NORTH-HOLLAND

International Review of Economics and Finance
10 (2001) 263–288

International Review of Economics & Finance

Daily price limits and stock price behavior: evidence from the Taiwan stock exchange

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Received 21 September 1998; received in revised form 22 August 2000; accepted 13 September 2000

Abstract

This research examines the price behavior of limit moves for stocks listed on the Taiwan Stock Exchange over the period 1990–1996. The results indicate price continuations for the overnight period following limit moves and price reversals for the subsequent trading time period. The results are consistent with the overreaction hypothesis in that overreaction is delayed by price limits and the overreaction is corrected in the trading time period following limit moves.

JEL classification: G14; G15; G18

Keywords: Price limits; Overreaction hypothesis; Taiwan Stock Exchange

1. Introduction

This research tests two hypotheses regarding the effect of price limits on stock prices. The information hypothesis states that price limits delay the process for prices to reflect intrinsic value. This hypothesis predicts price continuations in the overnight period following limit moves and no price change in the subsequent trading period. In contrast, the overreaction hypothesis states that price limits delay both intrinsic value and overreaction. Moreover,

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1059-0560/00/$ – see front matter
PII: S1059-0560(00)00082-4

overreaction tends to correct in the trading period following limit moves. The overreaction hypothesis predicts price continuations for the overnight period and price reversals for the subsequent trading period.

This research extends previous studies by expanding the period for testing these hypotheses. Testing the hypotheses by examining the trading period following limit moves is important. Since trading is suspended in the overnight period following limit moves, noise traders in general cannot infer the intrinsic value of the stock in this period. The private information possessed by information traders regarding the change of intrinsic value of the stock is typically revealed in the trading period. Thus, it is more likely to observe an overreaction correction in the trading period following limit moves. As a result, observations of price reversals in the trading period following limit moves are still consistent with the overreaction hypothesis and reveal market inefficiency.

The sample analyzed here consists of upward and downward closing limit moves up to three consecutive trading days for stocks listed on the Taiwan Stock Exchange over 1990–1996. For comparison, intraday limit moves and near-limit cases are also examined. Sensitivity tests regarding the measurement of abnormal returns are conducted to ensure the robustness of the results.

The research presented here indicates price continuations in the overnight period following limit moves, as well as price reversals in the subsequent trading period. The results are consistent with the overreaction hypothesis.

The paper is organized as follows. Section 2 reviews the literature. Section 3 develops the hypotheses. Section 4 introduces the institutional background and Section 5 describes the data and the methodology. Results and concluding remarks are presented in Sections 6 and 7, respectively.

2. Literature review

This section presents two major hypotheses regarding the effects of price limits on stock price behavior, namely, the overreaction hypothesis and the information hypothesis.[1]

2.1. The overreaction hypothesis

The overreaction hypothesis states that investors tend to overreact to new information. Previous research suggests that if limit-hits are driven by investors' overreaction, price limits will provide a cooling-off period for investors to reassess the intrinsic value about securities. Following the cooling-off period, securities prices should reverse the original trend and move toward the intrinsic value. Thus, according to previous research, the overreaction hypothesis predicts a price reversal after limit-hits.

[1] DeBondt and Thaler (1985, 1987) test the overreaction hypothesis in regard to the US stock market. Chen (1993) and Lee and Kim (1995) examine the effect of price limits on volatility. Lehmann (1989) and Miller (1989) comment on the effectiveness of price limits. Huang (1998) examines the price behavior following limit moves for stocks listed on the Taiwan Stock Exchange.

Ma, Rao, and Sears (1989a, 1989b) examine the price behavior of Treasury bond futures surrounding limit moves. They find that price trends, in general, stabilize or reverse themselves after reaching limits and tend to move back into prelimit price ranges. Their conclusions show results consistent with the overreaction hypothesis in that price limits can aid in the price resolution process.

2.2. The information hypothesis

The information hypothesis, also known as the delayed price discovery hypothesis, asserts that the major effect of price limits is to delay the discovery of the intrinsic value of securities. If the intrinsic value of securities exceeds the range of price limits, trading will suspend and will resume in later periods until the intrinsic value lies within the new trading range. Thus, the information hypothesis predicts continued price trends following limit moves.

Chen (1998) and Kim and Ghon Rhee (1997) examine the price behavior following limit moves. Kim and Ghon Rhee study the price behavior for stocks listed on the Tokyo Stock Exchange. Chen investigates the price behavior for 19 futures contracts. Both studies find that the prices in the overnight period following limit moves tend to continue the original trend preceding limit moves. Thus, the researchers conclude that the results are consistent with the prediction of the information hypothesis.

Previous research tests the two hypotheses by focusing on the overnight price behavior following limit moves. In contrast, the present research suggests that price behavior in both the overnight and the trading period following limit moves should be examined.

3. Hypotheses

3.1. The overreaction hypothesis

Consider a market where traders for a particular stock include both information traders and noise traders. The initial value of the stock is V_t at the beginning of day t and is known to both information traders and noise traders. Shortly before the close of trading for day t, the stock's intrinsic value increases by an amount Δ_t to $V_t+\Delta_t$. From that time on, the stock's intrinsic value remains unchanged at $V_t+\Delta_t$. The information traders know the change in the intrinsic value for certain, based on fundamental analysis or inside information. The noise traders, who tend to overreact to new information, consider the stock as worth $V_t+\Delta_t+O_t$ where O_t represents overreaction to the new information and O_t is assumed to be positively related to Δ_t. For example, the information traders may bid up the price gradually, say, from $V_t+0.1\Delta_t$ to $V_t+\Delta_t$, which forms an upward price trend. The noise traders, observing the upward price trend without knowing the identity of the bidders, infer the stock as worth $V_t+\Delta_t+O_t$. The noise traders may infer the stock value by extrapolating the price trend.

On day $t+1$, the information traders' private information regarding the intrinsic value of the stock will become public information in the process of trading. For example, the information traders, observing the price bid by the noise traders at the opening on day $t+1$, $V_t+\Delta_t+O_t$, know the price being overvalued. The information traders will sell or short the stock. The selling pressure from the information traders will continue until the overreaction is reversed. Eventually, the stock will be priced at the new intrinsic value, $V_t+\Delta_t$.

Without price limits, the equilibrium closing price for day t, $P^{e}_{t,c}$ which equates supply and demand among information traders and noise traders, will equal $V_t+\Delta_t+O_t$, i.e., $P^{e}_{t,c}=V_t+\Delta_t+O_t$. This is the fair price perceived by the noise traders. Thus, the equilibrium closing price for day t contains both the intrinsic value and the overreaction effect.[2]

With the imposition of price limits, the equilibrium closing price, $P^{e}_{t,c}=V_t+\Delta_t+O_t$, will be truncated by the price limit on day t, P_t^{lmt}, if the equilibrium price exceeds the price limit. Here, P_t^{lmt} is the maximum or minimum price that can be observed under price limits.[3] The truncated portion of the equilibrium closing price for day t, $V_t+\Delta_t+O_t-P_t^{\text{lmt}}$, will be delayed and reflected on day $t+1$, provided that $V_t+\Delta_t+O_t$ falls within the new trading range. By assuming that the overreaction on day t, O_t, will fully reverse on day $t+1$, the equilibrium closing price on day $t+1$, $P^{e}_{t+1,c}$ will reflect both the truncated portion of the equilibrium price from day t, $V_t+\Delta_t+O_t-P_t^{\text{lmt}}$, and the overreaction reversal, $-O_t$. That is, $P^{e}_{t+1,c}=P_t^{\text{lmt}}+(V_t+\Delta_t+O_t-P_t^{\text{lmt}})+(-O_t)=V_t+\Delta_t$. This is the new intrinsic value of the stock.

Day $t+1$ consists of the overnight period and the trading time period. The overnight period for day $t+1$ extends from the close on day t to the opening on day $t+1$. Since no trading occurs during this overnight period, information regarding the change in the intrinsic value of the stock is not revealed by the information traders. The value of the stock would still be perceived by the noise traders as $V_t+\Delta_t+O_t$. Therefore, the opening price for day $t+1$ would be $P^{e}_{t+1,o}=V_t+\Delta_t+O_t$, which is assumed to fall within the new trading range. This assumes that, at the opening of day $t+1$, selling pressure from the information traders is either limited or prohibited. Following the opening, selling pressure from the information traders will gradually reveal the intrinsic value of the stock to the public. Eventually, the overreaction will fully reverse when the information regarding the intrinsic value is fully disclosed by the end of the trading period for day $t+1$.

Thus, under the overreaction hypothesis, the effect of price limits is to delay the truncated portion of the equilibrium price, $V_t+\Delta_t+O_t-P_t^{\text{lmt}}$. That is, price limits delay both the change in the intrinsic value and the overreaction effect. The overreaction hypothesis predicts price continuations for the overnight period following limit moves and price reversals for the subsequent trading period. The overnight price continuations reflect the truncated portion of the equilibrium price, $V_t+\Delta_t+O_t-P_t^{\text{lmt}}$, and the trading time price reversals reflect the correction of the overreaction, $-O_t$.

Moreover, the overreaction effect, O_t, is assumed to be positively related to the change in the intrinsic value, Δ_t. Since the change in the intrinsic value about the stock is revealed in the process of trading, noise traders can eventually infer the change in the intrinsic value of the

[2] The overreaction effect may partially occur at the close of day t and partially reflect in the overnight period following the close of day t. The analysis in Section 3.1 remains unchanged when the overreaction effect is delayed to the overnight period following the limit moves.

[3] The daily price limit is 7% above or below the closing price of the preceding trading day over the sample period 1990–1996. Since trading prices must take multiple values of tick size, the actual limit-hit price, P_t^{lmt}, is usually less than 7% away from the closing price of the previous trading day.

stock. By assuming that the overreaction effect, O_t, is positively related to the change in intrinsic value, Δ_t, the overreaction hypothesis predicts larger trading time price reversals for higher overnight price continuations following the close of day t.

Sometimes, consecutive limit moves may occur. For a 2-day period of consecutive limit moves, for example, the equilibrium price for day t, $V_t+\Delta_t+O_t$, exceeds not only the price limit for day t, P_t^{lmt}, but also the price limit for day $t+1$, P_{t+1}^{lmt}. If so, the equilibrium price, $V_t+\Delta_t+O_t$, will still be truncated on day $t+1$. The truncated portion of the equilibrium price, $V_t+\Delta_t+O_t-P_{t+1}^{\mathrm{lmt}}$, will reflect on day $t+2$. The overreaction hypothesis would predict price continuations in the overnight period and price reversals in the trading period on day $t+2$.

3.2. The information hypothesis

According to the information hypothesis, the noise traders do not overreact to new information. The overreaction effect as presented in the overreaction hypothesis would now degenerate into zero, or $O_t=0$. When the new intrinsic value, $V_t+\Delta_t$, is greater than the price limit, P_t^{lmt}, price continuations would occur following limit moves. The overnight price continuation would simply reflect the truncated portion of the intrinsic value, $V_t+\Delta_t-P_t^{\mathrm{lmt}}$, and there would be no price reversals in the subsequent trading time period. Thus, the information hypothesis predicts price continuations in the overnight period following limit moves and no price changes in the subsequent trading time period.

3.3. Summary of hypotheses

The information hypothesis (the null hypothesis) and the overreaction hypothesis (the alternative hypothesis) presented in this section are summarized as follows.

The information hypothesis asserts that:

H_o: Price continuations occur in the overnight period following limit moves. Neither price continuations nor price reversals occur in the subsequent trading period.

The overreaction hypothesis asserts that:

H_{a1}: Price continuations occur in the overnight period following limit moves. Price reversals occur in the subsequent trading period.

H_{a2}: The higher the degree of price continuations in the overnight period following limit moves, the larger the degree of price reversals in the subsequent trading period.

3.4. Near-limit moves and intraday limit moves

For comparison, price behavior for both near-limit moves and intraday limit moves is also examined. Near-limit moves involve daily returns that are close to, but within, price limits. Intraday limit moves involve hit limits in the intraday but that do not close at limits.

Both the near-limit moves and the intraday limit moves do not close at limits. Under the overreaction hypothesis, noise traders would overreact to the new information. However, the overreaction effect, O, need not be fully reflected at the close of day t. The subscript t is dropped to indicate that the overreaction effect might not be fully reflected at the close of day t. In particular, part of the overreaction effect might occur in the overnight period following the close of day t and price reversals might occur in the following trading period. If so, the overreaction hypothesis would predict price continuation and subsequent price reversals following the near-hit returns on day t for near-limit samples. The degree of price continuations and subsequent price reversals should be weaker for near-limit samples than for limit-hit samples due to a smaller change in intrinsic value and a smaller overreaction effect.

In summary, price continuations may still occur in the overnight following the close of day t for both near-limit moves and intraday limit moves. In general, price reversals would occur in the trading time of day $t+1$. However, the price continuations and the price reversals for day $t+1$ should be smaller for near-limit moves and intraday limit moves than for limit moves. Since the change in intrinsic value, Δ_t, for near-limit and for intraday limit moves is smaller than that for limit moves, the magnitude of overreaction, O, and subsequent overreaction reversals, $-O$, should be smaller, provided that the overreaction effect, O, is positively related to the change in the intrinsic value, Δ_t.

In contrast, for near-limit and intraday limit moves, the information hypothesis predicts no price changes in both the overnight and the trading time following the close of trading on day t.

3.5. Comparison with previous research

This study extends previous research in the period over which the hypotheses are examined. Previous research (i.e., Chen, 1998; Kim & Ghon Rhee, 1997; Ma et al., 1989a, 1989b) tests the hypotheses by examining the price behavior in the overnight period following limit moves. The rationale is that, following limit moves, investors will reassess the intrinsic value of the stock in the overnight period. If overreaction exists at the limit moves, this reassessment will lead to price reversals when trading resumes at the opening of the subsequent trading period. This would imply price reversals in the overnight period following limit moves if the overreaction hypothesis is valid. In contrast, if the information hypothesis is valid, price continuations in the overnight period following limit moves would be observed. Thus, according to previous research, the two hypotheses predict different overnight price behaviors and that these hypotheses can be differentiated by examining the overnight price behavior.

While price reversals in the overnight period following limit moves are an indication of overreaction, this study suggests that it is possible that the overreaction to new information on day t could be delayed to the overnight period following the close of day t. Due to a lack of trading in the overnight period following the close of day t, noise traders might not be able to infer the intrinsic value despite the elapsed time in the overnight period following limit moves. Noise traders, for example, might not even know that the equilibrium closing price $P^{e}_{t,c} = V_t + \Delta_t + O_t$ for day t contains an overreaction effect. As a result, overreaction can be delayed until the intrinsic value is revealed by information traders in the trading time on day $t+1$. Thus, observations of overnight price continuations and subsequent price reversals on day $t+1$ are still consistent with the overreaction hypothesis. As a result, the present study extends previous research by considering both the overnight and the subsequent trading periods for day $t+1$ to differentiate the two hypotheses.

4. Institutional background

The Taiwan Stock Exchange has imposed daily price limits since it was established in 1962. Daily price limits were set at 5% for most of the time period before 1989. Starting from October 11, 1989, daily price limits were relaxed to 7% for both upward movements and downward movements. Thus, the maximum daily price variation is 7% from the closing prices of the previous trading day for the sample period 1990–1996 in this study.

However, because of the tick-size constraint, discrete returns for limit moves are usually less than 7%. (But continuous returns for down-limit moves could exceed − 7%.) Table 1 reports the tick sizes, which vary in different price ranges. The relative tick size is measured by dividing the tick size by the relevant stock price, which ranges from 0.1% to 1% with an average of around 0.5%.

Daily trading operates from 9:00 a.m. to 12:00 a.m., Monday through Friday, and from 9:00 a.m. to 11:00 a.m. on Saturday. Starting from the beginning of 1998, trading has occurred only on the first and the third Saturdays of each month.

Over the period from August 1985 through the end of 1986, an electronic system was introduced to facilitate trading. Starting in 1987, all stock tradings have been executed by the electronic system except for trading of odd lots, block trading, convertible bonds, and mutual funds. After August 1993, all securities tradings have been executed by the computer system. Under the electronic system, the call market method is adopted to determine both the opening prices and the closing prices in the trading period. For the opening prices, traders submit orders from 8:30 a.m. until 9:00 a.m. These buy-and-sell orders are accumulated and matched at 9:00 a.m. by the electronic system to determine the opening price. The opening price is the price that matches buy-and-sell orders as much as possible.

Following the opening, the call market method is again adopted and the time span for each batch ranges from 1 to 2 min. For each round, buy-and-sell orders are accumulated and the

Table 1
Tick sizes over 1990–1996

Price range (P, in NT$)	Tick size (in NT$)
$P<5$	0.01
$5 \leq P<15$	0.05
$15 \leq P<50$	0.1
$50 \leq P<150$	0.5
$150 \leq P<1000$	1.0
$1000 \leq P$	5.0

clearing price is determined by maximizing the matched volume. For the pre-August 1993 period, the time span for each round was about 1.5 to 2 min. For the post-August 1993 period, the time span for each round was reduced to about 1 min. The shorter time span per round for the post-August 1993 period represents a response to the request of investors for a faster order processing in view of the heavy trading on the Taiwan Stock Exchange.[4] The time span for each round varies slightly for different stocks. This process continues until the end of the trading period. No specialists are involved in the determination of the clearing prices. Apart from daily price limits, price movements in the trading period cannot exceed two ticks from the clearing price in the previous round. On average, the constraints of two ticks limit the stock price movements to no more than 1% from the clearing prices in the previous round.[5]

5. Data and methodology

5.1. Data

To examine how price limits affect stock price behavior, daily stock prices are utilized for all stocks listed on the Taiwan Stock Exchange over the 7-year period from 1990 to 1996. During this 7-year sample period, the daily price limits are all identical at 7%. Stock prices are adjusted for cash dividends, stock dividends, and stock splits. Stock price data are available from the Ministry of Education and several vendors.[6]

The sample contains closing limit moves for which the stock closes at limits. Limit moves up to three consecutive trading days are included. Table 2 presents the frequency of daily limit moves. Over the sample period 1990–1996, the numbers for 1-, 2-, and 3-day upward limit moves are 7684, 1298, and 286, respectively. For downward limit moves, the corresponding figures are 6127, 1011, and 263, respectively.

For comparison purposes, the intraday limit moves and the near-limit cases are examined. The intraday limit moves refer to stocks that reach price limits in the trading time but do not close at limits. The near-limit cases are defined as daily returns greater than 5% or less than −5% but that do not close at limits where daily limits are 7% for the 1990–1996 period. Finally, stock returns ranging from 3% to 5% or −5% to −3% are also examined. The frequency of these observations is also reported in Table 2.

[4] Ma (1998) examines the impact of trading frequencies on stock market performance for the pre-August 1993 and post-August 1993 periods for stocks listed on the Taiwan Stock Exchange. An introduction regarding the trading features is also provided.

[5] The constraint of two ticks for each round will affect closing prices if new information arrives in the last several rounds. In contrary, if new information arrives earlier, say 10 min prior to the close of trading, there is usually enough time for closing prices to reflect the new information. In general, the two-tick constraint is not effective for most closing prices.

[6] The original data source is from the Taiwan Stock Exchange. For data, researchers may wish to contact, e.g., Taiwan Economic Journal (Tel.: +886-2752-9777; fax: +886-2777-1336) or EPS/AREMOS (Tel.:+886-2366-1944; fax: +886-2366-0403).

Table 2
Distribution of sample stocks

Panel A: Distribution of 1-, 2-, and 3-day limit moves and near-limit moves

Year	Total number of daily returns	Number of closing up limit-hits			Number of closing down limit-hits			Number of near-limit moves	
		1 day	2 days	3 days	1 day	2 days	3 days	$r_0 > 5\%$	$r_0 < -5\%$
1990	47,629	2053	493	143	2126	672	179	1378	1420
1991	54,518	1300	227	32	1364	96	28	1050	1050
1992	63,031	515	53	16	558	41	14	529	632
1993	73,204	1030	202	39	335	51	8	1130	585
1994	79,792	1154	146	24	590	37	9	925	693
1995	91,020	818	74	16	630	77	17	892	1127
1996	101,477	814	103	16	524	37	8	771	504
1990–1996	510,671	7684	1298	286	6127	1011	263	6675	6011

Panel B: Distribution of intraday limit moves and returns in the range 3–5%

Year	Number of intraday limit hits		Number of Day 0 returns in 3–4% and −4% to −3%		Number of Day 0 returns in 4–5% and −5% to −4%	
	Up	Down	$3\% < r_0 \leq 4\%$	$-4\% \leq r_0 < -3\%$	$4\% < r_0 \leq 5\%$	$-5\% \leq r_0 < -4\%$
1990	828	1157	1554	1525	1137	1085
1991	490	847	1948	1786	1325	1005
1992	293	392	1722	1758	827	849
1993	601	325	2320	1822	1312	835
1994	456	453	2135	1884	1117	888
1995	401	778	2207	2557	1147	1311
1996	376	317	2201	1572	1095	653
1990–1996	3445	4269	14,087	12,904	7960	6626

5.2. Methodology

To examine the effect of price limits, abnormal returns are estimated relative to an appropriate benchmark. The market model is adopted as the appropriate return-generating process. The market model takes the form (Eq. (1)):

$$r_{it} = \alpha_i + \beta_i r_{mt} + \varepsilon_{it} \tag{1}$$

where r_{it} is the continuous daily return for stock i on day t: $r_{it} = \ln(p_{it}/p_{i,t-1})$, p_{it} and $p_{i,t-1}$ are closing prices on days t and $t-1$. The market return on day t, r_{mt}, is a value-weighted index compiled by the Taiwan Stock Exchange, which includes essentially all listed stocks on the exchange and is the most widely cited market index.

The market model parameters, α_i and β_i, are estimated over a 125-day estimation period from $t = -140$ to $t = -16$ where $t = 0$ is the event day of limit moves. In cases of 2- or 3-day consecutive limit moves, the event day ($t = 0$) refers to the two or three trading days, respectively. Trading in the Taiwan stock market for the sample period of 1990–1996 was quite active compared with other major stock markets in the world. Thus, the potential impact of infrequent trading on the estimation of the market model parameters should be limited. However, to ensure that the estimation of the market model parameters is not subject to a potential bias due to infrequent trading, at least 80% (100 trading days) of the return data for the 125-day estimation period must be available when model parameters are estimated.

Abnormal daily returns, AR_{it}, for the event days $t = 0$ and 1 are computed as follows:

$$AR_{it} = r_{it} - (\hat{\alpha}_i + \hat{\beta}_i r_{mt}). \tag{2}$$

For Day 1, which extends from the close on Day 0 to the close on Day 1, the overnight (close-to-open) abnormal return, $AR_{i1,co}$, and the trading time (open-to-close) abnormal returns, $AR_{i1,oc}$ are estimated for stock i. Specifically, the Day 1 overnight abnormal return, $AR_{i1,co}$, and the trading time abnormal return, $AR_{i1,oc}$, are estimated as (Eqs. (3) and (4)):

$$AR_{i1,co} = r_{i1,co} - (\hat{\alpha}_i + \hat{\beta}_i r_{m1,co}) \tag{3}$$

$$AR_{i1,oc} = r_{i1,oc} - (\hat{\alpha}_i + \hat{\beta}_i r_{m1,oc}) \tag{4}$$

where $r_{i1,co}$ and $r_{m1,co}$ are returns over the overnight period on Day 1 for stock i and for the market portfolio, respectively. Similarly, $r_{i1,oc}$ and $r_{m1,oc}$ are returns for the trading time period for Day 1. Finally, the market model parameters, $\hat{\alpha}_1$ and $\hat{\beta}_1$, are obtained from Eq. (2).

The abnormal returns for individual stocks are aggregated for portfolios comprised of 1-, 2-, and 3-day upward- as well as downward limit moves, respectively. The t statistics are computed to evaluate the significance of abnormal returns for these portfolios.

Tests of the hypotheses are conducted through tests of abnormal returns over the overnight and the trading time periods following limit moves. The information hypothesis predicts price continuations in the overnight period and no price change in the subsequent trading time period.

H_0 (the information hypothesis):

$AR_{1,co} > 0$, $AR_{1,oc} = 0$ for up-limit moves; and
$AR_{1,co} < 0$, $AR_{1,oc} = 0$ for down-limit moves.

The overreaction hypothesis asserts the existence of overreaction and predicts price continuations in the overnight period following limit moves, and price reversals in the subsequent trading period. The overreaction hypothesis also predicts higher price reversals in the trading period for higher price continuation in the overnight period following limit moves.

H_a (the overreaction hypothesis):

1. $AR_{1,co} > 0$, $AR_{1,oc} < 0$ for up-limit moves; $AR_{1,co} < 0$, $AR_{1,oc} > 0$ for down-limit moves.
2. The magnitude of $AR_{1,oc}$ is positively related to the magnitude of $AR_{1,co}$.

6. Results

6.1. Price continuations and reversals

Table 3, panel A presents the frequency of price continuations, price reversals, and no changes for Day 1 overnight abnormal returns. The results indicate significantly higher price continuations than for price reversals. For 1- to 3-day upward limit moves, price continuations occur 65–66% of the time while price reversals occur 17–20% of the time. For downward limit moves, price continuations occur 60–77% of the time while price reversals occur 11–26% of the time.

Results for the close-to-close period on Day 1, presented in Table 3, panel B, indicate roughly the same pattern: price continuations occur more often than price reversals for the limit moves. When Day 1 overnight and close-to-close abnormal returns are compared, however, price continuations occur more frequently for the overnight period than for the close-to-close period.

Table 3, panel C reports the trading time abnormal returns for Day 1. The results differ from those in panels A and B. Price reversals occur more often than price continuations for the limit moves. Price reversals occur 58–64% and 53–69% of the time for 1- to 3-day upward- and downward limit moves, respectively. In contrast, price continuations occur only 31–36% and 27–42% for upward- and downward limit moves, respectively.

When the price behavior of limit moves is compared with that of near-limit moves with returns more than 5% or less than −5%, price continuations occur more frequently for limit moves than for near-limit moves in the overnight. From Table 3, panel A, price continuations occur only 46% of the time for upward near-limit moves and only 42% for downward near-limit moves. The overnight price continuations for near-limit moves are significantly lower than those for limit moves.

Table 3
Distribution of price continuations and reversals over 1990–1996

Panel A: Price behavior of Day 1 overnight abnormal returns ($AR_{1,co}$)

Price behavior of $AR_{1,co}$	1-day limit move (1)	2-day limit move (2)	3-day limit move (3)	near-limit move (4)	(1)–(4) (*t* value) (5)
Upward price movements					
Continuation ($AR_{1,co} > 0$)	0.66	0.65	0.66	0.46	0.21 (24.93)
Reversal ($AR_{1,co} < 0$)	0.17	0.20	0.19	0.33	− 0.15 (− 21.38)
No change ($AR_{1,co} = 0$)	0.16	0.16	0.15	0.22	− 0.05 (− 8.08)
Downward price movements					
Continuation ($AR_{1,co} < 0$)	0.70	0.60	0.77	0.42	0.28 (30.64)
Reversal ($AR_{1,co} > 0$)	0.17	0.26	0.11	0.36	− 0.20 (− 24.46)
No change ($AR_{1,co} = 0$)	0.13	0.14	0.12	0.21	− 0.08 (− 11.64)

Panel B: Price behavior of Day 1 abnormal returns (AR_1)

Price behavior of AR_1	1-day limit move (1)	2-day limit move (2)	3-day limit move (3)	near-limit moves (4)	(1)–(4) (*t* value) (5)
Upward price movements					
Continuation ($AR_1 > 0$)	0.51	0.54	0.54	0.33	0.19 (22.48)
Reversal ($AR_1 < 0$)	0.43	0.40	0.40	0.60	− 0.18 (− 21.47)
No change ($AR_1 = 0$)	0.06	0.06	0.06	0.07	− 0.01 (− 1.59)
Downward price movements					
Continuation ($AR_1 < 0$)	0.62	0.64	0.68	0.39	0.23 (25.33)
Reversal ($AR_1 > 0$)	0.31	0.30	0.27	0.52	− 0.20 (− 22.59)
No change ($AR_1 = 0$)	0.07	0.06	0.04	0.09	− 0.03 (− 5.68)

Panel C: Price behavior of Day 1 trading time abnormal returns ($AR_{1,oc}$)

Price behavior of $AR_{1,oc}$	1-day limit move (1)	2-day limit move (2)	3-day limit move (3)	near-limit move (4)	(1)–(4) (*t* value) (5)
Upward price movements					
Continuation ($AR_{1,oc} > 0$)	0.36	0.32	0.31	0.32	0.04 (4.50)
Reversal ($AR_{1,oc} < 0$)	0.58	0.64	0.63	0.61	− 0.03 (− 3.63)
No change ($AR_{1,oc} = 0$)	0.06	0.04	0.06	0.07	− 0.01 (− 1.47)
Downward price movements					
Continuation ($AR_{1,oc} < 0$)	0.35	0.42	0.27	0.40	− 0.05 (− 5.54)
Reversal ($AR_{1,oc} > 0$)	0.60	0.53	0.69	0.54	0.06 (7.02)
No change ($AR_{1,oc} = 0$)	0.05	0.05	0.04	0.07	− 0.01 (− 3.40)

For the subsequent trading period, price reversals occur for near-limit moves. Price reversals occur 61% of the time for upward near-limit moves, and 54% of the time for downward near-limits as indicated in Table 3, panel C.

Overall, Table 1 indicates price continuations for the Day 1 overnight period and price reversals for the Day 1 trading period following limit moves. Day 1 overnight price

Table 4
Abnormal returns for 1-, 2-, and 3-day limit moves sorted by $AR_{1,co}$ over 1990–1996

Portfolio	AR_0	AR_1	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,co})$	$t(AR_{1,oc})$
Panel A: 1-day up-limit moves						
Smallest	0.0280	−0.0081	−0.0252	0.0171	−26.41	16.28
2	0.0351	−0.0058	−0.0043	−0.0015	−5.53	−1.73
3	0.0305	−0.0019	0.0000	−0.0019	0.00	−1.95
4	0.0386	0.0010	0.0029	−0.0018	4.15	−2.20
5	0.0391	0.0009	0.0082	−0.0072	11.35	−8.29
6	0.0405	0.0059	0.0125	−0.0066	17.10	−7.46
7	0.0413	0.0052	0.0171	−0.0118	22.31	−13.18
8	0.0398	0.0108	0.0225	−0.0116	28.52	−12.54
9	0.0383	0.0117	0.0314	−0.0196	36.63	−19.98
Largest	0.0356	0.0212	0.0530	−0.0318	52.67	−29.14
All	0.0367	0.0041	0.0118	−0.0077	45.37	−25.66
Panel B: 2-day up-limit moves						
Smallest	0.0485	−0.0009	−0.0376	0.0367	−14.57	12.96
2	0.0725	−0.0082	−0.0085	0.0003	−3.83	0.14
3	0.0644	0.0019	−0.0000	0.0020	−0.02	0.81
4	0.0760	−0.0021	0.0020	−0.0042	0.97	−1.74
5	0.0820	−0.0006	0.0097	−0.0103	4.66	−4.29
6	0.0691	0.0056	0.0172	−0.0116	7.81	−4.74
7	0.0750	0.0046	0.0256	−0.0210	11.43	−8.60
8	0.0606	0.0071	0.0374	−0.0303	14.12	−10.81
9	0.0500	0.0128	0.0533	−0.0405	19.42	−14.15
Largest	0.0506	0.0258	0.0648	−0.0390	23.24	−13.45
All	0.0649	0.0046	0.0164	−0.0118	21.59	−14.24
Panel C: 3-day up-limit moves						
Smallest	0.1188	−0.0082	−0.0354	0.0272	−6.19	4.52
2	0.1245	−0.0034	−0.0086	0.0051	−1.89	1.01
3	0.1021	−0.0072	−0.0000	−0.0072	0.00	−1.32
4	0.1256	−0.0062	0.0025	−0.0088	0.48	−1.47
5	0.1238	0.0001	0.0110	−0.0108	2.17	−1.93
6	0.1173	0.0158	0.0205	−0.0047	3.92	−0.82
7	0.1126	0.0029	0.0276	−0.0247	5.00	−4.17
8	0.1072	0.0193	0.0449	−0.0255	7.52	−3.90
9	0.1233	0.0078	0.0596	−0.0518	11.52	−8.95
Largest	0.0954	0.0197	0.0655	−0.0458	10.68	−7.24
All	0.1150	0.0040	0.0187	−0.0147	11.03	−7.92
Panel D: 1-day down-limit moves						
Smallest	−0.0105	−0.0218	−0.0700	0.0482	−60.55	38.15
2	−0.0109	−0.0112	−0.0588	0.0476	−52.45	38.52
3	−0.0130	−0.0131	−0.0450	0.0319	−44.42	27.68
4	−0.0173	−0.0109	−0.0322	0.0213	−32.72	18.84
5	−0.0241	−0.0125	−0.0222	0.0096	−24.38	9.03
6	−0.0231	−0.0112	−0.0144	0.0032	−17.70	3.29
7	−0.0280	−0.0075	−0.0066	−0.0008	−8.20	−0.86

(continued on next page)

Table 4 (*continued*)

Portfolio	AR_0	AR_1	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,co})$	$t(AR_{1,oc})$
Panel D: 1-day up-limit moves						
8	− 0.0230	− 0.0045	− 0.0000	− 0.0045	− 0.06	− 4.22
9	− 0.0259	− 0.0007	0.0046	− 0.0054	5.25	− 5.23
Largest	− 0.0222	0.0003	0.0272	− 0.0268	26.08	− 22.96
All	− 0.0198	− 0.0093	− 0.0217	0.0124	− 70.66	35.36
Panel E: 2-day down-limit moves						
Smallest	− 0.0468	− 0.0342	− 0.0717	0.0375	− 26.97	12.52
2	− 0.0425	− 0.0277	− 0.0676	0.0399	− 26.50	13.75
3	− 0.0518	− 0.0128	− 0.0552	0.0423	− 20.28	14.09
4	− 0.0628	− 0.0136	− 0.0362	0.0226	− 14.22	7.93
5	− 0.0580	− 0.0168	− 0.0240	0.0072	− 9.57	2.57
6	− 0.0711	− 0.0069	− 0.0089	0.0019	− 3.75	0.70
7	− 0.0442	− 0.0114	− 0.0000	− 0.0114	− 0.01	− 3.75
8	− 0.0459	− 0.0076	0.0037	− 0.0114	1.32	− 3.73
9	− 0.0423	− 0.0019	0.0181	− 0.0201	6.09	− 6.20
Largest	− 0.0338	0.0029	0.0450	− 0.0421	14.18	− 12.57
All	− 0.0499	− 0.0130	− 0.0197	0.0066	− 22.84	7.00
Panel F: 3-day down-limit moves						
Smallest	− 0.1017	− 0.0235	− 0.0723	0.0488	− 12.97	7.93
2	− 0.1293	− 0.0288	− 0.0703	0.0414	− 11.15	6.20
3	− 0.0742	− 0.0420	− 0.0659	0.0238	− 11.52	3.66
4	− 0.0806	− 0.0248	− 0.0583	0.0335	− 9.49	4.96
5	− 0.0787	− 0.0174	− 0.0484	0.0309	− 8.67	4.85
6	− 0.0872	− 0.0125	− 0.0350	0.0225	− 5.95	3.50
7	− 0.0860	− 0.0145	− 0.0223	0.0078	− 4.04	1.30
8	− 0.0994	− 0.0149	− 0.0068	− 0.0080	− 1.28	− 1.37
9	− 0.0703	0.0031	− 0.0000	0.0031	0.00	0.52
Largest	− 0.0871	0.0007	0.0108	− 0.0101	2.45	− 1.91
All	− 0.0895	− 0.0174	− 0.0368	0.0193	− 20.70	9.85

continuations and trading time price reversals for limit moves are consistent with the overreaction hypothesis. This implies that price limits delay not only intrinsic value but also overreaction on Day 0.

6.2. Overnight and trading time abnormal returns

Table 4 presents overnight and trading time abnormal returns following limit moves. Consistent with the results in Table 3, price continuations occur more frequently in the overnight period following limit moves, and price reversals occur in the subsequent trading time period. For upward limit movements, the Day 1 overnight abnormal returns, $AR_{1,co}$, are 1.18%, 1.64%, and 1.87%, respectively, for 1-, 2-, and 3-day limit moves. In contrast, the subsequent trading time abnormal returns, $AR_{1,oc}$, are − 0.77%, − 1.18%, and − 1.47%, respectively, as shown in Table 4, panels A–C. The ratio of $AR_{1,oc}$ to $AR_{1,co}$ ranges from − 0.65 to − 0.79. This means that, on average, around two thirds of the overnight abnormal

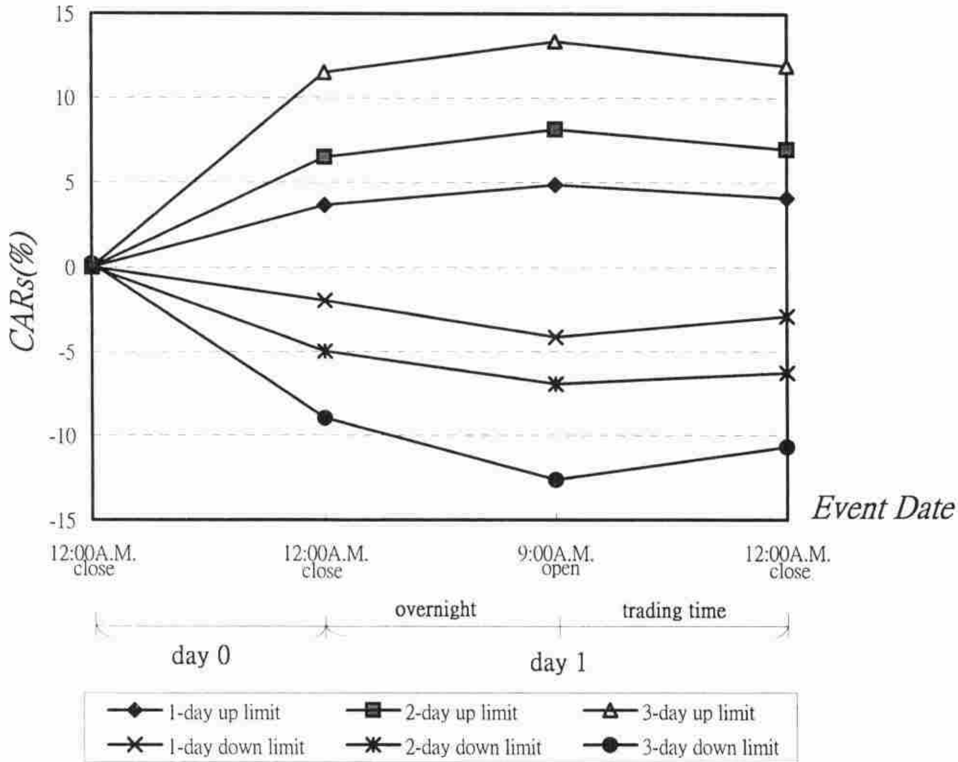

Fig. 1. Cumulative abnormal returns (CARs) for one-, two-, and three-day limit moves for days 0 and 1.

returns, $AR_{1,co}$, is offset by the price reversals in the following trading period. For downward limit moves, the same pattern of overnight price continuations and trading time price reversals is observed. The overnight abnormal returns, $AR_{1,co}$, are −2.17%, −1.97%, and −3.68%, respectively, for 1-, 2-, and 3-day limit moves, while the subsequent trading time abnormal returns are 1.24%, 0.66%, and 1.93% as indicated in Table 4, panels D–F. On average, 34–57% of the overnight abnormal returns is offset by the price reversals in the subsequent trading period. The cumulative abnormal returns (CARs) for 1-, 2-, and 3-day limit moves are displayed in Fig. 1.

The abnormal returns in Table 4 can be used to measure the degree of overreaction. If the Day 1 closing prices reflect the new intrinsic value of securities, the CARs on Days 0 and 1 $(AR_0 + AR_1)$ will reflect the unexpected change of intrinsic value for the stock. The degree of overreaction is measured as the ratio of the magnitude of Day 1 price reversals to change in intrinsic value: O_t/Δ_t or $-AR_{1,oc}/(AR_0 + AR_1)$. The degree of overreaction is 19%, 17%, and 12% for 1-, 2-, and 3-day up-limit moves, respectively, and 43%, 10%, and 18% for the corresponding down-limit moves, respectively.

Table 4 also indicates that the magnitude of trading time price reversals is a positive function of the magnitude of overnight price continuations. The stocks are sorted into deciles in an ascending order according to the overnight abnormal returns. For 1-day up-limit moves, for example, the Day 1 overnight abnormal return, $AR_{1,co}$, increases from −2.52% for the first decile to 5.30% for the last decile. The Day 1 trading time abnormal return, $AR_{1,oc}$, decreases from 1.71% for the first decile to -3.18% for the last decile. Similarly, for 1-day down-limit-moves, the Day 1 overnight abnormal return increases from -7.00% for the first decile to 2.72% for the last decile, while the Day 1 trading time abnormal return, $AR_{1,oc}$, decreases from 4.82% to -2.68%.

6.3. Price behavior for near-limit and intraday limit moves

Table 5 presents abnormal returns for near-limit moves with Day 0 returns more than 5% or less than -5% but not at limits. The results indicate price continuations and price reversals in the overnight and trading time, respectively, for Day 1 for the near-limit sample. Moreover, the magnitude of price continuations and price reversals is much smaller than that for limit moves. The Day 1 overnight and trading time abnormal returns are 0.23% and -0.72%, respectively, for upward near-limit moves, and -0.25% and 0.52%, respectively, for downward near-limit moves.

For Day 1, the larger the overnight price continuations, the greater the trading time price reversals. Near-limit moves are sorted into deciles according to the Day 1 overnight return, $AR_{1,co}$. For upward near-limit moves, when overnight abnormal returns increase from

Table 5
Abnormal returns for near-limit moves sorted by $AR_{1,co}$ over 1990–1996

Portfolio	AR_0	AR_1	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,co})$	$t(AR_{1,oc})$
Panel A: Near-limit moves with $r_0 > 5\%$						
Smallest	0.0246	−0.0150	−0.0317	0.0167	−31.35	15.04
2	0.0287	−0.0128	−0.0111	−0.0017	−13.70	−1.86
3	0.0321	−0.0095	−0.0054	−0.0041	−7.75	−4.78
4	0.0304	−0.0079	−0.0009	−0.0070	−1.37	−8.27
5	0.0286	−0.0074	0.0000	−0.0074	0.01	−7.80
6	0.0330	−0.0064	0.0020	−0.0085	3.19	−10.34
7	0.0324	−0.0031	0.0065	−0.0097	8.95	−10.83
8	0.0332	0.0001	0.0103	−0.0101	14.28	−11.42
9	0.0298	0.0020	0.0163	−0.0143	19.48	−14.55
Largest	0.0295	0.0110	0.0369	−0.0259	34.82	−22.46
All	0.0302	−0.0049	0.0023	−0.0072	8.98	−23.95
Panel B: Near-limit moves with $r_0 < -5\%$						
Smallest	−0.0201	−0.0068	−0.0488	0.0420	−46.12	35.33
2	−0.0241	−0.0024	−0.0210	0.0185	−23.69	17.66
3	−0.0254	−0.0021	−0.0117	0.0096	−14.98	10.07
4	−0.0274	−0.0009	−0.0060	0.0051	−8.22	5.55
5	−0.0294	0.0019	−0.0007	0.0027	−1.05	2.94
6	−0.0252	0.0026	0.0000	0.0026	0.01	2.66
7	−0.0314	0.0044	0.0026	0.0018	3.84	2.10
8	−0.0297	0.0067	0.0081	−0.0013	10.89	−1.46
9	−0.0282	0.0090	0.0157	−0.0067	18.52	−6.53
Largest	−0.0237	0.0144	0.0363	−0.0219	35.22	−18.75
All	−0.0265	0.0026	−0.0025	0.0052	−9.61	16.46

Table 6
Abnormal returns for r_0 in the range of $3\% < r_0 \leq 5\%$ and $-5\% \leq r_0 < -3\%$ sorted by $AR_{1,co}$ over 1990–1996

Panel A: Day 0 returns in the range of 3–5% for 1990–1996 (daily limit = 7%)

	$3\% < r_0 \leq 4\%$				$4\% < r_0 \leq 5\%$			
Portfolio	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$
Smallest	0.0173	−0.0218	0.0120	17.32	0.0209	−0.0258	0.0131	13.99
2	0.0195	−0.0065	−0.0008	−1.46	0.0244	−0.0079	−0.0009	−1.27
3	0.0190	−0.0013	−0.0042	−7.93	0.0267	−0.0024	−0.0039	−5.50
4	0.0181	−0.0000	−0.0051	−8.49	0.0221	−0.0000	−0.0074	−8.71
5	0.0195	0.0005	−0.0051	−9.35	0.0234	0.0002	−0.0060	−7.55
6	0.0192	0.0041	−0.0054	−10.29	0.0258	0.0040	−0.0059	−8.14
7	0.0189	0.0070	−0.0071	−12.71	0.0249	0.0072	−0.0090	−11.38
8	0.0184	0.0096	−0.0087	−15.26	0.0242	0.0102	−0.0101	−12.45
9	0.0179	0.0139	−0.0098	−16.28	0.0242	0.0149	−0.0128	−14.82
Largest	0.0181	0.0269	−0.0138	−20.35	0.0235	0.0317	−0.0193	−19.83
All	0.0186	0.0032	−0.0048	−25.87	0.0240	0.0032	−0.0062	−23.85

Panel B: Day 0 returns in the range of −5% to −3%

	$-4\% < r_0 \leq -3\%$				$-5\% < r_0 \leq -4\%$			
Portfolio	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$
Smallest	−0.0139	−0.0308	0.0206	29.29	−0.0161	−0.0382	0.0297	28.49
2	−0.0162	−0.0123	0.0074	11.96	−0.0203	−0.0152	0.0089	9.81
3	−0.0171	−0.0073	0.0035	5.97	−0.0207	−0.0090	0.0053	6.18
4	−0.0186	−0.0031	0.0019	3.55	−0.0241	−0.0044	0.0035	4.36
5	−0.0171	−0.0000	−0.0007	−1.12	−0.0230	−0.0001	0.0009	1.13
6	−0.0174	0.0000	0.0005	0.86	−0.0222	0.0000	0.0017	1.97
7	−0.0192	0.0014	−0.0005	−0.89	−0.0244	0.0017	0.0013	1.71
8	−0.0196	0.0059	−0.0027	−4.71	−0.0248	0.0067	−0.0016	−1.84
9	−0.0211	0.0105	−0.0052	−8.55	−0.0249	0.0125	−0.0049	−5.37
Largest	−0.0193	0.0250	−0.0142	−19.93	−0.0207	0.0293	−0.0168	−15.63
All	−0.0180	−0.0010	0.0010	5.42	−0.0221	−0.0016	0.0028	9.87

−3.17% to 3.69%, trading time abnormal returns decrease from 1.67% to −2.59%. For downward near-limit moves, when overnight abnormal returns increase from −4.88% to 3.63%, the corresponding trading time abnormal returns decrease from 4.20% to −2.19%.

For Day 1, on average, trading time price reversals more than offset overnight price continuations. This implies that the Day 0 closing price contains not only the change in intrinsic value but also part of the overreaction effect. The ratio of overreaction, $-AR_{1,oc}/(AR_0 + AR_1)$, is 28% and 22% for upward and downward near-limit moves, respectively. This suggests that the degree of overreaction is around one quarter of the intrinsic value for near-limit moves.

Table 6 presents abnormal returns for stocks with Day 0 returns in the ranges of 3% to 5% and −5% to −3%, respectively. The patterns are similar to those for near-limit moves in Table 5, but the magnitude of both the overnight price continuations and the trading time price reversals is smaller. For Day 0 returns in the ranges of 3–4% and 4–5%, the overnight abnormal return is 0.32%, and the trading time abnormal returns lie within the ranges of

Table 7
Abnormal returns for intraday limit moves sorted by $AR_{1,co}$ over 1990–1996

Portfolio	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$
Panel A: Intraday up-limit moves				
Smallest	0.0238	− 0.0384	0.0246	14.97
2	0.0264	− 0.0143	0.0020	1.43
3	0.0331	− 0.0071	− 0.0037	− 3.01
4	0.0324	− 0.0021	− 0.0047	− 3.92
5	0.0258	− 0.0000	− 0.0081	− 6.13
6	0.0323	0.0009	− 0.0066	− 5.14
7	0.0306	0.0062	− 0.0129	− 9.75
8	0.0301	0.0103	− 0.0114	− 8.79
9	0.0301	0.0164	− 0.0147	− 10.27
Largest	0.0300	0.0382	− 0.0283	− 16.83
All	0.0295	0.0010	− 0.0064	− 14.47
Panel B: Intraday down-limit moves				
Smallest	− 0.0148	− 0.0518	0.0443	28.83
2	− 0.0147	− 0.0245	0.0176	13.51
3	− 0.0167	− 0.0147	0.0116	9.69
4	− 0.0186	− 0.0081	0.0039	3.46
5	− 0.0221	− 0.0022	0.0016	1.52
6	− 0.0163	0.0000	− 0.0004	− 0.34
7	− 0.0230	0.0021	0.0001	0.09
8	− 0.0212	0.0086	− 0.0033	− 2.74
9	− 0.0151	0.0171	− 0.0085	− 6.44
Largest	− 0.0122	0.0391	− 0.0274	− 18.72
All	− 0.0175	− 0.0034	0.0039	9.79

− 0.62% to − 0.48%. For Day 0 returns in the ranges of − 5% to − 4% and − 4% to − 3%, the overnight abnormal returns are within − 0.16% to − 0.1%, and the trading time abnormal returns are between 0.10% and 0.28%.

Table 7 presents abnormal returns for intraday limit moves. The results are similar to those for near-limit moves. On average, price reversals occur in the Day 1 close-to-close period. For intraday up-limit moves, the abnormal returns are 2.95% for Day 0 and − 0.54% for Day 1 ($AR_1 = AR_{1,co} + AR_{1,oc}$). For intraday down-limit moves, the abnormal returns are − 1.75% and 0.05%, respectively, for Days 0 and 1. For Day 1, price reversals tend to occur in the trading time, but price continuations in the overnight period are less evident.

On average, the Day 1 close-to-close abnormal returns, AR_1, experience price reversals for near-limit moves and intraday limit moves. The Day 0 overreaction is reversed mainly in the Day 1 trading time.

6.4. Price behavior for tick-size and size portfolios

Price reversals as reported above, however, need not be caused by investors' overreaction. For example, price reversals could be caused by measurement errors such as a bid–ask bounce. Stock prices that close at an ask price in the first period and close at a bid price in the

Table 8
Abnormal returns for 1-day limit moves over 1990–1996 sorted by relative tick size

Portfolio	AR_0	AR_1	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,co})$	$t(AR_{1,oc})$	Relative tick size
Panel A: 1-day up-limit moves							
Smallest	0.0353	0.0042	0.0139	−0.0097	16.04	−9.90	0.0022
2	0.0359	0.0062	0.0127	−0.0065	14.36	−6.60	0.0026
3	0.0357	0.0057	0.0102	−0.0044	12.17	−4.68	0.0031
4	0.0362	0.0044	0.0102	−0.0058	12.16	−6.10	0.0035
5	0.0385	0.0055	0.0123	−0.0067	15.70	−7.37	0.0040
6	0.0397	0.0044	0.0122	−0.0077	15.66	−8.49	0.0047
7	0.0368	0.0021	0.0125	−0.0103	15.80	−11.13	0.0055
8	0.0358	0.0026	0.0116	−0.0089	14.35	−9.28	0.0064
9	0.0368	0.0030	0.0118	−0.0087	14.76	−9.17	0.0078
Largest	0.0363	0.0027	0.0111	−0.0083	13.22	−8.73	0.0093
All	0.0367	0.0041	0.0118	−0.0077	45.50	−25.74	0.0049
Panel B: 1-day down-limit moves							
Smallest	−0.0191	−0.0126	−0.0226	0.0100	−22.47	8.68	0.0022
2	−0.0192	−0.0114	−0.0203	0.0088	−18.82	7.48	0.0027
3	−0.0200	−0.0110	−0.0207	0.0097	−19.97	8.56	0.0032
4	−0.0193	−0.0079	−0.0230	0.0151	−23.27	13.69	0.0036
5	−0.0195	−0.0085	−0.0215	0.0129	−22.39	11.87	0.0041
6	−0.0185	−0.0093	−0.0224	0.0131	−24.20	12.10	0.0047
7	−0.0197	−0.0095	−0.0224	0.0129	−23.94	11.83	0.0054
8	−0.0194	−0.0081	−0.0229	0.0147	−24.93	13.67	0.0063
9	−0.0199	−0.0064	−0.0213	0.0149	−23.07	13.58	0.0077
Largest	−0.0232	−0.0080	−0.0192	0.0112	−20.28	10.20	0.0093
All	−0.0198	−0.0093	−0.0216	0.0123	−70.27	35.11	0.0049

Relative tick size = tick size/$P_{1,open}$.

subsequent period would create a trend of price reversals. To examine this possibility, stocks that experienced 1-day limit moves are sorted into deciles according to a measure of bid–ask spread. For the Taiwan Stock Exchange, the periodic call market method is adopted to determine the equilibrium price. Casual observations indicate that bid–ask spreads typically equal one tick for most stocks. For convenience, the relative tick size, computed by dividing the tick size by the Day 1 opening prices, is used as a measure of the relative bid–ask spread. The relative tick size ranges from 0.1% to 1%, as can be seen in Table 1. If the price reversals reported above are caused by a bid–ask bounce, price reversals should occur more frequently for portfolios with a larger relative tick size.

Table 8 presents the abnormal returns for the deciles sorted by relative tick size. The results indicate that there is no discernible pattern of price reversals among the deciles. For up-limit moves, the trading time abnormal return for Day 1, $AR_{1,oc}$, is −0.97% for the decile of the smallest relative tick size, and −0.83% for the largest decile. For the down-limit moves, the trading time abnormal return is 1.00% for the smallest decile and 1.12% for the largest decile. The results do not support the bid–ask bounce as an explanation of price reversals.

Table 9
Abnormal returns of size quintiles for 1-day limit moves over 1990–1996

Portfolio	AR_0	AR_1	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,co})$	$t(AR_{1,oc})$
Panel A: 1-day up-limit moves						
Smallest	0.0427	0.0062	0.0141	−0.0079	20.29	−11.42
2	0.0376	0.0058	0.0124	−0.0066	17.88	−9.55
3	0.0376	0.0035	0.0114	−0.0078	17.27	−11.84
4	0.0341	0.0032	0.0108	−0.0075	16.54	−11.58
Largest	0.0294	0.0009	0.0096	−0.0087	15.94	−14.43
All	0.0367	0.0041	0.0118	−0.0077	101.62	−57.42
Panel B: 1-day down-limit moves						
Smallest	−0.0252	−0.0125	−0.0244	0.0118	−29.01	14.13
2	−0.0201	−0.0122	−0.0216	0.0094	−26.62	11.56
3	−0.0194	−0.0102	−0.0208	0.0106	−26.58	13.54
4	−0.0187	−0.0078	−0.0215	0.0136	−29.18	18.53
Largest	−0.0146	−0.0028	−0.0195	0.0167	−26.77	22.92
All	−0.0198	−0.0093	−0.0216	0.0123	−157.29	78.47

Aside from the bid–ask bounce, price reversals could relate to firm size. For example, stock prices could be manipulated more easily for small firms than for large firms. Further, information regarding the change in the intrinsic value of securities could be less available for small firms than for large firms. If so, investors of small firms might tend to overreact to new information. As a result, price reversals could occur more frequently for smaller firms than for larger firms. The possibility of overreaction and price reversal related to firm size is tested by examining the price behavior for size quintiles. For each 1-day limit move, the stock is assigned into quintiles according to the market value in the month preceding the limit move.

Table 9 presents abnormal returns for the size portfolios. The results do not support the size explanation. For the 1-day up-limit moves, the Day 1 trading time abnormal return, $AR_{1,oc}$, is − 0.79% for the smallest size quintile and − 0.87% for the largest size quintile. For the down-limit moves, the trading time abnormal return is 1.18% for the smallest size quintile and 1.67% for the largest size quintile.

6.5. Abnormal returns estimated by different models

The above analysis is based on the abnormal returns estimated by the market model. Although the market model is widely adopted, the issue of parameter estimation is complicated since the estimation period itself might also contain other limit moves. Aside from this issue, it is informative to know whether the results are sensitive to the model selection.

To resolve these issues, the above analysis is repeated by using (1) raw returns, (2) market-adjusted abnormal returns, and (3) mean-adjusted abnormal returns. For the market-adjusted method, abnormal returns are computed as the difference between the stock return and the corresponding market return. This assumes that the systematic risk of the stock equals one. For the mean-adjusted model, the estimation period from $t = -140$ to $t = -16$ is used to

Table 10
Abnormal returns for 1-day limit moves with abnormal returns estimated by different models

	Raw returns				Market-adjusted			
Portfolio	R_0	$R_{1,co}$	$R_{1,oc}$	$t(R_{1,oc})$	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$
Panel A: 1-day up-limit moves								
Smallest	0.0653	− 0.0252	0.0053	5.08	0.0289	− 0.0252	0.0163	15.53
2	0.0653	− 0.0034	− 0.0082	− 8.59	0.0368	− 0.0044	− 0.0013	− 1.44
3	0.0649	0.0000	− 0.0030	− 3.20	0.0318	− 0.0000	− 0.0026	− 2.69
4	0.0654	0.0034	− 0.0052	− 5.89	0.0392	0.0027	− 0.0021	− 2.46
5	0.0651	0.0088	− 0.0067	− 7.72	0.0400	0.0082	− 0.0072	− 8.20
6	0.0653	0.0133	− 0.0069	− 7.72	0.0425	0.0125	− 0.0069	− 7.87
7	0.0649	0.0177	− 0.0075	− 8.45	0.0416	0.0170	− 0.0117	− 12.97
8	0.0652	0.0230	− 0.0105	− 11.38	0.0410	0.0224	− 0.0112	− 12.17
9	0.0652	0.0318	− 0.0171	− 17.83	0.0397	0.0313	− 0.0191	− 19.51
Largest	0.0653	0.0533	− 0.0350	− 32.27	0.0361	0.0529	− 0.0326	− 29.86
All	0.0652	0.0123	− 0.0095	− 31.60	0.0378	0.0117	− 0.0078	− 26.19
Panel B: 1-day down-limit moves								
Smallest	− 0.0702	− 0.0696	0.0389	30.62	− 0.0143	− 0.0700	0.0475	37.47
2	− 0.0702	− 0.0587	0.0379	30.83	− 0.0144	− 0.0588	0.0469	38.11
3	− 0.0699	− 0.0446	0.0248	21.18	− 0.0166	− 0.0450	0.0318	27.48
4	− 0.0700	− 0.0315	0.0178	15.71	− 0.0203	− 0.0322	0.0213	18.78
5	− 0.0698	− 0.0214	0.0101	9.49	− 0.0276	− 0.0221	0.0110	10.28
6	− 0.0699	− 0.0126	0.0067	6.63	− 0.0266	− 0.0141	0.0027	2.82
7	− 0.0701	− 0.0032	− 0.0005	− 0.57	− 0.0290	− 0.0065	− 0.0002	− 0.26
8	− 0.0697	0.0000	− 0.0008	− 0.80	− 0.0249	− 0.0000	− 0.0043	− 4.05
9	− 0.0701	0.0074	− 0.0018	− 1.87	− 0.0274	0.0046	− 0.0055	− 5.45
Largest	− 0.0702	0.0314	− 0.0197	− 17.65	− 0.0239	0.0272	− 0.0266	− 22.71
All	− 0.0700	− 0.0203	0.0113	32.23	− 0.0225	− 0.0217	0.0124	35.41

	Mean-adjusted			
Portfolio	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$
Panel C: 1-day up-limit moves				
Smallest	0.0667	− 0.0241	0.0055	5.62
2	0.0652	− 0.0052	− 0.0026	− 3.03
3	0.0657	− 0.0008	− 0.0055	− 6.56
4	0.0659	0.0038	− 0.0036	− 4.04
5	0.0664	0.0080	− 0.0060	− 6.45
6	0.0664	0.0123	− 0.0053	− 5.85
7	0.0657	0.0167	− 0.0043	− 4.74
8	0.0662	0.0229	− 0.0106	− 11.31
9	0.0672	0.0326	− 0.0137	− 13.51
Largest	0.0684	0.0557	− 0.0357	− 31.00
All	0.0664	0.0122	− 0.0082	− 27.28
Panel D: 1-day down-limit moves				
Smallest	− 0.0691	− 0.0693	0.0412	35.28
2	− 0.0673	− 0.0569	0.0381	30.10
3	− 0.0679	− 0.0439	0.0248	21.03

(continued on next page)

Table 10 (*continued*)

	Mean-adjusted			
Portfolio	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$
Panel D: 1-day down-limit moves				
4	− 0.0688	− 0.0316	0.0179	16.32
5	− 0.0691	− 0.0219	0.0121	11.12
6	− 0.0693	− 0.0134	0.0089	8.69
7	− 0.0698	− 0.0050	0.0037	3.80
8	− 0.0688	− 0.0000	0.0004	0.50
9	− 0.0681	0.0081	− 0.0015	− 1.36
Largest	− 0.0673	0.0327	− 0.0196	− 16.85

estimate the mean return. Abnormal returns are estimated by deducting the mean return from the stock returns for the event days.

Table 10 presents results for 1-day limit moves. For Day 1, the three methods produce similar results of overnight price continuations and trading time price reversals. For up-limit moves, the overnight raw return, $R_{1,co}$, is 1.23%. The overnight abnormal return is 1.17% under the market-adjusted method, and 1.22% under the mean-adjusted method. In contrast, the trading time raw return, $R_{1,oc}$, is − 0.95%. The trading time abnormal return is − 0.78% under the market-adjusted method, and − 0.82% under the mean-adjusted method. Results for down-limit moves are similar among the three methods.

Moreover, the higher the overnight price continuation, the larger the subsequent trading time price reversal. For up-limit moves, as the overnight raw return increases from − 2.52% for the first decile to 5.33% for the last decile, the subsequent trading time raw return decreases from 0.53% to − 3.5%. The same pattern applies to other methods and to down-limit moves.

The Day 0 returns, however, differ among the three methods. The market-adjusted Day 0 returns are smaller in magnitude relative to the other two methods. Although firm-specific limit moves have limited impact on market returns, the contrary is not true. A large market swing usually leads individual stocks to limit moves. Thus, on average, the market returns are larger in the period in which individual stock hits price limits.

Since tests of the relevant hypotheses are based mainly on Day 1 price behavior, the similar Day 1 results produced by the three methods indicate that the tests of hypotheses are not sensitive to the model selection.[7]

6.6. Analysis of the magnet effect of price limits

In Section 3.1, the overreaction effect, O, is assumed to be positively related to the change in the intrinsic value, Δ_t, upon the arrival of new information, or $O=f(\Delta_t)$ where $\partial O/\partial \Delta_t > 0$. The interpretation is that noise traders tend to overreact to new information.

[7] The results are also examined for the pre-August 1993 and the post-August 1993 subsamples. While the two subsamples differ in trading frequencies, the price behavior of overnight price continuation following limit moves and the price reversal in the following trading period is qualitatively the same for the two subsamples.

With the imposition of price limits, however, it is possible that price limits per se may cause the overreaction due to the magnet effect of price limits. When prices approach daily limits on day t, traders might speed up buying or selling before prices hit limits. In an upward price trend, for example, the new equilibrium prices in the next trading period on day $t+1$ might be higher following limit moves on day t. Speculators who are bullish should speed up buying when prices approach daily limits on day t. Day traders who sell short at the beginning of day t might wish to close the position by buying back when prices approach limits.[8] Thus, when prices are close to daily limits, the original price trend may accelerate. As a result, price limits behave like a magnet that draws prices toward the limit. The acceleration of price trends when prices approach limits is termed the magnet effect of price limits.

The overreaction caused by the magnet effect of price limits might result in price behavior similar to that caused by noise traders' overreaction to new information. In particular, when prices approach limits at the close of day t, the magnet effect of price limits could cause price continuation in the overnight period following the close of trading on day t. Price reversals could occur in the subsequent trading period when traders gradually cool down. Thus, the price continuation and the subsequent price reversals for the near-limit sample are also consistent with the magnet explanation of price limits. Moreover, the degree of both the overnight price continuation and the subsequent price reversals on day $t+1$ increases when the closing prices on day t are closer to daily price limits. Thus, the magnet explanation suggests that the overreaction effect, O, is positively related to the proximity to limits on day t, X_t, or $O=f(X_t)$ where $\partial O/\partial X_t>0$.

Consequently, the results for the near-limit samples, particularly in Tables 5 and 6, are also consistent with the notion that the overreaction is due to a magnet effect of price limits. As prices approach daily limits, prices are drawn toward price limits in the overnight period following near-limit moves. Price reversals are observed in the subsequent period when investors cool down.

Thus, the overreaction effect, O, can be explained either (1) by noise traders' overreaction to change in intrinsic value, Δ_t, or $O=f(\Delta_t)$ where $\partial O/\partial \Delta_t>0$; or (2) by the magnet effect of price limits, or $O=f(X_t)$ where $\partial O/\partial X_t> 0$; or (3) by both effects, or $O=f(\Delta_t, X_t)$ where $\partial O/\partial \Delta_t>0$ and $\partial O/\partial X_t>0$.

To examine which explanation can better explain the overreaction effect, a further dataset over the 1979–1986 period is examined. Daily price limits were 5% for the 1979–1986 period as opposed to the 7% for the 1990–1996 period.[9] The near-limit samples with returns in the ranges of 3–5% and −5% to −3% for the 1979–1986 period are examined and are compared with those for the 1990–1996 period where daily limits were at 7%. Both sets of data experience similar returns or change in intrinsic value, Δt, on day t but differ in their proximity to price limits, X_t. If the overreaction effect is mainly related to noise traders'

[8] Arak and Cook (1997) discuss and examine the effect of the magnet effects of price limits for the Treasury bond futures. For other research regarding the magnet effect of price limits, see, e.g., France, Kodres, and Moser (1994) and Subrahmanyam (1994, 1995).

[9] For a description of changes of price limits on the Taiwan Stock Exchange, please refer to Huang (1998, p. 471).

overreaction to new information, similar price patterns would be observed for both the 1979–1986 and 1990–1996 near-limit samples. In contrast, if the overreaction is related mainly to the magnet effect of price limits, stronger price continuation following near-limit returns and stronger subsequent price reversals would be observed for the 1979–1986 sample than for the 1990–1996 sample. For the 1979–1986 sample, the near-limit returns of 3–5% or − 5% to − 3% are closer to the price limits of 5% than for the 1990–1996 sample with price limits at 7%.

Table 11 reports abnormal returns for the 1979–1986 near-limit sample. Following the close of near-limit returns on Day 0, the price continuations and the subsequent price reversals are not stronger, and are in fact weaker, for the 1979–1986 sample than for the 1990–1996 sample. For Day 0 returns in the range 3–4%, the Day 0 abnormal return is 2.12% for the 1979–1986 sample (Table 11, panel A), which is higher than the 1.86% for the 1990–1996 sample (Table 6, panel A). However, the Day 1 overnight abnormal return

Table 11
Abnormal returns for r_0 in the range of $3\% < r_0 \leq 5\%$ and $-5\% \leq r_0 < -3\%$ sorted by $AR_{1,co}$ over 1979–1986 (daily limit = 5%)

Panel A: Day 0 returns in the range of 3–5%

	$3\% < r_0 \leq 4\%$				$4\% < r_0 \leq 5\%$			
Portfolio	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(R_{1,oc})$	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$
Smallest	0.0231	− 0.0173	0.0084	11.47	0.0281	− 0.0160	0.0085	6.40
2	0.0210	− 0.0088	0.0020	2.95	0.0269	− 0.0082	0.0038	2.76
3	0.0219	− 0.0055	− 0.0001	− 0.24	0.0294	− 0.0047	− 0.0020	− 1.41
4	0.0218	− 0.0014	− 0.0041	− 5.92	0.0299	− 0.0001	− 0.0040	− 2.81
5	0.0202	− 0.0000	− 0.0024	− 3.43	0.0289	0.0000	− 0.0022	− 1.61
6	0.0219	0.0000	− 0.0031	− 4.28	0.0270	0.0000	− 0.0041	− 2.78
7	0.0212	0.0018	− 0.0050	− 7.00	0.0278	0.0028	− 0.0062	− 4.54
8	0.0200	0.0052	− 0.0078	− 11.05	0.0278	0.0055	− 0.0102	− 7.64
9	0.0213	0.0077	− 0.0083	− 11.28	0.0266	0.0080	− 0.0092	− 6.45
Largest	0.0196	0.0144	− 0.0099	− 13.02	0.0272	0.0151	− 0.0070	− 4.76
All	0.0212	− 0.0004	− 0.0030	− 13.34	0.0280	0.0002	− 0.0033	− 7.38

Panel B: Day 0 returns in the range of − 5% to − 3%

	$-4\% \leq r_0 < -3\%$				$-5\% \leq r_0 < -4\%$			
Portfolio	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(R_{1,oc})$	AR_0	$AR_{1,co}$	$AR_{1,oc}$	$t(AR_{1,oc})$
Smallest	− 0.0192	− 0.0181	0.0109	13.04	− 0.0271	− 0.0186	0.0091	5.38
2	− 0.0204	− 0.0095	0.0073	8.89	− 0.0216	− 0.0091	0.0081	4.88
3	− 0.0198	− 0.0067	0.0052	6.46	− 0.0251	− 0.0061	0.0033	1.97
4	− 0.0193	− 0.0034	0.0031	4.04	− 0.0251	− 0.0040	0.0016	1.05
5	− 0.0197	− 0.0000	− 0.0008	− 0.96	− 0.0236	− 0.0000	− 0.0010	− 0.64
6	− 0.0194	0.0000	0.0004	0.52	− 0.0238	0.0000	0.0003	0.19
7	− 0.0197	0.0008	− 0.0006	− 0.80	− 0.0225	0.0010	− 0.0029	− 1.74
8	− 0.0171	0.0055	− 0.0020	− 2.67	− 0.0251	0.0054	− 0.0019	− 1.15
9	− 0.0192	0.0091	− 0.0073	− 9.00	− 0.0222	0.0092	− 0.0055	− 3.39
Largest	− 0.0190	0.0171	− 0.0089	− 10.89	− 0.0202	0.0184	− 0.0115	− 6.90
All	− 0.0193	− 0.0005	0.0007	2.81	− 0.0236	− 0.0003	− 0.0000	− 0.05

is −0.04% for the 1979–1986 sample, which indicates no price continuation, as compared with the price continuation of 0.32% for the corresponding 1990–1996 sample. Further, the degree of the Day 1 trading time price reversal of −0.3% for the 1979–1986 sample is smaller than the −0.48% for the 1990–1996 sample. The patterns of less price continuation and less following price reversals, for the 1979–1986 sample than for the 1990–1996 sample following Day 0 near-limit returns, are also observed when Day 0 returns are in the ranges of 4–5%, −4% to −3%, and −5% to −4%.

Thus, the results from the data sets of 1979–1986 and 1990–1996 are consistent with the explanation that the overreaction effect is mainly related to noise traders' overreaction to new information rather than to the magnet effect of price limits. However, since market conditions differ for the two sample periods 1979–1986 and 1990–1996, more research is needed to further understand the magnet effect of price limits on the price behavior surrounding price limits.[10]

7. Conclusions

This research examines the price behavior of limit moves for stocks listed on the Taiwan Stock Exchange over 1990–1996. The results indicate price continuations in the overnight period following limit moves and price reversals in the subsequent trading time period. The results are consistent with the overreaction hypothesis in that overreaction is delayed by price limits and the overreaction is corrected in the trading time period following limit moves.

Acknowledgments

The authors thank Carl Chen (the editor) and two anonymous reviewers for their insightful comments and assistance on earlier versions of this paper. All remaining errors are ours.

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[10] We thank the suggestions of the anonymous referees for strengthening the hypothesis development (Sections 3.1, 3.2, and 3.3) and for examining the magnet effects of price limits (Section 6.6).

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