we should also observe a more delayed price correction in a difficult-to-short industry for the overpriced stocks. Thus, in the regression using negative earnings sample, $\beta_1$ in equations (2) and (3) should be negative.

However, table 5 indicates that *Difficult* has no significant relations with both *CARs* and *Fracs* for negative earnings stocks. The negative PEAD in a difficult-to-short industry is not larger and more persistent than those in an easy-to-short industry, unlike positive PEAD. This result contradicts that greater positive PEAD in difficult-to-short industry is associated with its illiquidity or information inefficiency.

Interestingly, for negative earnings sample, *Shorted* report the significant relationship with both *CARs* and *Fracs*. There is a negative relationship between $CAR_{[0,19]}$ and *Shorted* in Panel A. When using $CAR_{[0,0]}$ as dependent variable, the negative relation becomes more significant, however, when using $CAR_{[1,19]}$, *Shorted* does not have a meaningful coefficient. Also, *Shorted* reports the significant positive relationship with $Frac_{10,}$ and the weak positive relationship with $Frac_{1,}$ $Frac_{3,}$ $Frac_{5.}$ It means that for negative earnings stocks, its own short-ability contributes to facilitate the immediate price response and resolve its overpricing anomaly efficiently.

We think that the negative PEAD are more influenced by its own short-ability, rather than its industry peer's short-ability, unlike the positive PEAD. Since negative earnings stocks tend to be overpriced, speculators short these stocks and their short selling activity create a downward pressure on overpriced stocks, alleviating the negative PEAD. In other words, investors would short the overpriced stock itself to exploit the overpricing after negative earnings

announcement, however, investors would create hedging position, buying the underpriced stocks and simultaneously shorting the industry peers of these underpriced stocks after positive earnings announcement. Investors utilize short-sales as means of speculating for overpriced stocks; however, utilize it as means of creating hedge position for underpriced stocks.

Overall, the results suggest that positive earnings stock in a difficult-to-short industry experiences larger and more persistent underpricing after earnings announcement than those in an easy-to-short industry; and furthermore that the observed underpricing in a difficult-to-short industry is associated with a short-sale constraint, not with their illiquidity or information inefficiency.

### 4.3. Robustness check

Some may argue that the difference observed in the positive PEAD phenomenon between two groups results from the sample stocks having no short-selling activities[17]. In order to eliminate this possibility, we exclude the stocks with zero short volumes during 20 days after earnings announcement day from our sample and perform the above regression. The signs of the main coefficients are the same as those shown in Table 4, suggesting that our results are not driven by stocks with zero short volumes.

We examine the possibility that our results are derived from some industries which have the small samples. According to Table 1, the industries with small number of firms tend to exhibit the extreme short selling activities in both directions, such as difficult-to-short and easy-to-short. Thus, we exclude the industries with the less than 10 firms from our

[17] Since stocks with no short-trades tend to be small, illiquid, and inefficient in information, they may experience more severe PEAD. And the possibility of stocks with no short-selling activities belonging to difficult-to-short industries is higher than that of those belonging to easy-to-short industries.

sample and perform the same analysis. The results are very similar[18].

We consider relatively more exogenous shocks in short-ability, that is, short sale bans imposed by regulators during the global financial crisis period and the European Financial crisis. During the short-sale prohibition period, investors cannot create hedging position where buying underpriced stocks and simultaneously shorting its industry peers. Thus, the underpriced stock cannot revert back to fundamental value quickly, causing the severe positive PEAD. Expectedly, table 6 presents that $\text{Frac}_1$ and $\text{Frac}_5$ is significantly smaller during the ban period than during the non-ban period. Similarly, during the short-sale prohibition period, since speculators cannot short the negative earnings stocks to exploit their overpricing, the negative PEAD can be stronger and more persistent. Actually, $\text{Frac}_{10}$ is significantly smaller during the ban period than during the non-ban period.

### 4.4. ELW and the effect of short-selling on stock underpricing

Generally, the short position can be synthesized by using ELWs (equity linked warrant).[19] For example, the aforementioned industry long-short arbitrage strategy is performed by buying the underpriced stocks and buying the put-ELWs of the (relatively) overpriced stocks belonging to the same industry. Based on these characteristics of the ELW, we investigate whether the relation between the positive PEAD and its industry' s short-ability varies in the periods of active and inactive ELW trade. During the inactive ELW trade period, the short-sale is the

[18] The results of all robustness tests can be provided if requested.

[19] Since availability and frequency of trading of put options for individual stocks are very low in the Korean stock market, we perform the analysis by using put ELWs.

only available means to arbitrageurs, so the short constraints strongly suppress the arbitrage activities, thereby intensifying a positive PEAD. Thus, the difference of a positive PEAD between a difficult-to-short and an easy-to-short industry may be larger in this period. However, during the active ELW period, the arbitrageur can freely use put-ELWs instead of actual short-sales, so the positive PEAD in a difficult-to-short industry becomes weaker. Thus, the difference of a positive PEAD between the two industry groups can be smaller.

Figure 3 shows the trading volumes of ELW (excluding ELW of which underlying asset is KOSPI200 index) from 2006 to 2013. The average daily trading volume was 13 million contracts in January 2005 when the ELW market newly opened, and then increased sharply, reaching to 5.17 billion contracts in September 2010. However, the persistent unfair market practices, such as large losses of individual investors, lawsuits against the scalper, and the large unfair spread offered by liquidity providers caused the South Korean financial authority to enact several regulations, which in turn significantly reduced the ELW trading volumes. After April 2012, the daily trading volume dropped to 1 billion contracts, recording an 80% decrease from the same period the year before. We find similar patterns in the put-ELWs (excluding put-ELW of which an underlying asset is the KOSPI200 index). The average daily trading volume of the put-ELW was 33 million contracts in January 2006 and 773 million contracts in September 2011, so reporting a 20-times increase during the 5-year period. In particular, during the 2008 global financial crisis and European financial crisis, the trading volume increased sharply, reaching 643 million and 773 million contracts, respectively. However, after the regulations, the daily trading volume dropped below 100

million contracts.

We divide the entire sample periods into three groups, active, normal, and inactive ELW trade periods, and by multiple regressions further examine in which period the inverse relation between the positive PEAD and its industry's short-ability is stronger. We calculate the daily average ELW trading volume for each quarter, by using individual ELW's trading data between 2005 and 2013. If the quarter belongs to the bottom (upper) 30% based on the daily average ELW trading volume, we define it as an inactive (active) ELW trade period. We run multiple regressions where the dependent variables are *CARs* and *Fracs*, controlling for a variety of firm characteristics. The main explanatory variable is the interaction variable created by multiplying $Difficult_{i,q-1}$with $Inactive_q$ and A$ctive_q$, respectively (*Difficult ✗ Inactive* and *Difficult ✗ Active*). *Difficult* is one if the stock belongs to a difficult-to-short industry, and zero otherwise. *Inactive* (*Active*) is one if the quarter is inactive (active) ELW trade period and zero otherwise. The definitions of dependent variables and other control variables are the same as Tables 4 and 5.

$$CARs_{i,q} = \beta_0 + \beta_1 Difficult_{1,q-1} + \beta_2 Inactive_q + \beta_3\left(Difficult_{1,q-1} \times Inactive_q\right) + \beta_4 Active_q + \beta_5(Difficult_{i,q-1} \times Active_q) + \beta_6 \times Controls_{i,q} + \varepsilon_{i,q} \quad (4)$$

$$Fracs_{i,q} = \beta_0 + \beta_1 Difficult_{1,q-1} + \beta_2 Inactive_q + \beta_3\left(Difficult_{1,q-1} \times Inactive_q\right) + \beta_4 Active_q + \beta_5(Difficult_{i,q-1} \times Active_q) + \beta_6 \times Controls_{i,q} + \varepsilon_{i,q} \quad (5)$$

$$CARs \in \left\{CAR_{[0,19]},\ CAR_{[0,0]},\ CAR_{[1,19]}\right\}$$

$$Fracs \in \{Frac_1, Frac_3, Frac_5, Frac_{10}\}$$

If the short-selling mitigates the underpricing anomaly in positive earnings samples, then $\beta_1$ has a positive value in equation (4) and a negative value in equation (5). Furthermore, this effect is strong for the inactive ELW period and weak for the active ELW period, than $\beta_3$s have the same signs with $\beta_1$ and $\beta_5$s have the opposite signs with $\beta_1$ in equations (4) and (5).

Panel A of Table 7 (equation (4)) reports that the coefficient of *difficult* is positive and that of *Difficult ⨯ Active* is negative when using $CAR_{[0,19]}$ and $CAR_{[1,19]}$ as dependent variables. Both coefficients are statistically significant. During the active ELW trade period, the difference in the magnitude of PEAD between two groups gets blurred, compared with the other two periods. Furthermore, the coefficient of *difficult* and *Difficult ⨯ Inactive* is significantly negative when using $Frac_3$ and $Frac_5$ as dependent variables, as shown in Panel B (equation (5)). During the inactive ELW trade period, the difference in the speed of alleviation of underpricing between the two groups tends to be more prominent.

In sum, there exists an inverse relation between the positive PEAD and its industry's short-ability; and this relation become stronger during the inactive ELW trade period and weaker during the active ELW trade period. These results support the hypothesis, that is, during the active ELW trade period, the arbitrageur can freely use put-ELWs, instead of actual short-sales, so the difference of a positive PEAD between two groups should be small. However, during the inactive ELW trade periods, the arbitrageur cannot use put-ELWs as substitutes of short sales, so the difference of a positive PEAD between the two groups should be large. It suggests that short-selling alleviate the underpricing of

the stock by facilitating arbitrage activities (not by the other channels); it also implies that ELWs act as alternatives for short trade when short-selling is constrained. We repeat the above analysis by using the put-ELW trading volume to focus on the impact of the put-ELW, which is the direct substitution of short-sales. The results are very similar to Table 7.

## 5. Conclusion

We examine whether short-selling facilitates the arbitrage activities and alleviates the stock underpricing by using a positive PEAD as the natural experiment. If the industry has a large pool of stocks available to short-selling and there is no limit to arbitrage, then the underpriced stocks can return to its fundamental value in a very short time owing to the aggressive arbitrage. However, if short-selling activity of the industry is constrained for some reason, stocks in that industry cannot revert back to fundamental value because the difficult hedging via the substitute stocks prevents arbitrageurs from trading aggressively.

Using the quarterly earnings announcement of KOSPI200 composite stocks between January 2006 and December 2013, we find that positive earnings stocks in a difficult-to-short industry suffer the larger and more persistent delayed price response, that is, a larger positive PEAD than those in an easy-to-short industry. To confirm that the observed underpricing in a difficult-to-short industry is associated with a short-sale constraint, not with their illiquidity or information inefficiency, we also examine the firms' reaction to a negative earnings announcement. We did not find greater drifts after negative earnings

announcements in a difficult-to-short industry. This result shows that stock illiquidity or information inefficiency stories may not be the cause. The inverse relation between the positive PEAD and its industry's short-ability is stronger during the inactive ELW trade period, whereas it is weaker during the active ELW trade period; thereby suggesting that short-selling alleviates the mispricing by facilitating the arbitrage activities (not by the other channels) and ELW actually play roles as an alternative of short trade. In sum, short-selling help not only overpriced stocks but also underpriced stocks revert back to its fundamental value.

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**Table 1. Summary statistics for quarterly short-sale activities of 15 industries**

The sample stocks are categorized into fifteen different industries based on KSIC (Korean Standard Industrial Classification). The table presents the details of our industry classification and the summary statistics for short-sale activities of 15 industries. We compute quarterly *shorted firm ratios* for each industry and estimate time-series distribution of the industry's *shorted firm ratio* during the entire sample period (32 quarters). The industry's *shorted firm ratio* is defined as the number of stocks with nonzero shorting volume during the quarter divided by the total number of stocks in a given industry. For each industry, we calculate the number of quarters belonging to the bottom 50% based on its industry's shorted firm ratio of the entire 32 quarters (# of quarters belonging to difficult-to-short industry).

| Class | Industry name | # of stocks | Industry's' shorted firm ratio | | | | | | # of quarters belonging to |
|---|---|---|---|---|---|---|---|---|---|
| | | | Avg. | Std. | Min | Med | Max | Autocorr. | |
| 1 | Utility | 6 | 0.714 | 0.200 | 0.167 | 0.667 | 1 | 0.316 | 25 |
| 2 | Manufacturing (material) | 60 | 0.798 | 0.207 | 0.083 | 0.889 | 0.951 | 0.567 | 25 |
| 3 | Manufacturing (industrial goods) | 33 | 0.801 | 0.167 | 0.250 | 0.875 | 0.968 | 0.718 | 29 |
| 4 | Manufacturing (consumer goods) | 33 | 0.799 | 0.201 | 0.303 | 0.879 | 1 | 0.805 | 20 |
| 5 | Manufacturing (essential consumer goods) | 26 | 0.801 | 0.217 | 0.038 | 0.846 | 1 | 0.676 | 23 |
| 6 | Manufacturing (medical goods) | 19 | 0.810 | 0.233 | 0.000 | 0.895 | 1 | 0.541 | 20 |
| 7 | Manufacturing(IT) | 27 | 0.824 | 0.170 | 0.296 | 0.852 | 1 | 0.662 | 17 |
| 8 | Construction | 14 | 0.967 | 0.109 | 0.429 | 1.000 | 1 | 0.387 | 0 |
| 9 | Wholesale and retail | 10 | 0.775 | 0.217 | 0.222 | 0.800 | 1 | 0.873 | 16 |
| 10 | Transportation | 7 | 0.881 | 0.216 | 0.143 | 1.000 | 1 | 0.624 | 4 |
| 11 | Education and leisure | 6 | 0.943 | 0.197 | 0.000 | 1.000 | 1 | 0.353 | 1 |
| 12 | Media | 4 | 0.703 | 0.233 | 0.000 | 0.750 | 1 | 0.290 | 25 |
| 13 | Telecommunications | 3 | 1.000 | 0.000 | 1.000 | 1.000 | 1 | 1.000 | 0 |
| 14 | IT service(industrial goods) | 21 | 0.827 | 0.158 | 0.143 | 0.857 | 0.952 | 0.511 | 24 |
| 15 | Finance | 6 | 0.784 | 0.241 | 0.167 | 0.833 | 1 | 0.500 | 17 |
| Total | | 275 | 0.828 | 0.208 | 0.000 | 0.893 | 1 | | 32 |

**Table 2. Summary statistics for difficult-to-short and easy-to-short industry**

We divide the sample stocks into fifteen industries based on KSIC and calculate the industry's *shorted firm ratio* for each quarter. The industry's *shorted firm ratio* is defined as the number of stocks with nonzero shorting volume during the quarter divided by the total number of stocks in a given industry. In quarter *q*, the stock *i* is categorized as being in a difficult-to-short industry, if it belongs to the bottom 50% group based on its industry's *shorted firm ratio* in quarter *q*-1, however, it is categorized as coming from an easy-to-short industry, otherwise. *N* is number of stock-quarter in a given industry during the entire sample period. *SUE* (standardize unexpected earning) is an earnings surprise measure which is defined in Ball and Brown (1986). We define samples with *SUE* values greater than 1 as positive earnings stocks, and those with *SUE* less than -1 as negative earnings stocks. *ln(BM)* and *ln(Size)* are log book-to-market ratio and log market capitalization at the end of previous year, respectively. *Vol* is the stock return volatility defined as the standard deviation of daily returns and *Turn* is the turnover defined as the daily trading volume divided by the outstanding shares. *Vol* and *Turn* are calculated by daily trading data of the previous quarter. Panels A, B and C refer to all sample stocks, positive earnings stocks and negative earnings stocks, respectively. The $^{*}$, $^{**}$, and $^{***}$ denote the statistically significance at 10%, 5% and 1% levels, respectively.

**Panel A. All sample stocks**

| Variable | Easy-to-short (1) | Difficult-to-short (2) | Diff (1-2) | |
|---|---|---|---|---|
| *N* | 2645 | 4499 | | |
| *SUE* | 0.037 | 0.036 | 0.001 | |
| *ln(BM)* | 0.245 | 0.066 | 0.179 | *** |
| *ln(Size)* | 27.471 | 26.947 | 0.524 | *** |
| *Vol* | 0.025 | 0.026 | -0.001 | |
| *Turn* | 0.081 | 0.071 | 0.010 | ** |

**Panel B. Positive earnings stocks**

| Variable | Easy-to-short (1) | Difficult-to-short (2) | Diff (1-2) | |
|---|---|---|---|---|
| *N* | 441 | 743 | | |
| *SUE* | 2.001 | 1.978 | 0.022 | |
| *ln(BM)* | 0.209 | 0.023 | 0.185 | *** |
| *ln(Size)* | 27.294 | 26.825 | 0.468 | *** |
| *Vol* | 0.265 | 0.264 | 0.001 | |
| *Turn* | 0.086 | 0.074 | 0.012 | * |

**Panel C. Negative earnings stocks**

| Variable | Easy-to-short(1) | Difficult-to-short(2) | Diff (1-2) | |
|---|---|---|---|---|
| *N* | 554 | 915 | | |
| *SUE* | -1.799 | -1.929 | 0.130 | *** |
| *ln(BM)* | 0.268 | 0.195 | 0.074 | * |
| *ln(Size)* | 27.553 | 27.046 | 0.507 | *** |
| *Vol* | 0.258 | 0.259 | -0.001 | |
| *Turn* | 0.089 | 0.071 | 0.018 | ** |

**Table 3. PEAD for difficult-to-short and easy-to-short industry**

The table reports the difference in *CAR* around the earnings announcements between difficult-to-short industry and easy-to-short industry. The *CARs* are calculated by accumulating the market-adjusted returns during each specified period following the earnings announcement day (day=0). The market-adjusted returns are computed by subtracting the return on the market portfolio, which is the equal-weighted portfolio of all sample stocks, from the raw return on each stock. $Frac_n$ is the proportion of the drift resolved during n days adjacent the earnings announcement in the total PEAD. $Frac_n$ is calculated by dividing $CAR_{[0,n]}$ by $CAR_{[0,19]}$, where *n* is the number of trading days following (except) earnings announcements day. We divide the sample stocks into fifteen industries based on KSIC and calculate the industry's *shorted firm ratio* for each quarter. The industry's *shorted firm ratio* is defined as the number of stocks with nonzero shorting volume during the quarter divided by the total number of stocks in a given industry. In quarter *q*, the stock *i* is categorized as being in a difficult-to-short industry, if it belongs to the bottom 50% group based on its industry's *shorted firm ratio* in quarter *q*-1, however, it is categorized as coming from an easy-to-short industry, otherwise. We define samples with *SUE* values greater than 1 as positive earnings stocks, and those with *SUE* less than -1 as negative earnings stocks. *N* is number of stock-quarter in a given industry during the entire sample period. For analysis of *CARs*, we use the total positive (negative) earnings stocks, however, for analysis of *Fracs*, we limit our sample to the positive (negative) earnings stocks with positive (negative) PEAD (stocks with *SUE* larger (less) than 1 and positive (negative) $CAR_{[0,19]}$). Panels A and B provide the result analyzing the *CARs* and *Fracs*, respectively. The $^{*}$, $^{**}$, and $^{***}$ denote the statistically significance at 10%, 5% and 1% levels, respectively.

**Panel A. The magnitude of PEAD (*CARs*)**

| Variable | Class | Positive earnings stocks | | | Negative earnings stocks | | |
|---|---|---|---|---|---|---|---|
| | | N | Mean | *t*-stat | N | Mean | *t*-stat |
| $CAR_{[0,19]}$ | Easy-to-short(1) | 439 | 0.0071 | | 540 | -0.0115 | |
| | Difficult-to-short(2) | 738 | 0.0195 | | 884 | -0.0139 | |
| | Diff (1-2) | | -0.0124 | -1.95 * | | 0.0023 | 0.41 |
| $CAR_{[1,19]}$ | Easy-to-short(1) | 439 | 0.0015 | | 544 | -0.0078 | |
| | Difficult-to-short(2) | 738 | 0.0136 | | 888 | -0.0082 | |
| | Diff (1-2) | | -0.0120 | -2.06 ** | | 0.0004 | 0.08 |
| $CAR_{[0,0]}$ | Easy-to-short(1) | 439 | 0.0058 | | 540 | -0.0044 | |
| | Difficult-to-short(2) | 738 | 0.0060 | | 884 | -0.0056 | |
| | Diff (1-2) | | -0.0002 | -0.12 | | 0.0011 | 0.66 |

**Panel B. The persistency of PEAD (*Fracs*)**

| Variable | Class | Positive earnings stocks | | | Negative earnings stocks | | |
|---|---|---|---|---|---|---|---|
| | | N | Mean | *t*-stat | N | Mean | *t*-stat |
| $Frac_1$ | Easy-to-short(1) | 230 | 0.7049 | | 316 | 0.4393 | |
| | Difficult-to-short(2) | 397 | 0.3273 | | 508 | 0.1989 | |
| | Diff (1-2) | | 0.3776 | 1.39 | | 0.2404 | 1.29 |
| $Frac_3$ | Easy-to-short(1) | 230 | 0.6292 | | 318 | 0.4891 | |
| | Difficult-to-short(2) | 399 | 0.4117 | | 512 | 0.2313 | |
| | Diff (1-2) | | 0.2175 | 0.60 | | 0.2578 | 1.11 |
| $Frac_5$ | Easy-to-short(1) | 230 | 0.6183 | | 318 | 0.63 | |
| | Difficult-to-short(2) | 399 | 0.4766 | | 512 | 0.4488 | |
| | Diff (1-2) | | 0.1417 | 0.34 | | 0.1812 | 0.76 |
| $Frac_{10}$ | Easy-to-short(1) | 230 | 0.8381 | | 318 | 0.9393 | |
| | Difficult-to-short(2) | 399 | 0.4097 | | 512 | 0.6804 | |
| | Diff (1-2) | | 0.4284 | 1.57 | | 0.2588 | 0.79 |

**Table 4. The relationship between the positive PEAD and the short-ability of the industry group**

The table presents the results of regression analysis of the relationship between the positive PEAD and the short-ability of the industry group. Dependent variables are *CARs* and *Fracs*. The *CARs* are calculated by accumulating the market-adjusted returns during each specified period following the earnings announcement day (day=0). The market-adjusted returns are computed by subtracting the return on the market portfolio, which is the equal-weighted portfolio of all sample stocks, from the raw return on each stock. $Frac_n$ is the proportion of the drift resolved during n days adjacent the earnings announcement day in the total PEAD. $Frac_n$ is calculated by dividing $CAR_{[0,n]}$ by $CAR_{[0,19]}$, where *n* is the number of trading days following (except) earnings announcements day. We transform *CAR* and $Frac_n$ into a decile rank between 0 and 1.

*Difficult* is a dummy variable that equals to one if the stock belongs to difficult-to-short industry in the quarter *q-1*, and zero otherwise. *Shorted* is a dummy variable that equals to one if the stocks itself have nonzero shorting volume during the quarter *q-1*, and zero otherwise. *SS.Vol* is shorted volume to total trading volume ratio during each period corresponding with the dependent variables ($CAR_{[0,19]}$, $CAR_{[0,0]}$, $CAR_{[1,19]}$, and $\text{Frac}_n$s). *ln(BM)* and *ln(Size)* are the log book-to-market ratio and the log market capitalization at the end of previous year, respectively. *Vol* is the stock return volatility defined as the standard deviation of daily returns and *Turn* is the turnover defined as the daily average trading volume divided by the outstanding shares. *Mom* is the lagged returns adjusted by the market portfolio returns. *Vol*, *Turn*, and *Mom* are calculated by trading data of the previous quarter, respectively. $Vol_{ind}$ and $Turn_{ind}$ are measured as the average *Vol* and *Turn* across all stocks in a given industry, respectively. For analysis of *CARs*, we use the total positive earnings stocks (stocks with *SUE* greater than 1), however, for analysis of *Fracs*, we limit our sample to the positive earnings stocks with positive PEAD (stocks with *SUE* larger than 1 and positive $CAR_{[0,19]}$). Panels A and B provide the result analyzing the *CARs* and *Fracs*, respectively. The $^{*}$, $^{**}$, and $^{***}$ denote the statistically significance at 10%, 5% and 1% levels, respectively.

**Panel A. The magnitude of PEAD (*CARs*)**

| Variables | $CAR_{[0,19]}$ | | | $CAR_{[1,19]}$ | | | $CAR_{[0,0]}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef | *t*-stat | | Coef | *t*-stat | | Coef | *t*-stat | |
| *Intercept* | 2.96 | 1.63 | * | 1.51 | 0.83 | | 6.93 | 3.93 | *** |
| *Difficult* | 0.23 | 1.32 | | 0.27 | 1.66 | * | -0.01 | -0.03 | |
| *Shorted* | -0.37 | -1.43 | | -0.35 | -1.33 | | -0.11 | -0.42 | |
| *SS.Vol* | -4.15 | -0.98 | | -5.81 | -1.40 | | -1.82 | -0.65 | |
| *ln(BM)* | -0.04 | -0.29 | | -0.13 | -1.00 | | 0.07 | 0.56 | |
| *ln(Size)* | 0.09 | 1.30 | | 0.13 | 1.92 | * | -0.07 | -1.04 | |
| *Vol* | -4.17 | -3.23 | *** | -2.78 | -2.15 | ** | -2.46 | -1.89 | * |
| *Turn* | 1.29 | 1.50 | | 1.66 | 1.93 | * | -0.51 | -0.58 | |
| *Mom* | 0.19 | 0.47 | | -0.04 | -0.09 | | 0.23 | 0.56 | |
| $Vol_{ind}$ | 1.25 | 0.55 | | 1.03 | 0.45 | | 0.08 | 0.03 | |
| $Turn_{ind}$ | 1.06 | 0.52 | | 0.84 | 0.42 | | 2.32 | 1.14 | |
| *Obs.* | 1151 | | | 1151 | | | 1151 | | |
| *Adj.*$R^2$ | 0.018 | | | 0.014 | | | 0.009 | | |

**Panel B. The persistency of PEAD (*Fracs*)**

| Variables | $Frac_1$ | | | $Frac_3$ | | | $Frac_5$ | | | $Frac_{10}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef | *t*-stat | | Coef | *t*-stat | | Coef | *t*-stat | | Coef | *t*-stat | |
| *Intercept* | 0.60 | 2.48 | ** | 0.88 | 3.65 | *** | 0.73 | 2.97 | *** | 0.89 | 3.58 | *** |
| *Difficult* | -0.04 | -1.85 | * | -0.06 | -2.31 | ** | -0.05 | -1.97 | ** | -0.04 | -1.72 | * |
| *Shorted* | -0.02 | -0.67 | | 0.01 | 0.41 | | 0.00 | -0.07 | | -0.04 | -1.03 | |
| $SS.Vol_{[0,n]}$ | 0.67 | 1.55 | | 1.28 | 3.04 | *** | 0.73 | 1.50 | | 0.56 | 1.04 | |
| *ln(BM)* | 0.00 | 0.11 | | 0.01 | 0.73 | | -0.01 | -0.35 | | 0.03 | 1.53 | |
| *ln(Size)* | 0.00 | -0.28 | | -0.02 | -1.72 | * | -0.01 | -0.96 | | -0.01 | -1.32 | |
| *Vol* | -0.05 | -0.26 | | 0.05 | 0.26 | | 0.01 | 0.03 | | -0.11 | -0.63 | |
| *Turn* | -0.07 | -0.64 | | -0.11 | -0.96 | | -0.06 | -0.56 | | 0.01 | 0.11 | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Mom* | 0.16 | 2.66 | *** | 0.06 | 1.02 | | 0.03 | 0.43 | | 0.05 | 0.78 | |
| $Vol_{ind}$ | 0.36 | 1.16 | | 0.36 | 1.16 | | 0.44 | 1.44 | | 0.31 | 1.00 | |
| $Turn_{ind}$ | -0.35 | -1.22 | | -0.11 | -0.39 | | -0.30 | -1.07 | | -0.14 | -0.51 | |
| *Obs.* | 610 | | | 610 | | | 610 | | | 610 | | |
| *Adj.*$R^2$ | 0.022 | | | 0.030 | | | 0.015 | | | 0.013 | | |

**Table 5. The relationship between the negative PEAD and the short-ability of the industry group**

The table presents the results of regression analysis of the relationship between the negative PEAD and the short-ability of the industry group. Dependent variables are *CARs* and *Fracs*. The *CARs* are calculated by accumulating the market-adjusted returns during each specified period following the earnings announcement day (day=0). The market-adjusted returns are computed by subtracting the return on the market portfolio, which is the equal-weighted portfolio of all sample stocks, from the raw return on each stock. $Frac_n$ is the proportion of the drift resolved during n days adjacent the earnings announcement day in the total PEAD. $Frac_n$ is calculated by dividing $CAR_{[0,n]}$ by $CAR_{[0,19]}$, where *n* is the number of trading days following (except) earnings announcements day. We transform *CAR* and $Frac_n$ into a decile rank between 0 and 1.

*Difficult* is a dummy variable that equals to one if the stock belongs to difficult-to-short industry, and zero otherwise. *Shorted* is a dummy variable that equals to one if the stocks have nonzero shorting volume during the previous quarter, and zero otherwise. *SS.Vol* is short-sale volume to total trading volume ratio during each specified period following the earnings announcement day. *ln(BM)* and *ln(Size)* are the log book-to-market ratio and the log market capitalization at the end of previous year, respectively. *Vol* is the stock return volatility defined as the standard deviation of daily returns and *Turn* is the turnover defined as the daily average trading volume divided by the outstanding shares. *Mom* is the lagged returns adjusted by the market portfolio returns. *Vol*, *Turn*, and *Mom* are calculated by trading data of the previous quarter, respectively. $Vol_{ind}$ and $Turn_{ind}$ are measured as the average *Vol* and *Turn* across all stocks in a given industry, respectively. For analysis of *CARs*, we use the total negative earnings stocks (stocks with *SUE* less than 1), however, for analysis of *Fracs*, we limit our sample to negative earnings stocks with negative PEAD (stocks with *SUE* less than 1 and negative $CAR_{[0,19]}$). Panels A and B provide the result analyzing the *CARs* and *Fracs*, respectively. The $^{*}$, $^{**}$, and $^{***}$ denote the statistically significance at 10%, 5% and 1% levels, respectively.

**Panel A. The magnitude of PEAD (*CARs*)**

| Variables | $CAR_{[0,19]}$ | | | $CAR_{[1,19]}$ | | | $CAR_{[0,0]}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef | *t*-stat | | Coef | *t*-stat | | Coef | *t*-stat | |
| *Intercept* | 2.96 | 1.65 | * | 3.44 | 1.92 | * | 1.49 | 0.86 | |
| *Difficult* | -0.07 | -0.44 | | -0.06 | -0.37 | | -0.10 | -0.62 | |
| *Shorted* | -0.38 | -1.73 | * | -0.20 | -0.82 | | -0.89 | -3.63 | *** |
| $SS.Vol$ | -0.65 | -0.21 | | -0.80 | -0.26 | | -0.23 | -0.11 | |
| *ln(BM)* | 0.14 | 1.14 | | 0.04 | 0.30 | | 0.30 | 2.42 | ** |
| *ln(Size)* | 0.06 | 0.89 | | 0.03 | 0.50 | | 0.15 | 2.35 | ** |
| *Vol* | 0.81 | 1.98 | ** | 0.45 | 1.10 | | 0.96 | 2.39 | ** |
| *Turn* | -2.52 | -2.16 | ** | -1.50 | -1.29 | | -1.73 | -1.49 | |
| *Mom* | -0.15 | -0.21 | | -0.46 | -0.62 | | 0.20 | 0.28 | |
| $Vol_{ind}$ | 3.99 | 1.91 | * | 3.34 | 1.60 | | 0.90 | 0.43 | |
| $Turn_{ind}$ | -1.31 | -0.62 | | -0.59 | -0.28 | | -1.57 | -0.75 | |
| *Obs.* | 1304 | | | 1304 | | | 1304 | | |
| *Adj.*$R^2$ | 0.012 | | | 0.005 | | | 0.027 | | |

**Panel B. The persistency of PEAD (*Fracs*)**

| Variables | $Frac_1$ | | | $Frac_3$ | | | $Frac_5$ | | | $Frac_{10}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef | *t*-stat | | Coef | *t*-stat | | Coef | *t*-stat | | Coef | *t*-stat | |
| *Intercept* | 0.78 | 3.44 | *** | 0.78 | 3.42 | *** | 0.54 | 2.37 | ** | 0.82 | 3.62 | *** |
| *Difficult* | -0.03 | -1.47 | | -0.03 | -1.33 | | -0.01 | -0.62 | | -0.02 | -1.02 | |
| *Shorted* | 0.04 | 1.17 | | 0.04 | 1.19 | | 0.04 | 1.21 | | 0.06 | 1.92 | * |
| $SS.Vol_{[0,n]}$ | 0.42 | 1.30 | | -0.12 | -0.36 | | -0.52 | -1.44 | | -0.30 | -0.86 | |
| *ln(BM)* | 0.02 | 1.19 | | 0.04 | 2.67 | *** | 0.03 | 1.82 | * | 0.04 | 2.18 | ** |
| *ln(Size)* | -0.01 | -1.21 | | -0.01 | -1.05 | | 0.00 | -0.05 | | -0.01 | -1.32 | |
| *Vol* | -0.05 | -0.84 | | -0.03 | -0.58 | | -0.09 | -1.75 | * | -0.01 | -0.24 | |
| *Turn* | 0.06 | 0.38 | | -0.28 | -1.86 | * | -0.18 | -1.17 | | -0.07 | -0.45 | |
| *Mom* | -0.10 | -0.92 | | -0.02 | -0.22 | | -0.03 | -0.29 | | 0.03 | 0.26 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $Vol_{ind}$ | 0.13 | 0.48 | 0.30 | 1.13 | 0.22 | 0.81 | 0.11 | 0.40 |
| $Turn_{ind}$ | -0.20 | -0.68 | -0.09 | -0.29 | -0.07 | -0.23 | -0.16 | -0.53 |
| *Obs.* | 760 | | 760 | | 760 | | 760 | |
| *Adj.*$R^2$ | 0.014 | | 0.019 | | 0.017 | | 0.015 | |

**Table 6. PEAD during short-sale prohibition period and short-sale permission period**

The table reports the difference in the PEAD between short-sale prohibition period and short-sale permission period. We define the global financial crisis period (Oct 1, 2008 - May 31, 2009) and the European Financial crisis period (Aug 10, 2001 – Nov 10, 2011) as the short-sale prohibition period (1) because South Korean financial authority banned all short sales during these periods. The remaining sample period is defined as the short-sale permission period (2).

We measure the magnitude and the persistence of PEAD by *CARs and Fracs. Cars* are calculated by accumulating the market-adjusted returns during each specified period following the earnings announcement day (day=0). The market-adjusted returns are computed by subtracting the return on the market portfolio, which is the equal-weighted portfolio of all sample stocks, from the raw return on each stock. $Frac_n$ is the proportion of the drift resolved during n days adjacent the earnings announcement in the total PEAD. $Frac_n$ is calculated by dividing $CAR_{[0,n]}$ by $CAR_{[0,\ 19]}$, where *n* is the number of trading days following (except) earnings announcements day. We define samples with *SUE* values greater than 1 as positive earnings stocks, and those with *SUE* less than -1 as negative earnings stocks. *N* is number of stock-quarter in a given industry during the entire sample period. For analysis of *CARs*, we use the total positive (negative) earnings stocks, however, for analysis of *Fracs*, we limit our sample to the positive (negative) earnings stocks with positive (negative) PEAD (stocks with *SUE* larger (less) than 1 and positive (negative) $CAR_{[0,19]}$). The $^{*}$, $^{**}$, and $^{***}$ denote the statistically significance at 10%, 5% and 1% levels, respectively.

| Variable | Class | **Positive earning stocks** | | | | **Negative earnings stocks** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | Mean | *t*-stat | | N | Mean | *t*-stat | |
| *SUE* | non-Ban(1) | 1212 | 1.987 | | | 1152 | -1.878 | | |
| | Ban(2) | 123 | 1.848 | | | 298 | -2.130 | | |
| | Diff (1-2) | | 0.138 | 1.76 | * | | 0.251 | 4.29 | ** |
| $CAR_{[0,19]}$ | non-Ban(1) | 1177 | 0.015 | | | 1424 | -0.013 | | |
| | Ban(2) | 119 | 0.016 | | | 367 | -0.013 | | |
| | Diff (1-2) | | -0.010 | -0.12 | | | 0.000 | -0.05 | |
| $CAR_{[1,19]}$ | non-Ban(1) | 1184 | 0.009 | | | 1432 | -0.008 | | |
| | Ban(2) | 120 | 0.010 | | | 372 | -0.008 | | |
| | Diff (1-2) | | -0.001 | -0.04 | | | 0.000 | 0.02 | |
| $CAR_{[0,0]}$ | non-Ban(1) | 1177 | 0.006 | | | 1424 | -0.005 | | |
| | Ban(2) | 119 | 0.007 | | | 367 | -0.005 | | |
| | Diff (1-2) | | -0.002 | -0.37 | | | 0.000 | 0.00 | |
| $Frac_1$ | non-Ban(1) | 633 | 0.660 | | | 829 | 0.348 | | |
| | Ban(2) | 57 | 0.207 | | | 203 | 0.462 | | |
| | Diff (1-2) | | 0.453 | 1.52 | † | | -0.114 | -0.38 | |
| $Frac_3$ | non-Ban(1) | 635 | 0.559 | | | 835 | 0.328 | | |
| | Ban(2) | 60 | 0.161 | | | 204 | 0.663 | | |
| | Diff (1-2) | | 0.398 | 0.79 | | | -0.335 | -0.80 | |
| $Frac_5$ | non-Ban(1) | 635 | 0.845 | | | 835 | 0.459 | | |
| | Ban(2) | 60 | 0.016 | | | 204 | 0.437 | | |
| | Diff (1-2) | | 0.829 | 1.51 | † | | 0.022 | 0.07 | |
| $Frac_{10}$ | non-Ban(1) | 635 | 0.335 | | | 835 | 1.183 | | |
| | Ban(2) | 60 | -0.397 | | | 204 | 0.563 | | |
| | Diff (1-2) | | 0.732 | 0.72 | | | 0.621 | 1.90 | * |

**Table 7. The impact of the ELW trading volumes on the relation between the positive PEAD and the short-ability of the industry group**

We divide the entire sample periods into three groups; active, normal, and inactive ELW trade periods and examine in which period the inverse relation between the positive PEAD and its industry's short-ability is stronger by the multiple regressions. We calculate the daily average ELW trading volume for each quarter, by using trading data of individual ELWs (except index ELWs). If the quarter belongs to the bottom (upper) 30% based on the daily average ELW trading volume, we define it as inactive (active) ELW trade period. We run multiple regressions where dependent variables are *CARs* and *Fracs*, controlling for a variety of firm characteristics. The main explanatory variables are the interaction variables created by multiplying $Difficult_{i,q}$ with $Inactive_q$ and $Active_q$, respectively. (*Difficult x Inactive*, and $Difficult \times Active$) *Difficult* is one if the stock belongs to difficult-to-short industry and zero otherwise. *Inactive* (*Active*) is one if the quarter is inactive (active) ELW trade period and zero otherwise.

The definitions of dependent variables and other control variables are the same as Tables 4 and 5. For analysis of *CARs*, we use the total positive earnings stocks (stocks with *SUE* greater than 1), however, for analysis of *Fracs*, we limit our sample to the positive earnings stocks with positive PEAD (stocks with *SUE* larger than 1 and positive $CAR_{[0,19]}$). Panels A and B provide the result analyzing the *CARs* and *Fracs*, respectively. The $^{*}$, $^{**}$, and $^{***}$ denote the statistically significance at 10%, 5% and 1% levels, respectively. The † denotes the statistically significance at 15% levels.

**Panel A. The magnitude of PEAD (*CARs*)**

| Variables | $CAR_{[0,19]}$ | | | $CAR_{[1,19]}$ | | | $CAR_{[0,0]}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef | *t*-stat | | Coef | *t*-stat | | Coef | *t*-stat | |
| Intercept | 1.53 | 0.85 | | 0.40 | 0.22 | | 6.41 | 3.65 | *** |
| *Difficult* | 0.59 | 1.66 | * | 0.65 | 1.82 | * | -0.25 | -0.69 | |
| *Inactive* | -0.18 | -0.47 | | -0.11 | -0.29 | | -0.40 | -1.02 | |
| *Difficult x Inactive* | 0.10 | 0.20 | | -0.05 | -0.11 | | 0.57 | 1.21 | |
| *Active* | 0.43 | 1.27 | | 0.38 | 1.12 | | -0.08 | -0.22 | |
| *Difficult x Active* | -0.86 | -1.93 | * | -0.79 | -1.77 | * | 0.16 | 0.35 | |
| *Shorted* | -0.38 | -1.44 | | -0.36 | -1.34 | | -0.11 | -0.41 | |
| $SS.Vol$ | -5.59 | -1.29 | | -6.84 | -1.61 | | -2.33 | -0.83 | |
| *ln(BM)* | -0.09 | -0.66 | | -0.16 | -1.24 | | 0.04 | 0.32 | |
| *ln(Size)* | 0.14 | 2.03 | ** | 0.17 | 2.46 | ** | -0.04 | -0.66 | |
| *Vol* | 0.00 | -0.41 | | 0.00 | 0.24 | | 0.00 | -0.16 | |
| *Turn* | -0.13 | -0.17 | | 0.74 | 0.99 | | -1.41 | -1.88 | * |
| *Mom* | -0.15 | -0.39 | | -0.29 | -0.73 | | 0.05 | 0.12 | |
| $Vol_{ind}$ | -3.11 | -1.53 | | -1.72 | -0.85 | | -2.30 | -1.12 | |
| $Turn_{ind}$ | 3.06 | 1.49 | | 2.26 | 1.10 | | 3.01 | 1.45 | |
| *Obs.* | 1147 | | | 1147 | | | 1147 | | |
| *Adj.*$R^2$ | 0.015 | | | 0.015 | | | 0.007 | | |

**Panel B. The persistency of PEAD (*Fracs*)**

| Variables | $Frac_1$ | | | $Frac_3$ | | | $Frac_5$ | | | $Frac_{10}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef | *t*-stat | | Coef | *t*-stat | | Coef | *t*-stat | | Coef | *t*-stat | |
| Intercept | 0.55 | 2.29 | ** | 0.88 | 3.70 | *** | 0.72 | 2.99 | *** | 0.83 | 3.37 | *** |
| *Difficult* | -0.04 | -1.18 | | -0.04 | -1.47 | †□ | -0.03 | -1.04 | | -0.04 | -1.24 | |
| *Inactive* | 0.04 | 0.71 | | 0.10 | 1.76 | * | 0.08 | 1.53 | † | 0.06 | 1.00 | |
| *Difficult x Inactive* | -0.04 | -0.68 | | -0.11 | -1.66 | * | -0.10 | -1.62 | †□ | -0.07 | -1.14 | |
| *Active* | 0.01 | 0.16 | | 0.00 | 0.09 | | 0.01 | 0.10 | | -0.02 | -0.40 | |
| *Difficult x Active* | -0.01 | -0.11 | | 0.01 | 0.21 | | 0.00 | 0.06 | | 0.05 | 0.74 | |
| *Shorted* | -0.02 | -0.51 | | 0.01 | 0.40 | | 0.00 | -0.12 | | -0.04 | -1.10 | |
| $SS.Vol_{[0,n]}$ | 0.71 | 1.63 | | 1.39 | 3.26 | *** | 0.83 | 1.67 | * | 0.56 | 1.04 | |
| *ln(BM)* | 0.00 | -0.15 | | 0.01 | 0.60 | | -0.01 | -0.45 | | 0.02 | 1.29 | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *ln(Size)* | 0.00 | -0.14 | | -0.02 | -1.80 | * | -0.01 | -1.02 | | -0.01 | -1.13 |
| *Vol* | 0.00 | 1.22 | | 0.00 | 0.39 | | 0.00 | 0.21 | | 0.00 | 0.44 |
| *Turn* | -0.08 | -0.81 | | -0.09 | -0.90 | | -0.06 | -0.57 | | -0.02 | -0.20 |
| *Mom* | 0.15 | 2.57 | *** | 0.06 | 1.06 | | 0.02 | 0.40 | | 0.04 | 0.64 |
| $Vol_{ind}$ | 0.33 | 1.19 | | 0.37 | 1.36 | | 0.44 | 1.58 | | 0.23 | 0.83 |
| $Turn_{ind}$ | -0.30 | -1.03 | | -0.04 | -0.15 | | -0.25 | -0.85 | | -0.08 | -0.28 |
| *Obs.* | 606 | | | 606 | | | 606 | | | 606 | |
| $Adj.R^2$ | 0.026 | | | 0.036 | | | 0.019 | | | 0.016 | |

**Figure 1. Historical trends of the short selling activities of the sample stocks**

The figure shows the short selling activities observed in our sample stocks during the entire sample period. We present the quarterly sum of shorting volumes of our sample stocks (Total short volume) and the quarterly proportion of the stocks with nonzero shorting volume in the total sample stocks (Proportion of shorted stocks). And we present the quarterly average and standard deviation of industry's *shorted firm ratio*, respectively. We divide the sample stocks into fifteen industries based on KSIC and calculate the industry's *shorted firm ratio* for each quarter. The industry's *shorted firm ratio* is defined as the number of stocks with nonzero shorting volume during the quarter divided by the total number of stocks in a given industry.

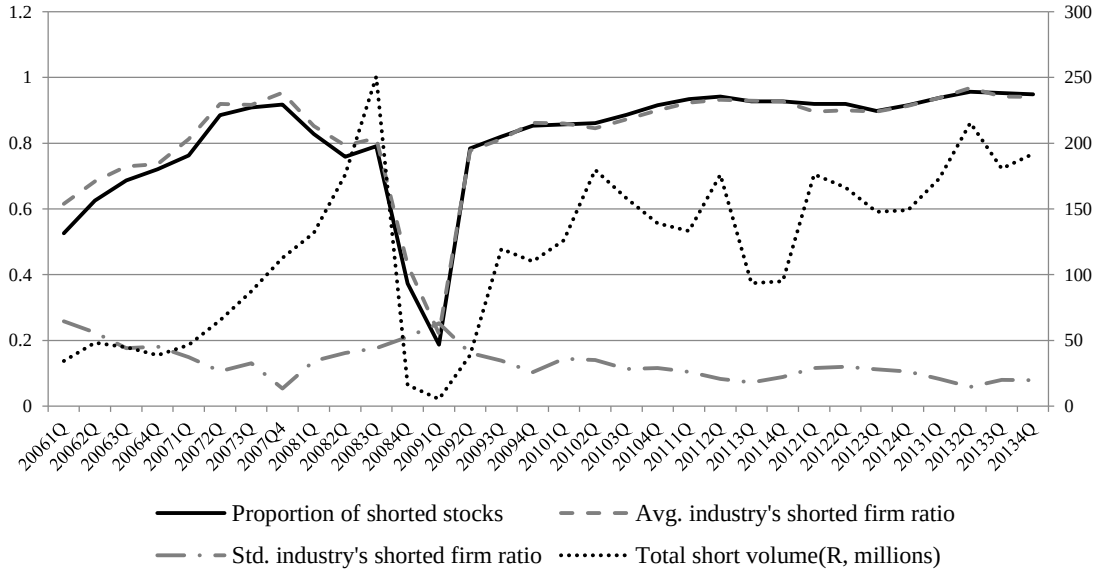
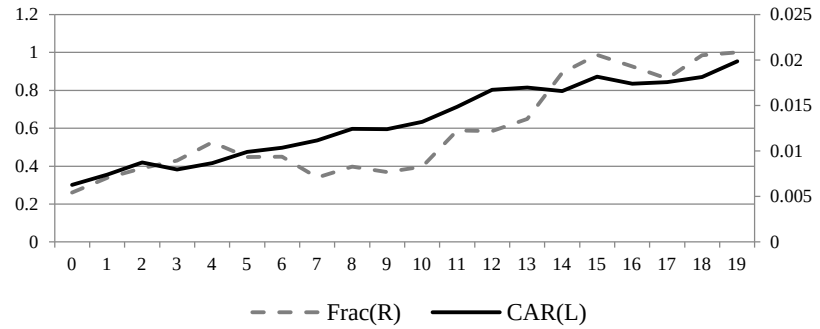


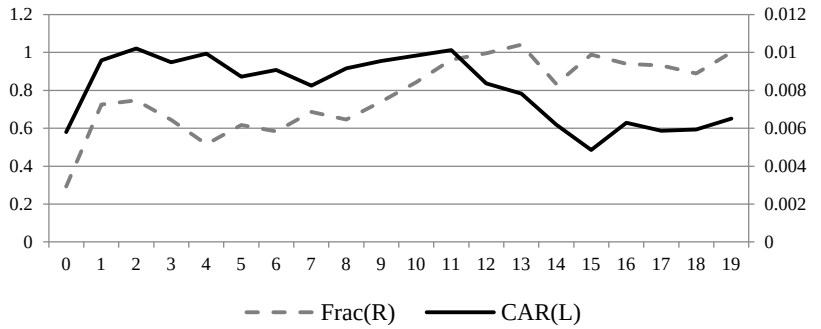
**Figure 2. *CARs* around earnings announcement day of difficult-to-short and easy-to-short industry**

The figure presents cumulative abnormal returns (*CARs*) around earnings announcement day of difficult-to-short and easy-to-short industry. We divide the sample stocks into fifteen industries based on KSIC and calculate the industry's *shorted firm ratio* for each quarter. The industry's *shorted firm ratio* is defined as the number of stocks with nonzero shorting volume during the quarter divided by the total number of stocks in a given industry. In quarter *q*, the stock *i* is categorized as being in a difficult-to-short industry, if it belongs to the bottom 50% group based on its industry's *shorted firm ratio* in quarter *q*-1, however, it is categorized as coming from an easy-to-short industry, otherwise. *SUE* (Standardize unexpected earning) is an earnings surprise measure which is defined in Ball and Brown (1986). We define samples with *SUE* values greater than 1 as positive earnings stocks, and those with *SUE* less than -1 as negative earnings stocks. Panels A and B shows *CARs* following earnings announcement day of positive earnings stocks in two groups. Panels C and D presents *CARs* following earnings announcements day of negative earnings stocks in two groups. The dash-line is the *Fracs*, which is the proportion of the drift resolved during n days adjacent the earnings announcement in the total PEAD ($CAR_{[0,19]}$).

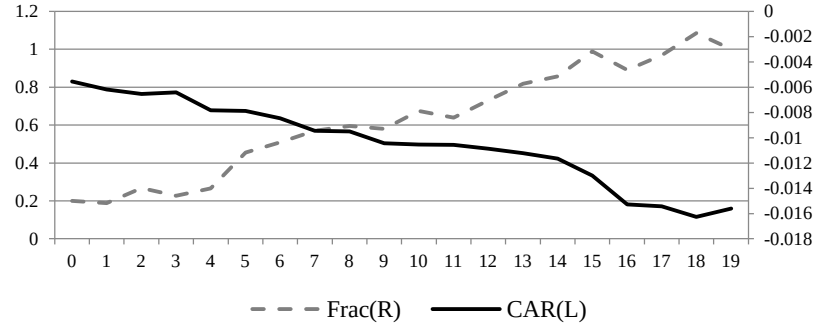
**Panel A. Positive earnings stocks in difficult-to-short industry**




**Panel B. Positive earnings stocks in easy-to-short industry**




**Panel C. Negative earnings stocks in difficult-to-short industry**




**Panel D. Negative earnings stocks in easy-to-short industry**

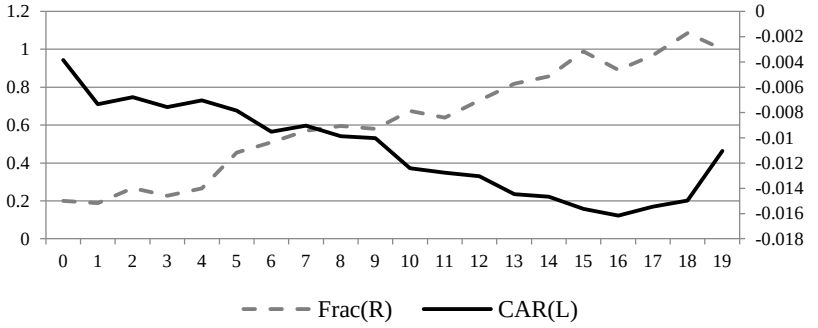


**Figure 3. ELW trading volume and KOSPI stock market index**

The figure shows the time-series relationship among daily average put-ELW trading volume, all ELW trading volume and KOSPI stock market index for each quarter from January, 2006 to December, 2013.