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EFFECTS OF THE PRE-REPURCHASE SYSTEMATIC RISK ON THE RELATIONSHIP BETWEEN INVESTOR BEHAVIOR, MARKET FACTORS AND THE STOCK PRICE RESPONSES

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Abstract. This study explores the pre-repurchase systematic risk will affect the abnormal returns in the open-market repurchase event period and also change the relationship between the investor sentiment, trading activity, market factors and stock price response during the event on Taiwan stock market. Based on threshold regression models, it is found that the pre-repurchase systematic risk will significantly change the relationship between investor behavior, market factors and stock price responses and the asymmetry of the relationship exists when pre-repurchase systematic risk is lower than a repartition, which supports that institutional investors and credit trading investors differ in these existing relationships. When the pre-repurchase beta is below repartition, it will be detrimental to the returns in event period. But on the contrary, the returns in the short-term shock of news exposure period present the favorable results, which may be related to the fact that there exists sentiment premium in short-term when credit trading investors' repurchase news exposure occurs. Finally, the study is to confirm the effect of systematic risk for returns and investor sentiment, these results have not been further explored in the past, and can be used as the firm's evaluation reference to the repurchase program in the future.

Keywords: the open-market share repurchases, investor sentiment, stock price responses, the pre-repurchase beta, asymmetry of the relationship, the threshold regression model.

JEL Classification: G14, C12.

Introduction

The Open-Market Repurchases (OMR) program is one of the hot topics studies in the current capital market, especially the main purpose of the implementation is to protect the interests of shareholders. Aimed at the fact whether OMR has the positive effect on *CAR* of share repurchase in the event period, there are some differences in the previous research results and these results are in contradiction with the argument of signaling undervaluation (Su & Lin, 2012; Huang, Liano, Manakyan, & Pan, 2013; Cheng & Hou, 2013); at the same time,

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the previous researches seldom analyze the effect of OMR in the event period on investor sentiment on the trading market from the perspective of behavioral finance, or only from the effect of market situations to analyze (Chen & Liu, 2018), not from the repurchase program in the stock price of risk, and emphasize the importance of systematic risk before the OMR.

Therefore, this study use the multiple linear regression models to explore the relationship between investor sentiment, trading activity, market factors and the stock price responses on the trading market in the share repurchase event period. Besides, the systemic risk is commonly used to evaluate the risk of the stock price changes (Sheu & Cheng, 2012), and the paper also apply the pre-repurchase systemic risk (threshold variable) used on threshold regression model to explore the impact of the pre-repurchase systematic risk on the relationship between investor sentiment, trading activity, market factors and the stock price responses, that is, when the pre-repurchase systematic risk is lower than one specific value, it will change the existing relationship. According to the results of this study, we can clarify the relationship between investor behaviors, market factors and the stock price responses on the market in the repurchase event period, and prove that the pre-repurchase systematic risk has influence on the stock price response in the share repurchase program.

This paper is structured as follows. Section 1 discusses the Literature Review and Section 2 presents Data and Empirical Methods. Section 3 shows the Empirical Results and Conclusions.

1. Literature review

The past research discussing the open-market repurchases (OMR) mostly supports that there are positive abnormal returns after the announcement of share repurchases (Ginglinger & L'her, 2006; Gong, Louis, & Sun, 2008; Cheng & Lin, 2012; Hsu & Huang, 2016; Caton, Goh, Lee, & Linn, 2016; Li, 2016; Chen & Liu, 2018). Therefore, part of research further makes the explanation according to the positive stock returns incurred. For instance, Andriosopoulos and Hoque (2013) found that size, cash dividends and ownership concentration have the significant effect on the stock price of share repurchase firms. Secondly, some research thought that the positive effect of share repurchases on stock price is related to corporate governance (Caton et al., 2016) and ownership structure (Ginglinger & L'her, 2006). Gong et al. (2008) believed that the abnormal returns after repurchase and the improvement of corporate operation performance partly come from the control of earnings management before repurchase, instead of really coming from the firm's earnings growth. Mishra, Racine, and Schmidt (2011) supported that the abnormal returns obtained from the current announcement are positively correlated to the credibility completed by the past announcement. Andriosopoulos and Lasfer (2015) found the concrete governance and corporate culture may all be the impact factors.

According to the signaling hypothesis, repurchase firms use the announcement of OMR's signal to convey the information of firm stock undervaluation to affect stock return on the market (Jagannathan & Stephens, 2003; Zhang, 2005; Dunn, Fayman, & McNutt, 2011; Huang, 2015). Li (2016) found that the positive abnormal returns incurred after the announcement of Taiwan's share repurchase have the first-month effect because it is the result of receiving the firm information. Ha, Hong, and Lee (2011) believed that the broad sense

of stock dividend includes cash dividends and share repurchases and the signal includes the current undervaluation and future cash flows. Wang, Strong, Tung, and Lin (2009) tested the market reaction to share repurchase announcement event and found that the market will positively respond to the event, which proves that the share repurchase announcement has other information implication and supports that the share repurchase will reduce firm's agency costs of excessive free cash-flow.

Some studies support that OMR firms' insiders (like firm managers) possess private information that significantly correlates to the announcement period and post-announcement abnormal returns or long-run abnormal returns (Babenko, Tserlukevich, & Vedrashko, 2012; Fei Leng, 2013; Jategaonkar, 2013; Chen, Chen, Huang, & Schatzberg, 2014; Leng & Zhao, 2014). But some studies have different views, Bonaimé and Ryngaert (2013) considered that repurchase firms' insider trading activity is not always consistent with undervaluation. Liu and Swanson (2016) found that the insiders of the repurchase stock during quarters is usually shorts sell. In addition, Golbe and Nyman (2013) researched how share repurchases affect the ownership stake of outside blockholders and mainly took institutional investors as the subjects. The results showed that share repurchases will make the tendency of outside ownership become decentralized, which may reduce the effect of outside shareholder on firm's decision-making. Jain (2007) found that individual investors and institutional investors have different preferences for share repurchase firms and the institutional investors having the information advantages will prefer larger share repurchase firms, but individual investors dislike share repurchase firms. Cheng and Hou (2017) found that foreign institutional investors have holdings in high-credibility firms that are linked to higher excess earnings during the period of open market repurchases.

Lin, Stephens, and Wu (2014) indicated that if the firm value presents the negative shock during the OMR announcement, it discloses that the repurchase firms' growth opportunity will slow down or the future asset performance will be poor. Thus, they will be likely to become takeover targets and it will also make the investors face higher takeover risk. Grullon and Michaely (2004) found that OMR's firm business performance will not increase with the announcement of repurchase program and meanwhile they found that share repurchase firm's systematic risk and cost of capital will significantly reduce compared with non-repurchasing firms. According to Liang (2016), the stock acquisition makes investors feeling high sensitivity, so mispricing is caused and sentiment-driven undervaluation may lead to the difficulty to value (limits to arbitrage), instead of investor overreaction. Finally, Chen and Liu (2018) used market return as threshold variable in threshold regression model to explain market situations for impact of the relationship between investor sentiment and CAR, and support investor sentiment can explain to the CAR, when stock market is extremely pessimistic, relation between investor sentiment and *CAR* will change.

2. Data and empirical methods

The subjects verified by this research were the common stocks listed on Taiwan's stock exchange market (SEM) and over-the-counter market (OTCM). The study period was from January 2008 to December 2015; OMR firms were used as the samples and then Financial

and Insurance industry stocks and the sample having the data vacancy were removed; the samples whose pre-repurchase beta estimated by market model has not significantly reached zero[1] were adopted and the sample size gained was 927. The data source was taken from Taiwan Economic Journal Database (TEJ). The following is a description of how to evaluate the pre-repurchase beta from the stock pricing model in the Event Study.

By reference to the verification method of Chen and Liu (2018), this research adopted Event Study to evaluate the abnormal returns (AR) of OMR stock price in the event period.[2] Event day is the announcement day of repurchase news. If $t = 0$ and event windows are indicated as [–20, +40] from the 20th trading day ($t = -20$) before the event day to the 40th trading day ($t = +40$) after the event day, "estimation period" refers to the trading day from the 200th trading day before event period to the 1st trading day before the event period, namely [–220, –21] was used as the estimation period and then the data during the estimation period and the market model were used as the evaluation model of stocks. Thus, we use ordinary least squares (OLS) to estimate the parameters for the market model $\hat{r}_{i,t} = \hat{\alpha}_i + \hat{\beta}_i \cdot r_{M,t}$, among which $\hat{r}_{i,t}$ is the repurchase firm's expected stock returns in the event period, $\hat{\alpha}_i$ and $\hat{\beta}_i$ respectively show the constant term and the pre-repurchase systematic risk (beta), and $r_{M,t}$ is the actual returns of the market index.

When the stock price is affected by the news exposure of OMR program, it will cause the stock's realized returns and expected returns to produce deviation, called abnormal return (AR), and its form is $AR_i = r_{i,t} - \hat{r}_{i,t}$. Besides, each AR on each trading day in the event period is accumulated and summed up to gain the cumulative abnormal returns (CAR). At this time, CAR [–20, +40] is used to measure the stock price responses in the share repurchase event. Furthermore, investor sentiment, trading activity, market factors and other explanatory variables are estimated together in the period corresponding to purchased shares in the event period. The related research model form is explained as below.

2.1. Multiple linear regression models

This research firstly used the multiple linear regression models to discuss the relationship between variables of investor sentiment, trading activity, market factors and price uncertainty in share repurchase event period and *CAR*. The model form is shown as below:

$$CAR_i = c_0 + \alpha_1 \cdot BSI_{Inst_i} + \alpha_2 \cdot BSI_{SE_i} + \alpha_3 \cdot BSI_{SL_i} + \beta_1 \cdot Turn_i + \gamma_1 \cdot HSR_{Inst_i} + \mu_1 \cdot BFR_i + \theta_1 \cdot UNCERT_i + \delta_1 \cdot DUM_{list_i} + \varphi_1 \cdot DUM_{down_i} + \varepsilon_i. \quad (1)$$

In Eq. (1), Ordinary Least Squares (OLS) is used to estimate various parameters in the model. Among them, CAR_i is *CAR*. At this time, it is viewed as dependent variable and classified into the CAR [–20, +40] in share repurchase event period and CAR [–1, +5] in the short-term shock of the repurchase news exposure period. Moreover, the independent

[1] If the BETA is zero, then the market return does not explain the individual stock return, and so the market model cannot be used as the pricing model for an individual stock.

[2] According to Taiwan's laws and regulations, the repurchase firms should make the announcement and complete the declaration within 2 business days since the date when the board of directors makes the decision, and meanwhile the repurchase should be completed within 2 months since the declaration date.

variables respectively corresponding to [–20, +40] and [–1, +5] were used to indicate BSI_{Inst_i}, BSI_{SE_i}, and BSI_{SL_i} as buy-sell imbalance (BSI) of institutional investors, margin trading investors and short selling investors (Kumar & Lee, 2006; Chen & Liu, 2018), so as to represent the investor sentiment in the calculation period. Among them, institutional investors tend to be the traders possessing the information while credit trading investors tend to be the short-swing traders. $Turn_i$ is the average of daily turnover rate. HSR_{Inst_i} is the average of shareholding ratio of institutional investors. BFR_i is the average of bearing/financing ratio. At this time, when BFR_i value is higher, it means that credit trading investors have the viewpoint that OMR stock price tends to fall.

$UNCERT_i$ is the average of daily price uncertainty of share repurchases, namely it is the average of "(high price – low price)/midpoint price" on each trading day in the event period. DUM_{list_i} is the dummy variable of listed market category of share repurchases, namely when the share repurchases belong to SEM, the given DUM_{list_i} value is 0. Otherwise, the given DUM_{list_i} value by OTCM is 1. When $\delta_1 \neq 0$, it means that the share repurchases of SEM and OTCM have the significant difference in stock price responses. In the end, in the calculation period, it is tested that market index has the significantly better performance in the stock price of repurchase firms during the fall period compared with the rise period. Therefore, DUM_{down_i} is defined as the dummy variable of down of the market index, namely when the share repurchases are in [–20, +40] ([–1, +5]) and the market index falls, the given DUM_{down_i} value is 1. Otherwise, it is 0. Therefore, if $\varphi_1 \neq 0$, it means that when market index falls and rises in the repurchase period, the different conditions will make the share repurchases have the significant difference in stock price responses.

2.2. Multiple linear regression models

This paper intends to further test when the pre-repurchase systematic risk is lower than one value (repartition), it will make the relationship investor sentiment, trading activity, market factors and *CAR* of share repurchases change. Thus, these relationships will have the asymmetry, namely the evidence that the pre-repurchase systematic risk will change the sensitivity between investor sentiment, trading activity, market factors and the stock price responses is found. Therefore, the pre-repurchase beta was used as the control variable to discuss that structural change will occurs to the multiple linear regression model (Eq. (1)) under some conditions.

If there are k potential thresholds and repartitions are respectively τ_1, τ_2, … and τ_1, CAR_i is the *CAR* of share repurchases in the i^{th} firm. At the same time, it will be related to various independent variables in Eq. (1) and comply with k+1 regime's regression model. Therefore, it can be indicated as below:

$$\begin{aligned} CAR_i = {} & (c_1 + \sum \alpha_1 \cdot Indpendent\_variables_i) \cdot I(Beta_i \leq \tau_1) + \\ & (c_2 + \sum \alpha_2 \cdot Indpendent\_variables_i) \cdot I(\tau_1 < Beta_i \leq \tau_2) + \\ & (c_{k+1} + \sum \alpha_{k+1} \cdot Indpendent\_variables_i) \cdot I(Beta_i \geq \tau_k) + \varepsilon_i. \end{aligned} \quad (2)$$

In Eq. (2), $I(\cdot)$ is indicator function and $Beta_i$ is the pre-repurchase systematic risk. At this time, it is regarded as threshold variable. When $\tau_i < Beta_i \leq \tau_{i+1}$, $I(\tau_i < Beta_i \leq \tau_{i+1}) = 1$ and the remaining $I(\cdot) = 0$. At this time, CAR_i of share repurchases will be explained by component $c_{j+1} + \sum \alpha_{j+1} \cdot Indpendent\_variables_i$ of the $(j+1)^{th}$ system. ε_i is the error term

and it conforms to the white noise. Secondly, threshold value and repartitions were tested by the method proposed by Bai and Perron (2003) to conclude the results. At this time, if it is tested that there at least exists the situation of single threshold value, it means that when the pre-repurchase systematic risk is lower than one value (repartition), it will make the relationship between investor sentiment, trading activity, market factors and *CAR* of share repurchases produce structural change.

3. Empirical results

3.1. Summary of statistics and correlations matrix

Figure 1 is the line chart of the average rate of AR ($\overline{AR}$) and the average rate of *CAR* ($\overline{CAR}$) of Taiwan's OMR in [–20, +40]. According to figure 1, it can be found that the repurchase firm's $\overline{CAR}$ before the repurchase news exposure will significantly be smaller than 0 and declines gradually. But under the shock after the repurchase news exposure and implementation of repurchase program, $\overline{CAR}$ conversely rises and finally converts into the positive value, showing that the share repurchase event has the positive effect on firm's stock price. Therefore, the fact that Taiwan's OMR program is in line with the signaling hypothesis is supported. Table 1 is the summary of statistics for a sample of 927 in Taiwan's open-market share repurchase programs, $\overline{CAR}$ [–20, +40] (the average rate of *CAR* in [–20, +40]) is 4.3908% and it is slightly smaller than $\overline{CAR}$ [–1, +5] (the average rate of *CAR* in [–1, +5]) which is 4.4185%, showing that the market has almost reflected all the information set of repurchase event in [–1, +5] in the stock price. The information also includes the follow-up information actually implemented in the repurchase period. So, it is believed that the market information reaction to the entire repurchase event tend to be efficient. In terms of BSI, it can be found that the average of BSI ($\overline{BSI}$) of institutional investors (BSI_{Insti}) and margin trading investors (BSI_{SEi}) is negative no matter whether it is in [–20, +40] or in [–1, +5], showing that institutional investors and margin trading investors have not been affected by the repurchase program to produce the positive investor sentiment. But the $\overline{BSI}\left[-20,+40\right]$ of short selling investors (BSI_{SL_i}) is –0.0187 and $\overline{BSI}$ [–1, +5] is 0.0160, which shows that the investor sentiment of short selling investors will go through the short-term shock of repurchase news exposure to present the effect of positive value.

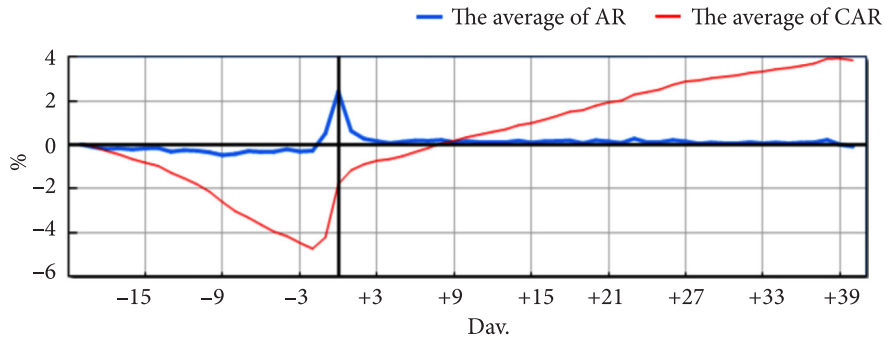

Figure 1. The line chart of stock price responses in the share repurchase event period [–20, +40]

The average of daily turnover rate ($Turn_i$) is 0.7964% and 0.9302% respectively in [–20, +40] and [–1, +5], showing that under the shock of repurchase news exposure, the daily turnover rate of share repurchase will increase. The average of institutional investors' shareholding ratio (HSR_{Inst_i}) is respectively 9.0042% and 8.9544% in [–20, +40] and [–1, +5]; the average of bearing/financing ratio (BFR_i) is respectively 2.3166% and 2.3591% in [–20, +40] and [–1, +5]. The average of daily price uncertainty ($UNCERT_i$) is respectively 5.5681% and 1.1877% in [–20, +40] and [–1, +5]. The results show that the daily price uncertainty of repurchase share decreases sharply under the short-term shock of repurchase news exposure, which also implies that the buyer and seller will reduce the difference degree in the cognition or information of the intraday trading price in the first time of repurchase announcement news exposure.

Table 1. Summary of statistics for a sample of 927 in Taiwan's open-market share repurchase programs

Period	Part I. The repurchase event period in [–20, +40]		Part II. The short-term shock of the repurchase news exposure in [–1,+5]	
Statistic	Mean	Std. Deviation	Mean	Std. Deviation
CAR_i	4.3908	19.7071	4.4185	7.4183
BSI_{Inst_i}	–0.1618	0.4201	–0.1795	0.6736
BSI_{SE_i}	–0.2860	0.3264	–0.2563	0.5483
BSI_{SL_i}	–0.0187	0.2453	0.0160	0.5935
$Turn_i$	0.7964	0.8492	0.9302	1.0383
HSR_{Inst_i}	9.0042	11.2753	8.9544	11.3441
BFR_i	2.3166	4.9440	2.3591	6.0370
$UNCERT_i$	5.5681	3.3770	1.1877	0.7565
DUM_{list_i}	0.3700	0.4820	0.3700	0.4820
DUM_{down_i}	0.6300	0.4820	0.4700	0.5000
Sample number	927	927	927	927

Table 2. Correlations matrix

Part I. The repurchases event period in [–20, +40]									
Variables	CAR_i	BSI_{Inst_i}	BSI_{SE_i}	BSI_{SL_i}	$Turn_i$	HSR_{Inst_i}	BFR_i	$UNCERT_i$	DUM_{list_i}
BSI_{Inst_i}	0.195	1							
	(0.000)	.							
BSI_{SE_i}	–0.097	–0.127	1						
	(0.001)	(0.000)	.						
BSI_{SL_i}	0.219	0.038	0.125	1					
	(0.000)	(0.125)	(0.000)	.					
$Turn_i$	–0.071	0.014	0.342	0.048	1				
	(0.015)	(0.332)	(0.000)	(0.073)	.				
HSR_{Inst_i}	–0.043	–0.095	0.251	0.065	0.043	1			
	(0.094)	(0.002)	(0.000)	(0.024)	(0.096)	.			

End of Table 2

Part I. The repurchases event period in [–20, +40]									
Variables	CAR_i	BSI_{Inst_i}	BSI_{SE_i}	BSI_{SL_i}	$Turn_i$	HSR_{Inst_i}	BFR_i	$UNCERT_i$	DUM_{list_i}
BFR_i	–0.063	0.097	0.175	0.044	0.315	0.317	1		
	(0.027)	(0.001)	(0.000)	(0.088)	(0.000)	(0.000)	.		
$UNCERT_i$	0.041	–0.128	–0.285	–0.107	0.009	–0.004	–0.029	1	
	(0.019)	(0.000)	(0.000)	(0.001)	(0.394)	(0.450)	(0.190)	.	
DUM_{list_i}	–0.073	0.021	0.023	–0.032	0.170	–0.277	0.004	0.110	1
	(0.013)	(0.263)	(0.242)	(0.165)	(0.000)	(0.000)	(0.447)	(0.000)	.
DUM_{down_i}	0.004	–0.112	–0.349	–0.041	–0.069	–0.040	–0.051	0.445	0.000
	(0.446)	(0.000)	(0.000)	(0.105)	(0.017)	(0.111)	(0.060)	(0.000)	(0.498)
Part II. The short-term shock of the repurchases news exposure period in [–1,+5]									
Variables	CAR_i	BSI_{Inst_i}	BSI_{SE_i}	BSI_{SL_i}	$Turn_i$	HSR_{Inst_i}	BFR_i	$UNCERT_i$	DUM_{list_i}
BSI_{Inst_i}	0.096	1							
	(0.002)	.							
BSI_{SE_i}	–0.067	–0.137	1						
	(0.021)	(0.000)	.						
BSI_{SL_i}	0.215	0.103	0.032	1					
	(0.000)	(0.001)	(0.164)	.					
$Turn_i$	–0.025	0.034	0.170	0.037	1				
	(0.224)	(0.149)	(0.000)	(0.131)	.				
HSR_{Inst_i}	–0.074	–0.086	0.136	–0.092	0.011	1			
	(0.012)	(0.004)	(0.000)	(0.003)	(0.366)	.			
BFR_i	–0.080	0.022	0.134	–0.020	0.221	0.264	1		
	(0.007)	(0.253)	(0.000)	(0.270)	(0.000)	(0.000)	.		
$UNCERT_i$	–0.004	–0.034	–0.200	–0.097	–0.003	0.006	–0.027	1	
	(0.446)	(0.153)	(0.000)	(0.002)	(0.459)	(0.426)	(0.202)		
DUM_{list_i}	–0.008	0.071	–0.022	0.051	0.164	–0.280	–0.013	0.047	1
	(0.401)	(0.016)	(0.254)	(0.060)	(0.000)	(0.000)	(0.344)	(0.075)	.
DUM_{down_i}	0.053	–0.111	–0.126	–0.095	–0.071	0.053	–0.006	0.159	–0.038
	(0.054)	(0.000)	(0.000)	(0.002)	(0.015)	(0.054)	(0.429)	(0.000)	(0.122)

Note: p-values in parentheses.

Table 2 is the Correlations Matrix, which mainly describes the linear correlation between variables and variables, have results of the estimated correlation coefficients of the part I (the repurchases event period in [–20, +40]) and part II (the short-term shock of the repurchases news exposure period in [–1, +5]). There is a significant correlation between the estimated correlation coefficients between these variables and *CAR* (at least one item in [–20, +40] or [–1, +5]) from table 2 (p-values < 0.1).

3.2. Results of the multiple linear regression model

Table 3 shows the various parameter results in the multiple linear regression model estimated by OLS and then t statistic estimated by these parameters was used to test the relationship between investor sentiment, trading activities, market factors and *CAR*. First of all, Part I in Table 3 is the repurchase event period in [–20, +40]. Under the significant level of 5%, the parameters for *BSI* of institutional investors (BSI_{Inst_i}) and short selling investors (BSI_{SL_i}) and the average of daily price uncertainty ($UNCERT_i$) are respectively 9.1055, 18.5927 and 0.5655 and they are significantly positive, showing that the *BSI* of institutional investors and short selling investors and the average of daily price uncertainty are respectively positively correlated to *CAR* [–20, +40]. Under the significant level of 10%, the parameters for bearing/financing ratio (BFR_i) and the dummy variable of listed market category (DUM_{list_i}) are respectively –0.2443 and –3.2913 and they are significantly negative, showing that the 2 variables are respectively negatively correlated to *CAR* [–20, +40], namely it supports the share repurchase having the higher bearing/financing ratio and OTCM, which will have the worse stock price response.

The part II in Table 3 is the results of short-term shock of the repurchase news exposure period in [–1, +5]. Under the significance at 5% level, the estimation parameters for BSI of institutional investors (BSI_{Inst_i}) and short selling investors (BSI_{SL_i}) and the dummy variable of down of market index (DUM_{bear_i}) are significantly positive, showing that BSI of institutional investors and short selling investors and the dummy variable of down of market index are respectively positively correlated to *CAR* [–1, +5]. Namely, it supports that when the investor sentiment of institutional investors or short-selling investors tend to be optimistic or the market index falls, there will be higher *CAR* [–1, +5]. After the comparison between the results of part I and part II, it is found that the effect of the dummy variable of down of market index (DUM_{down_i}) on *CAR* only exists in *CAR* [–1, +5] and no evidence shows that it will affect *CAR* [–20, +40], indicating that these relationships are only limited to the short-term shock after the news exposure.

Table 3. The relationship between investor behaviors, market factors and repurchase stock price responses

Period	Part I. The repurchases event period in [–20, +40]		Part II. The short-term shock of the repurchases news exposure period in [–1, +5]	
Statistic	Coeff. (t-stat.)	V.I.F.	Coeff. (t-stat.)	V.I.F.
BSI_{Inst_i}	9.1055** (5.9648)	1.093	0.8577** (2.3750)	1.058
BSI_{SE_i}	–3.2383 (–1.4051)	1.508	–0.5380 (–1.1689)	1.139
BSI_{SL_i}	18.5927** (7.3341)	1.030	2.6615** (6.5694)	1.045
$Turn_i$	–0.8264 (–1.0056)	2.059	–0.0272 (–0.1133)	1.486

End of Table 3

Period	Part I. The repurchases event period in [–20, +40]		Part II. The short-term shock of the repurchases news exposure period in [–1, +5]	
HSR_{Inst_i}	–0.0499 (–0.7971)	1.323	–0.0260 (–1.1378)	1.458
BFR_i	–0.2443* (–1.7512)	1.280	–0.0747* (–1.7838)	1.153
$UNCERT_i$	0.5655** (2.6784)	1.426	–0.0117 (–0.0359)	1.107
DUM_{list_i}	–3.2913** (–2.4107)	1.153	–0.5192 (–0.9971)	1.126
DUM_{down_i}	–1.3405 (–0.9034)	1.359	1.1450** (2.3466)	1.063
Intercept	5.8645** (3.5581)	–	4.4875** (7.5516)	–
Sample size	927		927	
Adjusted R^2	0.1025		0.0591	
F-statistic	12.7500**		7.4641**	

Note: * $p \leq .10$; ** $p \leq .05$; V.I.F. is the variance inflation factor to a test of the multicollinearity.

Table 4. The structural change tests of pre-repurchase beta for the relationship between investor behaviors, market factors and repurchase stock price responses

Period	Part I. The repurchases event period in [–20, +40]		Part II. The short-term shock of the repurchases news exposure period in [–1, +5]	
Threshold variable	*Beta*		*Beta*	
Sequential F-statistic determined thresholds:	1		1	
Threshold Test	0 vs. 1**	1 vs. 2	0 vs. 1**	1 vs. 2
F-statistic	6.2795	2.3201	2.8539	1.9909
Scaled F-statistic	62.7951	23.2012	28.5394	19.909
Critical Value[a]	27.03	29.24	27.03	29.24
Threshold value	1		1	
Sequential	0.8652		0.7141	
Repartition	0.8652		0.7141	

Note: ** $p \leq .05$; [a] are critical values (Bai & Perron, 2003).

Under the significance at 10% level, the parameter of bearing/financing ratio (BFR_i) is –0.0747 and it is significantly negative. So it is found that when bearing/financing ratio is higher, the *CAR* [–1, +5] will be lower. Besides, it is also found that the average of daily price uncertainty ($UNCERT_i$), the dummy variable of listed market category (DUM_{list_i}) and *CAR* are correlated to each other in the repurchase event period in [–20, +40] in part I, but the 2

relationships are irrelevant in the short-term shock of the repurchase news exposure period in [–1, +5]. In the end, by comparing the results of part I and part II in Table 3, it can be found that estimation parameters for *BSI* (BSI_{SE_i}) of margin trading investors, the average of daily turnover rate ($Turn_i$) and the average of institutional investors' shareholding ratio (HSR_{Inst_i}) are not significant, so no evidence supports that the 3 variables have the specific relationship with *CAR* [–1, +5] (*CAR* [–20, +40]).

3.3. The multiple structural change tests

In Table 4, the pre-repurchase beta was used as threshold variable and multiple structural change tests proposed by Bai and Perron (2003) were adopted to test that m break points may exist in multiple linear regression model (Eq. (1)), namely it is tested that when threshold value is *m*, double maximum tests are used to conduct the analysis. Namely, the null hypothesis is tested as: under the premises that there exist *k* break points v.s. *k*+1 break points, $k = 0, 1, 2,\ldots\ldots, m$. According to the results of Table 4, it can be found that in the repurchase event period ([–20, +40]) and the short-term shock of the repurchase news exposure period ([–1, +5]), there exists single threshold value and repartition (*Beta**) is respectively 0.8652 and 0.7141.

3.4. Results of the threshold regression model

Table 5 shows the result of the parameters estimated by threshold regression model and t statistic and it can be divided into the results of part I (the repurchase event period in [–20, +40]) and part II (the short-term shock of the repurchase news exposure period in [–1, +5]). The threshold type is the result estimated after threshold value and repartition concluded by Bai and Perron tests in table 4 are adopted.

The part I in Table 5 shows the results of parameters estimated by the repurchase event period in [–20, +40] and t statistic. Under the situation that systematic risk of repartition (*Beta**) of single threshold value is equal to 0.8652, it can be found that the parameter of *BSI* (BSI_{Inst_i}) of institutional investors of the low pre-repurchase systematic risk firms ($Beta_i <$ 0.8652) 6.7846 (t-statistic = 2.8787), the parameter of *BSI* (BSI_{SL_i}) of short selling investors is 10.4101 (t-statistic = 2.7931), and they are significantly greater than 0 under the significance at 5% level. It supports that *BSI* of institutional investor and short selling investors respectively have the direct relationship with *CAR* [–20, +40]. Thus, it is believed that the investor sentiment of institutional investors and margin trading investors has the positive stock price response to low systematic risk firms ($Beta_i < 0.8652$) in the repurchase event period, but the significantly specific relationship between investor sentiment of margin trading investors and *CAR* [–20, +40] has not been found. Besides, it is also found that the parameter of the average of daily turnover rate ($Turn_i$) is –3.7865 (t-statistic = –2.1652), the parameter of bearing/financing ratio (BFR_i) is –0.8696 (t-statistic = –3.8038), and they are significantly smaller than 0 under the significance at 5% level, supporting that the average of daily turnover rate and bearing/financing ratio will respectively have the inverse relationship with *CAR* [–20, +40]. In the end, there is no enough evidence showing that the average of shareholding ratio of

institutional investors (HSR_{Inst_i}), price uncertainty ($UNCERT_i$), the dummy variable of listed market category (DUM_{list_i}) and the dummy variable of down of market index (DUM_{down_i}) have the significant relationship with *CAR* [–20, +40] because the parameters estimated are not significant, indicating that these variables are not correlated to the performance of stock price of the low pre-repurchase systematic risk firms in the repurchase event period.

In the part of non-low pre-repurchase systematic risk firms ($Beta_i \geq 0.8652$), it is found that the parameter of *BSI* (BSI_{Inst_i}) of institutional investors is 9.2405 (t-statistic = 4.7421), the parameter of *BSI* (BSI_{SL_i}) of short selling investors is 25.7800 (t-statistic = 7.8060), and they are significantly greater than 0 under the significance at 5% level. These results are identical to those results verified by low systematic risk firms ($Beta_i < 0.8652$), but this parameter will be higher than the parameter of low systematic risk firms, showing that *CAR* [–20, +40] has the higher reaction sensitivity to investor sentiment of institutional investors and short selling investors than low systematic risk firms, where the asymmetry exists in the relationship. The parameter of *BSI* (BSI_{SE_i} of margin trading investors is –7.7321 (t-statistic = –2.6838), and it is significantly smaller than 0 under the significance at 5% level, showing that the investor sentiment of margin trading investors has the inverse relationship with *CAR* [–20, +40] of non-low systematic risk firms ($Beta_i \geq 0.8652$). Besides, it is also found that the parameter of the average of daily turnover rate ($Turn_i$) is –0.7621 (t-statistic = –0.8180), the parameter of bearing/financing ratio (BFR_i) is 0.1528 (t-statistic = 0.8960), and they are not significant under the significance at 5% level. So it supports that there exists the specific relationship between the average of daily turnover rate (bearing/financing ratio) and *CAR* [–20, +40]. The parameter of the price uncertainty ($UNCERT_i$) is 0.9387 (t-statistic = 3.7914), the parameter of the dummy variable of listed market category (DUM_{list_i}) is –4.3838 (t-statistic = –2.6597), and they are significant under the significance at 5% level. So it supports that the greater the price uncertainty in the non-low pre-repurchase systematic risk firms is, the higher the *CAR* [–20, +40] will be. Compared with OTCM's repurchase firms, SEM's repurchase firms will have the higher *CAR* [–20, +40]. In the end, in the variables of the average of institutional investors' shareholding ratio (HSR_{Inst_i}) and the dummy variable of down of market index (DUM_{down_i}), there is no enough evidence showing that the two variables are significantly correlated to *CAR* [–20, +40] because the parameters estimated are not significant and this result is identical to that of low pre-repurchase systematic risk firms.

In conclusion, it is found both in the firms of low pre-repurchase systematic risk ($Beta_i < 0.8652$) and non-low pre-repurchase systematic risk ($Beta_i \geq 0.8652$) that *BSI* of institutional investors and short selling investors is significantly positively correlated to *CAR*, but *BSI* of margin trading investors of the non-low pre-repurchase systematic risk firms has the significantly inverse relationship with *CAR*. Besides, the average of daily turnover rate (bearing/financing ratio) of low pre-repurchase systematic risk firms has the significantly inverse relationship with *CAR*. In the non-low systematic risk firms, there exists the premium of price uncertainty and SEM's repurchase firms have the better stock price response. In the end, both the average of institutional investors' shareholding ratio of low systematic risk firms and non-low systematic risk firms and the environment factor that market index falls cannot affect the performance in repurchase stock price.

Table 5. The results of the estimated parameters of the threshold regression model

Period	Part I. The repurchases event period: [–20, +40]		Part II. The short-term shock of the repurchases news exposure: [–1, +5]	
Firms	the low risk $Beta_i < 0.8652$	the non-low risk $Beta_i \geq 0.8652$	the low risk $Beta_i < 0.7141$	the non-low risk $Beta_i \geq 0.7141$
BSI_{Inst_i}	6.7846** (2.8787)	9.2405** (4.7421)	–0.5248 (–0.6594)	1.3121** (3.2479)
BSI_{SE_i}	5.8254 (1.6049)	–7.7321** (–2.6838)	–2.7403** (–2.6205)	0.0120 (0.0235)
BSI_{SL_i}	10.4101** (2.7931)	25.7800** (7.8060)	3.7833** (4.5402)	2.2145** (4.7943)
$Turn_i$	–3.7865** (–2.1652)	–0.7621 (–0.8180)	0.0189 (0.2733)	–0.0273 (–1.1282)
HSR_{Inst_i}	–0.1569 (–1.2342)	–0.0670 (–0.9432)	0.6577 (0.9554)	0.0361 (0.1397)
BFR_i	–0.8696** (–3.8038)	0.1528 (0.8960)	–0.0829 (–0.8241)	–0.0679 (–1.4868)
$UNCERT_i$	–0.1365 (–0.3660)	0.9387** (3.7914)	–0.0524 (–0.0648)	0.1239 (0.3516)
DUM_{list_i}	1.2199 (0.5322)	–4.3838** (–2.6597)	1.5292 (1.2920)	–0.9992* (–1.7424)
DUM_{down_i}	–3.5821 (–1.4968)	–0.2998 (–0.1635)	–1.3505 (–1.2275)	1.7867** (3.3053)
Intercept	13.3738** (4.9806)	2.4296 (1.1921)	4.4912** (3.2710)	4.0236** (6.0681)
Sample size	321	606	182	745
Adjusted R^2	0.1514		0.0778	
F-statistic	9.6922**		5.1092**	

Note: t-statistics in parentheses; *$p \leq .10$; **$p \leq .05$.

The part II in Table 5 shows the results of parameters estimated by the short-term shock of the repurchase news exposure period in [–1, +5] and t statistic. Among them, when the repartition *Beta**) of single threshold value of systematic risk is 0.7141, it can be classified into 2 systems in share repurchase: the low pre-repurchase systematic risk ($Beta_i < 0.7141$) and the non-low pre-repurchase systematic risk ($Beta_i \geq 0.7141$). It can be found that only the parameter of *BSI* (BSI_{Inst_i}) of institutional investors of non-low systematic risk firms ($Beta_i \geq 0.7141$) is 1.3121 (t-statistic = 3.2479), and it is significantly greater than 0 under the significance at 5% level. In the part of *BSI* (BSI_{SL_i}) of short selling investors, the parameters estimated are significantly greater than 0 both either in the low systematic risk firms ($Beta_i < 0.7141$) or in the non-low systematic risk firms ($Beta_i \geq 0.7141$). Therefore, it is found that the investor sentiment of institutional investors has the positive effect on the stock price of non-low systematic risk firms in [–1, +5] and the investor sentiment of short selling investors of low systematic risk firms or non-low systematic risk firms has the positive effect on the stock price in [–1, +5]. The parameter

of *BSI* (BSI_{SE_i}) of margin trading investors is –2.7403 (t-statistic = –2.6205) only in low systematic risk firms, and it is significantly smaller than 0 under the significance at 5% level, showing that investor sentiment of margin trading investors of low systematic risk firms has the inverse relationship with *CAR* [–1, +5].

The parameter of the dummy variable of listed market category (DUM_{list_i}) of non-low systematic risk firms ($Beta_i \geq 0.7141$) is –0.9992 (t-statistic = –1.7424), and it is significantly smaller than 0 under the significance at 10% level. The parameter of the dummy variable of down of market index (DUM_{down_i}) is 1.7867 (t-statistic = 3.3053), and it is significantly greater than 0 under the significance at 5% level. Therefore, it is found that if the market index of SEM's repurchase firms falls in the repurchase news exposure period in the non-low systematic risk firms ($Beta_i \geq 0.7141$), there is better *CAR* [–1, +5]. Among the parameters of the average of daily turnover rate ($Turn_i$), bearing/financing ratio (BFR_i) and price uncertainty ($UNCERT_i$), the parameters of the low systematic risk firms ($Beta_i < 0.7141$) or the non-low systematic risk firms ($Beta_i \geq 0.7141$) are not significant under the significance at 5% level. Therefore, it is found that the 3 variables are irrelevant to *CAR* [–1, +5]. This result is different from the result obtained in Part I in [–20, +40] supporting that there exist the specific relationship under some circumstances. In the end, it is found that no enough evidence shows that there exists the relationship between the average of institutional investors' shareholding ratio (HSR_{Inst_i}) and *CAR* [–1, +5] both in the low systematic risk firms ($Beta_i < 0.7141$) and the non-low systematic risk firms ($Beta_i \geq 0.7141$).

3.5. Differential tests of the $\overline{CAR}$: Low v.s. non-low systematic risk firms

Figure 2 shows the frequency distribution and summary of statistics of the pre-repurchase beta for a sample of 927 in Taiwan's open-market share repurchase programs. Figure 3 is the scatter chart for the pre-repurchase beta and *CAR* in the open-market share repurchase event period in [–20, +40] (left) and the short-term shock of the repurchase news exposure period in [–1, +5] (right). It can be found from the scatter chart of event period (left) that most sample points will focus on the position where *CAR* is greater than 0, supporting that most stock prices of repurchase firms present the positive responses. Especially, the distribution status that non-low systematic risk firms have the positive response to stock prices ($CAR_i > 0$) is more obvious. Besides, it can also be found from the scatter chart of the short-term shock of the repurchase news exposure period (right) that it has more obvious result than the scatter chart of the event period (left) and has more sample points focusing on the regional scope of $CAR > 0$. Both the low systematic risk firms and the non-low systematic risk firms have the consistent results. So, it is believed that in the short-term shock of the repurchase news exposure period, the stock price of most repurchase firms presents the positive response. Especially, more sample points in the low systematic risk firms will fall into the regional scope of $CAR > 0$. So, it is believed that the distribution status that the stock price of share repurchases in short-term shock of the repurchase news exposure period presents the positive response will be more obvious.

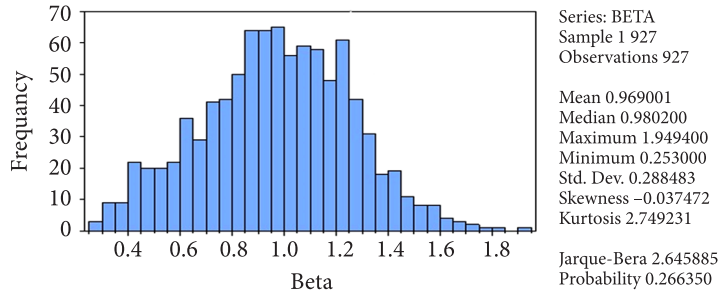

Figure 2. The frequency distribution graph and summary of statistics of the pre-repurchase beta

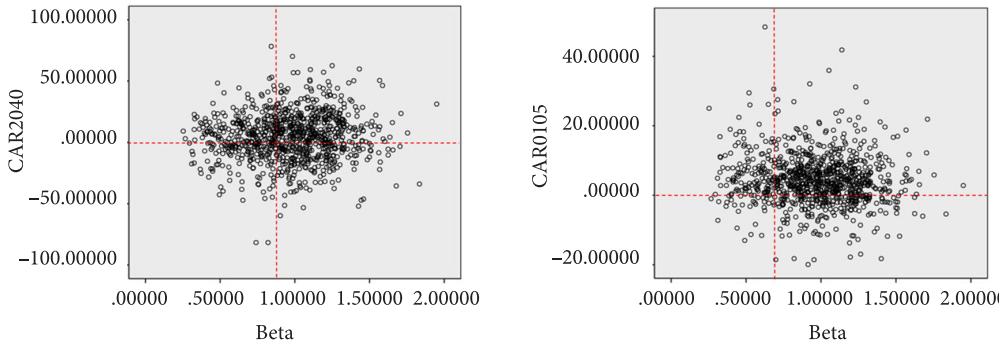

Figure 3. The frequency distribution graph and summary of statistics of the pre-repurchase beta

Table 6 is the test of the difference of $\overline{CAR}$ of the low v.s. the non-low pre-repurchase systematic risk firms in event period (the short-term shock of the news exposure period), namely aimed at the repartition ($Beta^*$) of single threshold value gained respectively in [–20, +40] and [–1, +5] in Table 4, they are classified into 2 kinds of share repurchases: the low systematic risk ($Beta_i < Beta^*$) and the non-low systematic risk ($Beta_i \geq Beta^*$) to test whether there exists difference in $\overline{CAR}$ of the low pre-repurchase systematic risk firms and the non-low pre-repurchase systematic risk firms in [–20, +40] and ([–1, +5]) through Independent-Samples t Test.

The part II in Table 6 shows the result estimated by *CAR* [–20, +40] and it can be found that F statistic is 2.172 and p-value is 0.141, so it accepts that there exists no significant difference in the variance of *CAR* [–20, +40] of the 2 kinds of share repurchase of the low systematic risk and the non-low systematic risk. Thus, t test of "two samples have the equal variances" was further adopted. The t statistic is –2.177, the degree of freedom is 925 and they are significant under the significance at 5% level. So it accepts that the low systematic risk firms $\overline{CAR}$ ([–20, +40] is 2.459%) have the significantly lower $\overline{CAR}$ [–20, +40] than non-low systematic risk firms $\overline{CAR}$ ([–20, +40] is 5.414%). Besides, according to the result estimated by *CAR* [–1, +5] in Table 6, when F statistic is 4.420 and p-value is 0.036, it accepts that there exists no significant difference in the variance of *CAR* [–1, +5] of the 2 kinds of share repurchase of the low systematic risk and the non-low systematic risk. Thus, t test of

"two samples have the unequal variances" was further adopted. The t statistic is 2.861, the degree of freedom is 247.204 and they are significant under the significance at 5% level. So it accepts that the low systematic risk firms ($\overline{CAR}$ [–1, +5] is 5.976%) have the significantly higher $\overline{CAR}$ [–1, +5] than non-low systematic risk firms ($\overline{CAR}$ [–1, +5] is 4.038%). As for the situation of adverse risk premium, the existence of this phenomenon may be related to investor sentiment of credit trading investor because the result of Table 1 (the average of BSI_{SE_i}: –0.2563 < 0; the average of BSI_{SL_i}: 0.0160 > 0) and Part II of table 5 (parameter of BSI_{SE_i}: $\alpha_2 = -2.7403 < 0$; parameter of $\overline{BSI_{SL_i}}$: $\alpha_3 = 3.7833 > 0$) can explain when the 2 components of credit trading investor $\alpha_2 \cdot \overline{BSI_{SE\,i}} + \alpha_3 \cdot \overline{BSI_{SLi}}$ $\overline{BSI_{SL}} > 0$, the credit trading investors' sentiment premium can be gained.

Table 6. The difference analysis of the low v.s. non-low systematic risk firms

CAR	*CAR* [–20, +40]		*CAR* [–1, +5]	
Firms	the low risk	the non-low risk	the low risk	the non-low risk
	$Beta_i < 0.8652$	$Beta_i \geq 0.8652$	$Beta_i < 0.7141$	$Beta_i \geq 0.7141$
Part I. Summary of statistics				
Mean	2.459	5.414	5.976	4.038
Std. Deviation	19.329	19.844	8.44	7.101
Number	321	606	182	745
Part II. Levene's test for equality of variances				
Assumptions	Equal variances assumed	Equal variances not assumed	Equal variances assumed	Equal variances not assumed
F-statistic	2.172		4.420**	
Sig.	0.141		0.036	
Decision	Accept	–	Reject	Accept
Part III. t test for equality of means				
t-statistic	–2.177**	–2.194	3.176	2.861**
df.	925	667.084	925	247.204
Sig. (2-tailed)	0.030	0.029	0.002	0.005

Note: *$p \leq .10$; **$p \leq .05$.

Conclusions

This study confirms that Taiwanese repurchase companies' share prices during the repurchase event period will gradually fall before the repurchase new exposure, then it begins to gradually rise after the news exposure and finally *CAR* changes into the positive. Therefore, it supports the signaling hypothesis. The institutional investors and margin trading investors have the negative investor sentiment in the repurchase event period and the short-term shock of the repurchase news exposure period, while short selling investors have the negative investor sentiment in the repurchase event period. These results are slightly different from

the opinion that investors consider a stock repurchase announcement as good news (Jagannathan & Stephens, 2003). Thus, it is suggested to further discuss whether this is caused by investors' cognitive difference in stock repurchase news (all investors will not regard the share repurchase news as good news) or is caused by the impact of the market situation (a significant decline in the market index) under which negative investor sentiment offsets the stock repurchase announcement.

Moreover, no matter whether it is in the repurchase event period or the short-term shock of the news exposure period, the investor sentiment of institutional investors and short selling investors has the positive relationship with the stock price and bearing/financing ratio has the inverse relationship with stock price response, showing that it has the reference value for the short selling investors to empty the direction of performance of stock price. In the repurchase event period, the premium of price uncertainty exists and SEM's repurchase firms will have better stock return than OTCM's repurchase firm. This result also shows the difference between SEM and OTCM in financial norms and standards as well as the trading system, which may make investors exhibit different levels of cognition from share repurchase announcements and affect stock price responses. Follow-up research can investigate the objective reasons for this.

This research conducts an analysis from the perspective of the systematic risk of stock repurchases and reviews the effect of the announcement event on stock price response under the basis of an investment risk evaluation of individual stocks. Overall, we show when the pre-repurchase beta is lower than repartition that this will make the relationship between investor behavior, market factors, and stock price response change significantly. Therefore, this study proves the effect of pre-repurchase systematic risk on repurchase announcement event and its importance. Besides, this paper also finds that the low pre-repurchase systematic risk firms will have the lower abnormal return in the repurchase event period, but they will obtain the higher abnormal return in the short-term shock of the repurchase news exposure period. This kind of low-risk and high-return transitory abnormal phenomenon can be explained by the sentiment premium.

This study's conclusion is based on the Event Study, and so beta is assumed to evaluate *CAR* of stock repurchase in the announcement event period under the condition of a fixed value, and the shock of repurchase information is not considered as a possible reason for change in the beta. In particular, we do not discuss whether the generation of a low-risk and high-return transitory abnormal phenomenon is related to the change of pre-repurchase beta caused by the shock of repurchase information. Therefore, it is suggested that the possible effect from the impact of repurchase announcement news on pre-repurchase beta should be considered in future research, with the hope that any gained results can further objectively present the effect of sentiment premium in the repurchase announcement event.

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