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Price reversals and price continuations following large price movements☆

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ABSTRACT

We concurrently examine price reversals and price continuations that follow extreme one-day price changes in the period 1986–2015. Consistent with the overreaction and underreaction hypotheses, we find that investors overreact to non-information-based price movements and underreact to public announcements containing firm-specific information. We also find that, consistent with the liquidity hypothesis, smaller firms and firms with lower institutional ownership are more likely to experience price reversals relative to price continuations. The magnitudes of reversals and continuations are also greater for smaller firms and firms with lower institutional ownership. Liquidity improvement following the post-decimalization period led to the reduction in the magnitudes of both, price reversals and continuations. These findings have implications for future debate about underlying reasons of observed price movements and the impact of decimalization on financial markets.

1. Introduction

The dynamics of security prices following large price movements have received significant attention in prior literature. The impetus for this line of inquiry has been the short-run predictability of stock return patterns following large price increases or decreases. The literature has offered several explanations for the observed pricing patterns following large price movements, including the liquidity, overreaction, and underreaction hypotheses.[2] A liquidity-provision-based explanation frames reversals and continuations in terms of compensation to liquidity providers for absorbing buy/sell order imbalances (Cheng, Hameed, Subrahmanyam, & Titman, 2017; Harris & Gurel, 1986; So & Wang, 2014).[3] The overreaction hypothesis posits that investors overweigh current information, causing excessive trading and initial price shocks that lead to price reversals (Daniel, Hirshleifer, & Subrahmanyam, 1998; De Bondt & Thaler, 1985; De Bondt & Thaler, 1987; Park, 1995; Tetlock, 2011). On the other hand, the underreaction explanation suggests that investors are slow to respond to relevant information, which leads to price continuations (Benou, 2003; Chan, 2003; Jegadeesh & Titman, 2001; Pritamani & Singal, 2001; Savor, 2012; Zhang, 2006).

In this paper, we concurrently explore the effects of the liquidity, under-, and overreaction hypotheses on both price reversals and continuations following large, one-day market-adjusted returns, both positive and negative, over the period from 1986 to 2015. To distinguish these hypotheses, we investigate how price reversals and continuations are associated with prior stock returns, excess trading volumes, liquidity variables, and firm-specific information. We first examine the likelihood of price reversals and continuations following large positive and negative price changes. The results, based on multivariate logistic regression, demonstrate significant support for the liquidity and under-(over-)reaction hypotheses. Consistent with the liquidity hypothesis, we

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[2] Amini, Gebka, Hudson, and Keasey (2013) provide a thorough review of related studies and discuss additional explanations, including risk aversion effects (Brown, Harlow, & Tinic, 1988), market liquidity effects (Grossman & Miller, 1988; Jegadeesh and Titman, 1995b), market microstructure effects (Cox & Peterson, 1994; Park, 1995) and non-synchronous trading effects (Lo & MacKinlay, 1990).

[3] Following Kaniel, Saar, and Titman (2008) and Hendershott, Jones, and Menkveld (2011) we use "liquidity providers" to refer to the broad category of investors, including designated market makers, institutions acting as quasi-market makers, other algorithmic traders, and even individual investors.

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find that reversals are more likely to occur among less liquid stocks with smaller market capitalization and lower institutional ownership. Consistent with the overreaction hypothesis, firms with larger price shocks on the event day are more likely to experience price reversals. Moreover, we observe that smaller cumulative abnormal returns and higher trading volumes prior to the event day are positively associated with the probability of price reversals following a one-day price shock. Consistent with the underreaction explanation, we show that return continuations are more likely to occur following earnings announcements. The results provide further support for findings from previous studies that show that firm-specific information has a significant effect on price continuations (Pritamani & Singal, 2001; Savor, 2012). Overall, our results indicate that markets underreact to news about firms' fundamentals and overreact to non-information-based price movements.

We next examine the factors that determine the magnitudes of price reversals and continuations subsequent to large price shocks. Our analysis reveals both similarities and differences in stock characteristics that affect the magnitudes of price reversals and continuations, confirming the liquidity and under-(over-)reaction hypotheses. First, our results confirm that stock liquidity is a significant determinant of price reversal and continuation magnitudes (Cheng et al., 2017). Specifically, we find that smaller firms and firms with lower institutional ownership experience greater reversals and continuations following large price shocks. Second, consistent with Daniel et al.'s (1998) argument that initial price changes reflect trading on private information and are positively associated with the level of overreaction, we find that the magnitude of price reversals is particularly strong for firms with large price shocks and firms with large cumulative returns prior to the event day. In sharp contrast, the magnitude of price continuations is relatively smaller when the initial price change is more extreme. Furthermore, stocks with greater abnormal trading volumes experience greater (lower) reversals (continuations). These findings also support the explanation of price reversals based on temporary liquidity pressure, as suggested by Grossman and Miller (1988) and Jegadeesh and Titman (1995). Our results suggest that volume increases could indicate price pressure that leads to subsequent price reversals (Campbell, Grossman, & Wang, 1993; Conrad, Hameed, & Niden, 1994; Pritamani & Singal, 2001). Finally, our findings are consistent across different price reversal and continuation horizons, including one, three, and ten days following large one-day price shocks.

Finally, we examine the effect of market microstructure changes on the magnitude of price reversals and continuations subsequent to major price shocks. Decimalization implemented in 2001 has led to decreased bid-ask spreads (Bessembinder, 2003).[4] Chordia, Sarkar, and Subrahmanyam (2005) document that market efficiency, quality, and liquidity have improved since decimalization (Blau & Griffith, 2016; Chakravarty, Harris, & Wood, 2001; Chakravarty, Wood, & Van Ness, 2004; Chordia, Roll, & Subrahmanyam, 2008).[5] Following Fang, Tian, and Tice (2014), we use decimalization as a measure of exogenous shock in market liquidity. Our findings suggest that decimalization leads to improved market efficiency in terms of decreased magnitudes of reversals and continuations.

Our study contributes to the literature in two respects. First, we extend prior literature with a concurrent examination of both price reversals and continuations following large negative and positive price shocks. Our study provides additional insights for the liquidity, overreaction, and underreaction explanations for price reversals and continuations following large one-day price changes. We confirm that investors underreact to public information and overreact both to private information which produces the initial price change (Daniel et al., 1998) and to pure, non-information-based, price movements (Hong & Stein, 1999). We find that reversals are less likely given public information and that the magnitudes of the reversals are greater for less liquid stocks and for stocks with larger initial price changes and abnormal trading volumes. In contrast, price continuations are more likely to occur in the presence of public information, suggesting that investors underreact to firm-specific public information. Second, we add to the literature that studies the effects of decimalization on market liquidity (Bessembinder, 2003; Chakravarty et al., 2004; Chakravarty, Van Ness, & Van Ness, 2005; Furfine, 2003). We find a significant decrease in returns associated with price reversals and continuations post decimalization, i.e., greater liquidity post-decimalization corresponds to reduced returns for the liquidity provision following large price shocks. This result is consistent with the observation that the number as well as the magnitude of extreme, one-day price changes declined significantly in the post-decimalization period relative to the pre-decimalization period, as improved market efficiency and trading costs reduced earning potential from the liquidity provision (Bessembinder, 2003).

2. Data

We use daily returns on stocks from January 1986 through December 2015 to identify firms with large one-day negative ($\leq -10\%$) and positive ($\geq 10\%$) market-adjusted returns in excess of the S&P 500 return.[6] Stock returns, share prices, and trading volumes are obtained from the Center for Research in Security Prices (CRSP) for all stocks traded on the New York Stock Exchange (NYSE), the American Stock Exchange (AMEX), and NASDAQ. Firms in the sample are screened according to two criteria. First, we include only common stocks with a price of at least $10 per share prior to the large one-day change, in order to reduce the incidence of price reversals caused by bid-ask price bound. Second, we eliminate observations where the closing prices reported on the day of the large return are based on the average of the closing bid and ask quotes rather than actual transaction prices.[7] We obtain the quarterly institutional holdings data from the Thomson Reuters Institutional (13F) Holdings Database for all common stocks in our sample. The institutional ownership for each stock is defined as the number of shares held by institutional investors divided by the stock's total number of shares outstanding.

We examine daily stock returns and trading volumes separately from 1986 through 2000, when fractional stock prices were used in U. S. stock markets, and from 2001 through 2015, when U.S. markets began reporting stock prices in decimals. Before decimalization, stock prices were reported in either eighths or sixteenths and the minimum price change, i.e., tick size for most stocks, was one-eighth of a dollar ($0.125) or one sixteenth of a dollar ($0.0625). Stock prices since decimalization have been reported in decimals and the minimum price change has been a penny. The NYSE and AMEX replaced the system of fractional pricing in January 2001, and NASDAQ changed it in April 2001. In our data, an observation falls into the post-decimalization period if it occurs after January 29, 2001 for NYSE or AMEX stocks and after April 9, 2001 for NASDAQ stocks. To eliminate time-series dependence, we use a maximum of one randomly selected observation per firm in each time period, i.e., one in the pre-decimalization period and

[4] In addition to bid-ask spreads, Chakravarty et al. (2004) also find that number of trades and trading volumes decreased due to decimalization. For additional literature on decimalization see Harris (1994); Chakravarty, Van Ness, and Van Ness (2005); Furfine (2003).

[5] Trading volumes have also increased, in part as a result of decreased trading costs (Bessembinder, 2003; Chakravarty, Panchapagesan, & Wood, 2005). For example, on the New York Stock Exchange, the value-weighted average monthly share turnover has increased from about 5% in 1993 to approximately 26% in 2008 (Chordia et al., 2011).

[6] A detailed procedure for defining market-adjusted returns is presented in the next section.

[7] CRSP occasionally reports stock returns based on the average of the closing bid and ask quotes rather than actual transaction prices (Bremer & Sweeney, 1991; Cox & Peterson, 1994).

Table 1
Summary statistics for firms with large negative and positive returns on Day 0.

	Firms with a large negative returns on Day 0 ($r \leq -10\%$)		Firms with a large positive returns on Day 0 ($r \geq 10\%$)	
	Number	Percent	Number	Percent
Panel A. Before decimalization (1986–2000)				
Return reversal on Day +1	4110	55%	5127	58%
Return continuation on Day +1	3361	45%	3712	42%
Total observations	7471	100%	8839	100%
Panel B. After decimalization (2001–2015)				
Return reversal on Day +1	2406	54%	2874	56%
Return continuation on Day +1	2049	46%	2259	44%
Total observations	4455	100%	5133	100%

This table reports the summary statistics for firms with one-day market-adjusted stock returns ≤ −10% or ≥ +10% from January 1986 through December 2015. The market-adjusted return is the daily return on the stock minus the daily return on the S&P 500 index. The period before (after) decimalization precedes (follows) 01/29/2001 for NYSE stocks, 01/29/2001 for AMEX stocks, and 04/09/2001 for NASDAQ stocks. The samples before and after decimalization each contain a maximum of one observation per stock. When a stock has more than one large negative (positive) adjusted return in a period, we randomly select one observation per firm in each time period. Firms are classified as exhibiting a return reversal (return continuation) if the adjusted return on Day +1 is the opposite (same) sign as the adjusted return on Day 0. Panels A and B report the number and percentage of firms in the sample before and after decimalization, respectively.

one in the post-decimalization period. A similar procedure is used in Bremer and Sweeney (1991).

The final sample in Table 1 consists of 7471 (4455) large one-day negative returns and 8839 (5133) large one-day positive returns before (after) decimalization. There are more cases of large negative and positive returns during the fifteen years before decimalization than during the fifteen years after decimalization, even though trading volume increases substantially and trading costs decline (Chordia, Roll, & Subrahmanyam, 2011) following decimalization. Although the majority of the sell-side and buy-side order imbalances are immediately followed by price reversals, there is a large number of observations with price continuations following a one-day price shock. Thus, we further divide the observations into two groups. One consists of observations where large price changes on Day 0 are followed by subsequent price reversals on Day +1. The other consists of observations where large price changes on Day 0 are followed by price continuations on Day +1. Table 1 shows that > 50% of the large one-day returns are followed by price reversals, both before and after decimalization.

Table 2 presents the characteristics of all firms with large positive and negative returns on Day 0 by size category. Since firm size has been shown to be a good proxy for liquidity and the depth of the market for a firm's shares (Atkins & Dyl, 1990; Cox & Peterson, 1994), we divide the sample according to firm size based on NYSE size deciles. Specifically, we categorize firms as either small or large according to market capitalization eleven days before Day 0. Firms in the three smallest NYSE size deciles are categorized as small firms, and firms in the seven largest NYSE size deciles are categorized as large firms. Panel A (Panel B) shows summary statistics for extreme, negative (positive) one-day market-adjusted returns. The table includes mean and median values for market-adjusted returns and trading volumes on the day of the large price decline (Day 0), non-event daily trading volume (from Day −60 to −10 and +11 to +60), and market capitalization and institutional ownership (eleven days before the day of the price decline), both before and after decimalization. The data shows that reversals are slightly more likely than continuations after both negative (Panel A) and positive (Panel B) stock returns. Furthermore, absolute values of adjusted returns do not show significant differences across panels. However, firms experiencing large price drops (Panel A) have higher average market value and trading volume on Day 0 than those experiencing large price increases (Panel B), both before and after decimalization. Institutional ownership is also higher in the sample with large negative stock returns (Panel A) than in the sample with large positive price changes (Panel B).

In the post-decimalization period, the number of significant, large price changes decreases while the total trading volume and market capitalization significantly increase. The mean trading volumes on Day 0 are significantly higher in the post-decimalization period than in the pre-decimalization period and are greater for large firms than for small ones. Mean institutional ownership for large and small firms also increases significantly in the post-decimalization period, consistent with Lewellen (2011). Furthermore, the data in Table 2 reveal that firms that undergo large price shocks experience a greater volume of trading after decimalization, possibly due to reduced transaction costs (Bessembinder, 2003).

3. Methodology

3.1. Market-adjusted returns

We define unexpected returns as the observed return, adjusted to take into account market-wide price changes. The market-adjusted return for stock i on Day t is computed as follows:

$$AR_{it} = r_{it} - r_{mt}, \tag{1}$$

where AR_{it} is the market-adjusted percentage return, r_{it} is the raw return on event Day t, and r_{mt} is the return on the CRSP equally weighted (S&P 500) index return on Day t. The average market-adjusted return ($\overline{AR}_t$) for a portfolio of n stocks on Day t is defined as the equally weighted mean of the daily AR_{it}'s:

$$\overline{AR}_t = \frac{1}{n}\sum_{i=1}^{n} AR_{it}. \tag{2}$$

The cumulative market-adjusted return for stock i from event Day −10 to Day −1 (CAR_{it}) is computed according to Eq. (3):

$$CAR_{it} = \prod_{t=-10}^{T} (1 + AR_{it}) - 1. \tag{3}$$

We use geometrically computed cumulative returns because arithmetically computed cumulative returns can cause a spurious drift in cumulative returns due to the accumulation of bid-ask bias in daily returns (Blume & Stambaugh, 1983). Finally, average cumulative market-adjusted abnormal returns for the portfolio of stocks ($\overline{CAR}_t$) are obtained similarly using the abnormal returns from Eq. (2).

3.2. Mean-adjusted trading volume

We measure unexpected event-day trading volume as mean-adjusted trading volume, adjusted to take into account a firm's historical trading volume. We use daily trading volume for 121 days around the day of the large negative or positive market-adjusted stock return. This time period is divided into two parts: the event window, which includes 21 days from Day −10 through Day +10, and the non-event period, which includes 100 days from Day −60 to −11 and from Day +11 to +60. The actual daily trading volume observed for firm i on day t is denoted by v_{it}. The average daily trading volume (v_{iu}) for firm i is estimated as the average of the firm's daily trading volumes during the non-event periods from Day −60 to −11 and from Day +11 to +60. The mean-adjusted trading volume for firm i on day t during the event period is calculated as follows:

Table 2
Characteristics of firms with large negative or positive one-day stock returns.

	Panel A. Firms with a large negative stock return on Day 0						Panel B. Firms with a large positive stock return on Day 0					
	All Firms		Small firms		Large firms		All firms		Small firms		Large firms	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
1. Before decimalization (1986–2000)												
Day 0 Adjusted Return	−13.89%	−12.03%	−13.61%	−11.98%	−14.18%	−12.10%	16.04%	12.44%	17.11%	12.66%	14.23%	12.11%
Day 0 Volume Shares	737	204	259	50	1246	368	579	155	258	69	1133	377
Non-event Volume [(−60, −11) & (+11, +60)]	224	64	51	20	409	129	151	40	43	17	337	133
Market Value ($ millions)	898	177	81	65	1771	358	604	106	79	58	1512	455
Institutional Ownership	0.29	0.24	0.20	0.16	0.39	0.33	0.25	0.20	0.2	0.17	0.34	0.30
Number of observations	7471		3860		3611		8839		5600		3239	
Reversals on Day +1 (%)	55.01%		58.17%		51.64%		56.89%		57.17%		56.38%	
2. After decimalization (2001–2015)												
Day 0 Adjusted Return	−13.53%	−12.02%	−12.70%	−11.92%	−14.06%	−12.10%	15.91%	12.60%	17.42%	12.95%	14.63%	12.38%
Day 0 Volume Shares	3982	672	398	76	6269	1609	3102	487	655	99	5191	1236
Non-event Volume [(−60, −11) & (+11, +60)]	920	220	133	51	1422	399	903	170	97	41	1591	389
Market Value ($ millions)	2604	503	177	132	4154	982	2103	401	129	101	3788	902
Institutional Ownership	0.51	0.57	0.31	0.29	0.64	0.69	0.41	0.41	0.29	0.25	0.51	0.64
Number of observations	4455		1735		2720		5133		2364		2769	
Reversals on Day +1 (%)	54.01%		54.62%		53.61%		57.90%		60.85%		55.43%	

This table reports mean and median market characteristics for a sample of firms with one-day market adjusted stock returns ≤ −10% or ≥ +10% from January 1986 through December 2015. Market-adjusted return is the daily return on the stock minus the daily return on the S&P 500 index. The period before (after) decimalization precedes (follows) 01/29/2001 for NYSE stocks, 01/29/2001 for AMEX stocks, and 04/09/2001 for NASDAQ stocks. The samples before and after decimalization each contain a maximum of one observation for each stock. If a stock has more than one large negative (positive) one-day adjusted return in a period, we randomly select one observation per firm in each time period. *Day 0 Adjusted Return* is the raw return minus the return on the S&P 500 on Day 0. *Day 0 Volume Shares* is the number of shares of the stock on Day 0. *Non-event Volume* is the average daily trading volume from 11 to 60 days before and after Day 0. *Market Value* is the market capitalization of a stock 11 days before Day 0. *Institutional Ownership* is the institutional ownership and defined as the number of shares held by institutional investors in the preceding quarter divided by the stock's total number of shares outstanding. Small firms are those in the three lowest NYSE market capitalization deciles. Large firms are those in the seven largest NYSE market capitalization deciles. Reversals on Day +1 denote the percentage of the observations with a price reversal following Day 0.

$$AV_{it} = \left(\frac{v_{it}}{v_{iu}} - 1\right)(100), \tag{4}$$

where AV_{it} is the percentage by which the day's trading volume, v_{it}, is above (or below) the normal daily trading volume, v_{iu}. In addition to adjusting for a firm's normal daily trading, this procedure also mitigates biases caused by any discrepancy in how trading volume is reported in auction markets versus dealers' markets.[8] The average mean-adjusted trading volume ($\overline{AV_t}$) for a portfolio of n stocks on each day t is computed as the equally weighted mean of the daily AV_{it}'s:

$$\overline{AV_t} = \frac{1}{n}\sum_{i=1}^{n} AV_{it} \tag{5}$$

The cumulative mean-adjusted trading volume for stock i from event Day −10 to Day −1 (CAV_{it}) is the sum of the daily average mean-adjusted trading volumes in Eq. (6):

$$CAV_{it} = \sum_{t=-10}^{T} AV_{it}. \tag{6}$$

The average cumulative mean-adjusted trading volume for the portfolio of stocks ($\overline{CAV_t}$) is obtained similarly, using the abnormal volume from Eq. (5).

[8] The overstatement of NASDAQ trading volume vis-à-vis NYSE trading volume is documented in Atkins and Dyl (1997) and Anderson and Dyl (2005). The NYSE is primarily an auction market, and most transactions are between members of the public as buyers and sellers. NASDAQ is a dealer market, with a dealer on one or the other side of every transaction and on both sides of interdealer transactions. These intermediate transactions by dealers can result in double counting of transactions that are in fact single trades between public investors.

4. Results

In this section, we present our main results. The discussion is structured around large price declines and increases. In the next section, we discuss characteristics of reversals and continuations for positive and negative price shock samples. Next, we discuss results from logistic regressions, where we model probabilities of reversals and continuations following large one-day price changes. Lastly, we present results from the regressions, examining magnitudes of reversals and continuations.

4.1. Large one-day positive and negative price shocks

Table 3 shows returns and trading volumes when there is a sell-side order imbalance. Liquidity in this case can be provided by market makers who are willing to take a position in a stock at the current price. We divide the sell order observations into two groups: those that are followed by a price reversal on Day +1 (Panel A) and those that are followed by a price continuation on Day +1 (Panel B).

Panel A in Table 3 shows daily returns and trading volumes for 6516 firms with extreme negative returns on Day 0, followed by a price reversal on Day +1.[9] The mean daily return on Day 0 for all firms is −13.58%, which is followed by a mean reversal of 5.02% on Day +1. This represents the average compensation for liquidity provision by the market makers who purchased the stocks in decline on Day 0 (column 1). The extreme negative return for these firms on Day 0 is preceded by a price run-up of 8.10% from Day −10 through Day −1. Therefore, price adjustment on Day 0 can be in response to a stock price bubble from Days −10 to −1. This effect is especially pronounced for small

[9] Henceforth, "return" refers to market-adjusted return and "trading volume" refers to mean-adjusted trading volume.

Table 3
Firms with extreme negative one-day returns.

Variable	(1) All firms	(2) Small firms	(3) Large firms	Variable	(1) All firms	(2) Small firms	(3) Large firms
A. Price reversals on Day +1							
A.1. Market-adjusted daily returns				*A.2. Mean-adjusted daily trading volume*			
Observations	6516	3193	3323	Observations	6516	3193	3323
$\overline{CAR}[-10;-1]$	8.10**	15.43**	1.06**	$\overline{CAV}[-10;-1]$	264**	483**	54**
$\overline{AR}[-2]$	0.95**	1.78**	0.15	$\overline{AV}[-2]$	45**	86**	6**
$\overline{AR}[-1]$	1.05**	2.01**	0.13	$\overline{AV}[-1]$	83**	156**	13**
$\overline{AR}[0]$	−13.58**	−13.23**	−13.92**	$\overline{AV}[0]$	407**	410**	404**
$\overline{AR}[+1]$	5.02**	5.55**	4.51**	$\overline{AV}[+1]$	242**	140**	340**
$\overline{AR}[+2]$	0.14*	0.05	0.23*	$\overline{AV}[+2]$	55**	71**	40**
$\overline{CAR}[+1;+10]$	6.60**	6.95**	6.30**	$\overline{CAV}[+1;+10]$	505**	524**	488**
B. Price continuations on Day +1							
B.1. Market-adjusted daily returns				*B.2. Mean-adjusted daily trading volume*			
Observations	5410	2402	3008	Observations	5410	2402	3008
$\overline{CAR}[-10;-1]$	12.75**	24.59**	3.31**	$\overline{CAV}[-10;-1]$	305**	547**	113**
$\overline{AR}[-2]$	1.67**	2.87**	0.73**	$\overline{AV}[-2]$	68**	115**	31**
$\overline{AR}[-1]$	2.14**	4.84**	0.02	$\overline{AV}[-1]$	145**	309**	16**
$\overline{AR}[0]$	−13.98**	−13.46**	−14.39**	$\overline{AV}[0]$	404**	538**	299**
$\overline{AR}[+1]$	−4.78**	−4.90**	−4.69**	$\overline{AV}[+1]$	196**	224**	174**
$\overline{AR}[+2]$	0.34*	0.36*	0.32*	$\overline{AV}[+2]$	125**	133**	119**
$\overline{CAR}[+1;+10]$	−4.91**	−4.87**	−4.94**	$\overline{CAV}[+1;+10]$	869**	871**	916**

This table reports the average adjusted return ($\overline{AR}[t]$), the average cumulative adjusted return ($\overline{CAR}[t]$), the average adjusted volume ($\overline{AV}[t]$), and the average cumulative adjusted volume ($\overline{CAV}[t]$) for a sample of firms with one-day market adjusted stock returns ≤ −10%. Variables are defined in Section 3. Panel A shows results for firms with a price reversal on Day +1 and Panel B shows results for firms with a price continuation on Day +1. *Market Value* is the market capitalization of a stock 11 days before Day 0. Small firms are those in the three lowest NYSE market capitalization deciles. Large firms are those in the seven largest NYSE market capitalization deciles. The sample period is from January 1986 to December 2015.

** Indicates significance at the 1% level (two-tailed test).

* Indicates significance at the 5% level (two-tailed test).

firms. These price movements are accompanied by high trading volumes relative to the normal trading volumes observed before and after the event period (Days −60 to −11 and + 11 to +60) (column 4 of Panel A). The cross-sectional mean daily trading volume on Day 0, $\overline{AV}[0]$, is 407% of the normal volume. The cross-sectional mean of average daily cumulative trading volume between Days −10 and −1, $\overline{CAV}[-10;-1]$, is 264% of normal. The corresponding cumulative trading volume from Day +1 to +10 is 505% of normal. As with the observed daily return patterns in Panel A, small firms experience significantly greater abnormal trading volumes than large firms. This is consistent with the discussion of trading volumes by Beaver (1968) and by Karpoff (1986).

Panel B shows returns and trading volumes for 5410 firms with extreme negative returns on Day 0 and a continuation of the price decline on Day +1. Price appreciation of 12.75% from Day −10 through Day −1 precedes the extreme negative return on Day 0. The returns on Days 0 and +1 are similar for the small and large firms. The major difference between the returns of small and large firms is that small firms experience a significantly greater price run-up ($\overline{CAR}[-10;-1] = 24.59\%$) than the large firms (3.31%). For the small firms, the price decline on Day +1 appears to be a continuation of the reversal following price run-up prior to Day 0. As with Panel A, we observe that the cross-sectional daily mean $\overline{CAV}[-10;-1]$ is significantly greater for small firms (547%) than for large firms (113%).

Table 4 shows returns and trading volumes for buy-side order imbalance observations. Liquidity during periods of increasing demand can be provided either by current stock owners or by designated market makers who are willing to take a short position in the stock at the current price. As in the previous section, we partition the buy-side observations into two groups: those that are followed by price reversals on Day +1 and those that are followed by price continuations on Day +1. Panel A (B) in Table 4 shows daily return and trading volume data for 8001 (5971) firms with large positive extreme returns on Day 0, followed by a price reversal (continuation) on Day +1. The primary difference between the returns of the small and large firms is that $\overline{CAR}[-10,-1]$ is significantly greater for small firms than for large firms. The pattern of returns for small firm stocks shows steady appreciation, whereas the stocks of the large firms decline prior to Day 0. We observe that the abnormal prior returns in the negative one-day price shock sample in Table 3 are significantly greater than the corresponding returns from the positive price shock sample in Table 4. Similarly, abnormal prior trading volumes are greater in the negative price shock sample (Table 3) than in the positive price shock sample (Table 4).

In sum, Tables 3 and 4 show that price continuations and reversals following large price shocks are concentrated in Day +1. Thus, similar to earlier studies (Atkins & Dyl, 1990; Berggrun, Cardona, & Lizarzaburu, 2018; Bremer & Sweeney, 1991; Cox & Peterson, 1994), our analysis focuses on reversals and continuations on the day following large one-day price shocks.[10]

4.2. Multivariate regression analyses

After observing abnormal trading volumes and abnormal returns prior to and following significant changes in returns, we examine what drives the likelihood of price reversals and price continuations and explore how the characteristics of firms affect the magnitudes of price reversals and continuations.

4.2.1. Propensity for price reversals and continuations following extreme price shocks

We first examine the relation between the likelihood of price reversals and continuations, on the one hand, and stock characteristics and firm-specific information, on the other. This analysis further allows us to distinguish the roles of the liquidity, overreaction, and

[10] In Section 4.2.3 we further extend our analysis and examine the magnitudes of price reversals and continuations over longer horizons.

Table 4
Firms with extreme positive one-day returns.

Variable	(1)	(2)	(3)	Variable	(4)	(5)	(6)
	All firms	Small firms	Large firms		All firms	Small firms	Large firms
A. Price reversals on Day +1							
A.1. Market-adjusted daily returns				*A.2. Mean-adjusted daily trading volume*			
Observations	8001	4640	3361	Observations	8001	4640	3361
$\overline{\text{CAR}}[-10;-1]$	2.79**	6.14**	−1.83**	$\overline{\text{CAV}}[-10;-1]$	256**	299**	197**
$\overline{\text{AR}}[-2]$	0.32*	0.85**	−0.41**	$\overline{\text{AV}}[-2]$	36**	47**	21**
$\overline{\text{AR}}[-1]$	0.42*	1.32**	−0.82**	$\overline{\text{AV}}[-1]$	97**	120**	65**
$\overline{\text{AR}}[0]$	15.90*,**	17.10**	14.24**	$\overline{\text{AV}}[0]$	445**	505**	362**
$\overline{\text{AR}}[+1]$	−4.13**	−4.56**	−3.53**	$\overline{\text{AV}}[+1]$	203**	234**	160**
$\overline{\text{AR}}[+2]$	−0.50*	−0.44*	−0.58*	$\overline{\text{AV}}[+2]$	70**	88**	45**
$\overline{\text{CAR}}[+1;+10]$	−4.87**	−5.18**	−4.44**	$\overline{\text{CAV}}[+1;+10]$	450**	680**	132**
B. Price continuation on Day +1							
B.1. Market-adjusted daily returns				*B.2. Mean-adjusted daily trading volume*			
Observations	5971	3324	2647	Observations	5971	3324	2647
$\overline{\text{CAR}}[-10;-1]$	0.88**	5.62**	−5.08**	$\overline{\text{CAV}}[-10;-1]$	246**	387**	68**
$\overline{\text{AR}}[-2]$	0.11	0.96**	−0.95**	$\overline{\text{AV}}[-2]$	56**	76**	31**
$\overline{\text{AR}}[-1]$	0.27**	0.94**	−0.57**	$\overline{\text{AV}}[-1]$	66**	75**	55**
$\overline{\text{AR}}[0]$	16.08**	17.35**	14.46**	$\overline{\text{AV}}[0]$	299**	455**	100**
$\overline{\text{AR}}[+1]$	4.62**	5.21**	3.90**	$\overline{\text{AV}}[+1]$	131**	189**	57**
$\overline{\text{AR}}[+2]$	−0.43**	−0.52**	−0.32**	$\overline{\text{AV}}[+2]$	138**	171**	96**
$\overline{\text{CAR}}[+1;+10]$	5.51**	5.46**	5.56**	$\overline{\text{CAV}}[+1;+10]$	709**	995**	347**

The table reports the average adjusted return ($\overline{\text{AR}}$[t]), the average cumulative adjusted return ($\overline{\text{CAR}}$[t]), the average adjusted volume ($\overline{\text{AV}}$[t]), and the average cumulative adjusted volume ($\overline{\text{CAV}}$[t]) for a sample of firms with one-day market adjusted stock returns ≥10%. Variables are defined in Section 3. Panel A shows results for firms with a price reversal on Day +1 and Panel B shows results for firms with a price continuation on Day +1. The market value is the market capitalization of a stock 11 days before Day 0. Small firms are those in the three lowest NYSE market capitalization deciles. Large firms are those in the seven largest NYSE market capitalization deciles. The sample period is from January 1986 to December 2015.

** Indicates significance at the 1% level (two-tailed test).

* Indicates significance at the 5% level (two-tailed test).

underreaction explanations for price reversals and continuations following extreme negative and positive returns. Specifically, we separately use logistic regression models for significant large negative and positive price changes on Day 0. Results are presented in Panels A and B of Table 5, respectively. In both cases, the dependent variable is the binary price reversal. In Panel A, the dependent variable is one if a reversal in stock price is observed following a significant decrease in market-adjusted stock return and zero otherwise. Similarly, in Panel B, the dependent variable equals one if there is a decrease in price on Day +1 following a large one-day increase on Day 0 and zero otherwise. We use the following logistic regression model:

$$\ln\left[\frac{P(Reversal_{i,t+1}=1\mid X)}{1-P(Reversal_{i,t+1}=1\mid X)}\right] = \alpha_1 + \alpha_2 Size_{it} + \alpha_3 OWN_{it} + \alpha_4 EarningsAnn_{it} + \alpha_5 MacroNews_{it} + \alpha_6 BM_{it} + \alpha_7 AR[0]_{it} + \alpha_8 CAR[-11;-1]_{it} + \alpha_9 AV[0]_{it} + \alpha_{10} CAV[-11;-1]_{it}. \quad (7)$$

Following prior literature (Banz, 1981; Reinganum, 1983), we use the natural logarithm of a stock's market capitalization on Day −11 (*Size*) to control for the effect of firm size on stock returns. Similar to Gompers and Metrick (2001), Avramov, Chordia, and Goyal (2006), and Huang, Wu, and Lin (2016), we use the percentage of institutional ownership in the preceding quarter (*OWN*) to capture the effects of institutional trading and stock liquidity. Previous literature documents that earnings announcements are an important source of new information in the equity markets (Brown, 1979; Chen, Wuh Lin, & Sauer, 1997). We model the effect of information on price reversals and continuations using both firm earnings and macroeconomic announcements. *EarningsAnn* is an indicator variable which equals one if earnings announcements are made on Day 0 or during the ten days prior. Earnings announcements are obtained from COMPUSTAT between Day 0 and Day −10. Macroeconomic news announcements (*MacroNews*) is an indicator variable which equals one if macroeconomic news is announced on the event day or during the ten days prior. Macroeconomic news announcements are obtained from Bloomberg Terminal and listed in Appendix A. In addition, we follow Daniel, Grinblatt, Titman, and Wermers (1997) by including book-to-market, *BM*, defined as the natural logarithm of book-to-market ratio at the end of a quarter. Previous studies document that the magnitude of past returns can predict future returns (Jegadeesh, 1990; Lee & Swaminathan, 2000; Lehmann, 1990; Lo & MacKinlay, 1990). Therefore, to control for past return predictability, we include *AR[0]*, the market-adjusted stock return on Day 0, and *CAR[−11;−1]*, the cumulative market-adjusted return over the ten days prior to the large price change. Finally, previous studies argue that high trading volume is associated with price reversals (Campbell et al., 1993; Cox & Peterson, 1994). To examine the role of trading volume on price reversals and continuations, we include two variables: *AV[0]* is the mean-adjusted trading volume during the event day and *CAV[−11;−1]* is the cumulative mean-adjusted trading volume over the ten days prior to the event day. Table 5 presents the results of this logistic regression for negative price shocks in Panel A and positive price shocks in Panel B.

We observe significant differences in the prior stock returns, trading volumes, and firm specific information across stocks that exhibit price reversals versus continuations. Daniel et al. (1998) argue that stock prices are likely to overreact to private information signals. In addition, Hong and Stein (1999) state that investors underreact to news and overreact to pure (non-information-based) price movements. Results in Table 5 support these arguments and show that stocks with greater initial price shocks, *AR[0]*, are more likely to experience price reversals in both panels. These results are consistent with Savor (2012), who finds that event-day price shock positively affects price reversals. Our analyses also indicate that the developing trends in returns over the ten days prior to Day 0 are important determinants of price reversals. Across all columns, we find significantly negative (positive) coefficients

Table 5
Price reversals vs. price continuations following either extreme negative or extreme positive returns.

	Panel A. Reversal|large one-day price drop						Panel B. Reversal|large one-day price increase					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log of Size		−0.099**				−0.091**		−0.024*				−0.023*
		[49.02]				[40.26]		[4.92]				[3.11]
Ownership			−0.575**						−0.181*			
			[53.81]						[8.36]			
EarningsAnn.				−0.314**		−0.276**				−0.230**		−0.173**
				[37.32]		[28.42]				[24.56]		[15.78]
MacroNews					0.142**	0.242**					−0.153**	−0.158*
					[10.68]	[28.68]					[13.38]	[8.46]
BM		−0.022	0.007	0.021	0.028	−0.021		0.129**	0.125**	0.122**	0.120**	0.132**
		[0.71]	[0.08]	[0.70]	[1.28]	[0.64]		[27.36]	[26.26]	[25.72]	[24.98]	[28.52]
AR[0]	−0.006*	−0.006*	−0.005*	−0.006*	−0.007*	−0.004*	0.003*	0.003*	0.005*	0.003*	0.003*	0.005*
	[3.62]	[3.52]	[4.58]	[3.57]	[3.73]	[3.18]	[4.02]	[3.64]	[6.31]	[3.98]	[3.84]	[4.88]
CAR[−11;−1]	−0.662**	−0.806**	−0.844**	−0.701**	−0.689**	−0.816**	0.428**	0.431**	0.327*	0.384**	0.387**	0.439**
	[72.86]	[69.50]	[70.58]	[57.4]	[56.06]	[70.98]	[19.8]	[12.22]	[6.78]	[10.46]	[10.68]	[12.64]
AV[0]	0.001	0.001	0.002	0.001	0.003	0.001	0.003	0.003	0.002	0.003	0.003	0.003
	[0.04]	[0.23]	[0.02]	[0.06]	[0.68]	[0.05]	[1.52]	[1.16]	[0.92]	[1.26]	[1.08]	[1.14]
CAV[−11;−1]	0.007**	0.007**	0.007**	0.007**	0.008**	0.007**	0.003*	0.004*	0.003*	0.003*	0.003*	0.003*
	[23.08]	[16.62]	[16.28]	[17.18]	[20.62]	[14.56]	[3.96]	[4.26]	[3.28]	[3.44]	[3.88]	[3.63]
Intercept	0.222**	0.768**	0.459**	0.292**	0.165*	0.762**	0.163**	0.168*	0.287**	0.292**	0.333**	0.170*
	[14.28]	[55.44]	[34.96]	[16.64]	[4.76]	[54.47]	[27.18]	[4.35]	[26.34]	[46.68]	[52.06]	[4.47]
N	11,926	10,101	9899	9899	9899	9899	13,972	12,021	11,955	11,955	11,955	11,955
χ^2	205.45	152.87	132.24	148.90	139.21*	146.77	38.89	19.29	19.94	20.12	18.37	20.07

This table presents the results of the logistic regression. In Panel A the dependent variable, reversal, takes the value of one if the reversal in stock prices is observed on Day +1 following a significant decrease in market-adjusted stock returns (≤ −10%) on Day 0, and takes the value of zero otherwise. In Panel B, reversal equals one if there is a decrease in price on Day +1 following a large one-day increase in market-adjusted stock returns (> +10%) on Day 0, and is zero otherwise. *Log of Size* is the natural logarithm of a stock's market capitalization on Day [−11]. *Institutional Ownership* is the institutional ownership, and defined as the number of shares held by institutional investors in the preceding quarter divided by the stock's total number of shares outstanding. *Earnings Announcements (EarningsAnn.)* is an indicator variable which equals one if earnings announcements are made on or during ten days prior to Day 0. *MacroNews* is an indicator variable which equals one if macroeconomic news is announced on or during the ten days prior to the event day. Macroeconomic news announcements are obtained from Bloomberg Terminal and listed in Appendix A. *Book-to-Market (BM)* is the natural logarithm of book-to-market ratio at the end of last quarter. *AR[0]* is the abnormal market-adjusted stock return on Day 0. *CAR[−11;−1]* is the cumulative market-adjusted return over the ten days prior to the event day. *AV[0]* is the mean-adjusted trading volume during the event day. *CAV[−11;−1]* is the cumulative mean-adjusted trading volume over the ten days prior to the event day. The table reports the coefficient estimates, Wald Chi-square statistics, and Chi-square values based on Hosmer and Lemeshow goodness-of-fit test. The sample period is from January 1986 to December 2015.

** Denotes statistical significance at the 1% level.

* Denotes statistical significance at the 5% level.

of *CAR[−11;−1]*, which indicates initial run-up, for stocks that experience large price declines (increases) in Panel A (Panel B).

Previous literature documents that informed liquidity traders influence trading volume (Campbell et al., 1993; Conrad et al., 1994; Gervais, Kaniel, & Mingelgrin, 2001; Karpoff, 1986). Our earlier analysis in Table 2 shows that stocks that experience large price shocks have significantly higher trading volumes during the event Day 0 than on nonevent days. On the other hand, Kudryavtsev (2017) finds that abnormal trading volume on Day 0 has no significant effect on returns following large price changes. Similarly, our results in Panels A and B of Table 5 indicate that there is no difference in abnormal trading volume on Day 0 between price reversals and continuations. Extending the approach of Kudryavtsev (2017), we also examine the effect of cumulative abnormal trading volumes. A significant and positive coefficient for *CAV[−11;−1]* suggests that greater trading volume prior to Day 0 increases the probability of reversal on Day +1. This result indicates that securities with greater lagged transaction volumes experience greater price reversals. Overall, our analysis provides additional evidence of the positive effect of trading volume on price pressure, which subsequently leads to price reversals (Campbell et al., 1993; Conrad et al., 1994; Pritamani & Singal, 2001).

We also find that firm size and institutional ownership, as proxies for stock liquidity, play important roles in determining the likelihood of reversals. The coefficients on *Size* in both panels are negative and statistically significant, indicating that smaller firms are more likely to experience reversals than larger firms. This is in agreement with Savor (2012), who finds that size has a negative effect on returns post major price shock. Cox and Peterson (1994) also find that reversals are more likely for smaller firms. Similarly, negative and statistically significant *Ownership* effects in columns (3) and (9) suggest that firms with lower institutional ownership are more likely to experience reversals than those with higher institutional ownership. This finding is consistent with Avramov et al. (2006) and Cheng et al. (2017), who document that institutional ownership is a significant factor in price reversals following large price changes. In sum, our results suggest that stock liquidity, in the form of firm size and institutional ownership, is a significant determinant of price reversals. These results are particularly pronounced for stocks that experience large one-day price declines in Panel A. Our analyses also indicate that price reversals are more likely to occur among value stocks and only for the sample of large, positive one-day price shocks.

Next, we investigate the effect of firm-specific information on price reversals and continuations. Previous studies demonstrate that price continuations occur following days when new relevant information can be identified, while price reversals occur following days when no new information can be identified (Boudoukh, Feldman, Kogan, & Richardson, 2013; Chan, 2003; Savor, 2012; Tetlock, 2011; Zhang, 2006). For example, Savor (2012) finds that price shocks accompanied by the release of new information are followed by momentum, whereas price shocks not accompanied by new information are followed by reversals. Boudoukh et al. (2013) find that stock price reversals are more likely to occur on days without any news. Pritamani and Singal (2001) also show that the release of public information positively (negatively) affects price continuations (reversals). We use earnings announcements to examine the effect of public information (Brown, 1979; Chen et al., 1997). Our results support the underreaction hypothesis and show that price continuations are affected by firm-specific news announcements (Pritamani & Singal, 2001; Stickel & Verrecchia, 1994). Specifically, we find that earnings announcements negatively affect the probability of reversals following large price movements, both positive and negative, as reported in columns (4) and (10). These results suggest that investors underreact to news related to fundamentals, which leads to price continuations. Likewise, the absence of relevant firm-specific public information leads to a greater probability of reversals, suggesting an overreaction effect. Further, macroeconomic indicator variables show contrasting effects across the two panels. When macroeconomic news announcements are made prior to the event day, price reversals are more likely to occur after negative price shocks (Panel A) and less likely to occur after positive price shocks (Panel B). Most importantly for our analysis, the *EarningsAnn* coefficient remains significant in columns (6) and (12) even after controlling for *MacroNews*, highlighting the distinct role of firm-specific information in the likelihood of price continuation.

To summarize, our results illustrate important differences in the characteristics of stocks that experience continuations and reversals following large one-day price changes. Consistent with the liquidity explanation, small stocks and stocks with lower institutional ownership are more likely to experience price reversals. That is, price reversals provide compensation to liquidity providers who are able to time price changes correctly. In addition, there is a significant relation between a large change in stock price and trading volume prior to event Day 0 and the likelihood of price reversals. This suggests that price reversals are more likely to be due to overreaction to shocks (Daniel et al., 1998; Hong & Stein, 1999). Finally, our analysis suggests that the market underreacts to news about firms' fundamentals (Savor, 2012). Together, these results suggest that the market overreacts to most shocks that move stock prices but underreacts to news about firms' fundamentals.

4.2.2. Magnitudes of price reversals and continuations

Next, we examine the magnitudes of price reversals and continuations subsequent to large price shocks. Specifically, for each reversal or continuation subsample of extreme positive and negative returns on Day 0, we estimate the following regression:

$$AR_{i,t+1} = \alpha_1 + \alpha_2 Size_{it} + \alpha_3 OWN_{it} + \alpha_4 DEC_{it} + \alpha_5 BM_{it} + \alpha_6 AR[0]_{it} + \alpha_7 CAR[-11;-1]_{it} + \alpha_8 AV[0]_{it} + \alpha_9 CAV[-11;-1]_{it} + \varepsilon_t, \quad (8)$$

where *DEC* is a binary indicator variable for decimalization which equals one for observations that come after 01/29/2001 for NYSE stocks and AMEX stocks and after 04/09/2001 for NASDAQ stocks. The descriptions of the remaining explanatory variables match the definitions in the previous section. The dependent variable is the market-adjusted return on Day +1. Table 6 reports results for price reversals and price continuations in Panels A and B, respectively. We further disaggregate the analysis in Panels A and B into stocks that experience large one-day price declines (Panel A1 or Panel B1) and stocks that experience large one-day price increases (Panel A2 or Panel B2).

Previous literature shows that smaller firms and firms with lower institutional ownership are less liquid (Chordia et al., 2011; Gompers & Metrick, 2001; Pástor & Stambaugh, 2003). In addition, larger firms with greater institutional ownership also attract more news coverage and more attention from analysts, suggesting an efficient diffusion of firm-specific news. Hypothesizing that greater liquidity and news coverage negatively affect reversals and continuations, we expect the magnitude of price reversals and price continuations to be greater in small firms and firms with lower institutional ownership. Consistent with our earlier analysis in Tables 3 and 4, we confirm in Panels A and B of Table 6 that smaller firms and firms with lower institutional ownership experience larger reversals and continuations following large one-day price shocks.[11] For example, significantly negative (positive) size and institutional ownership coefficients in Panel A.1 (B.1) indicate that the magnitudes of price reversals (continuations) following a large price decline on Day 0 are greater for less liquid firms. Panels A.2 and B.2 confirm these findings for stocks that experience large one-day price increases. These results are consistent with the results of prior literature. Kudryavtsev (2017) shows that low capitalization firms are more likely to overreact to stock price shocks when they are accompanied by corresponding jumps in stock market index returns. He shows that major positive (negative) price shocks are more amplified by concurrent positive (negative) changes in stock market index returns for smaller stocks than for larger ones. A similar firm-size-dependent effect is found in Kliger and Kudryavtsev (2010). Baker and Wurgler (2006) also find that the returns of small stocks are more susceptible to mispricing and investor sentiment waves then the returns of larger stocks.

Book-to-market ratio provides no clear effect on the magnitude of price reversals and continuations. The effect is generally not statistically significant in the large price decline sample. However, in the large price increase sample in Panels A.2 and B.2, there is some indication that the magnitude of price reversals is greater for value stocks. As documented by Daniel and Titman (1999) and Asness (1997), growth stocks are more difficult to value, which contributes to price continuation. Consistent with these studies, Panel B.2 shows that the magnitudes of price continuations are particularly high for growth stocks.

Daniel et al. (1998) argue that initial price changes reflect investors trading on private information. Therefore, a large price change is likely to reflect investor overreaction. Thus, we expect a positive association between initial price changes (and abnormal trading volume) and subsequent price reversals. The results in Table 6 provide evidence in support of this hypothesis. Specifically, in the large, positive price change sample, we find that both *AR[0]* and *CAR[−11;−1]* are positively related to the magnitude of the price reversals (Panel A). This result is consistent with Savor (2012). In contrast, in Panel B, *AR[0]* and *CAR[−11;−1]* have negative effects on the magnitudes of price continuations. That is, the magnitudes of price continuations are relatively smaller when initial price changes are greater. Overall, our results are in line with prior literature, which documents that reversals are greater when abnormal event-day returns are larger (Bremer & Sweeney, 1991; Brown & Harlow, 1988; Larson & Madura, 2003; Savor, 2012).

Table 6 further shows differences in the effect of trading volume on the magnitudes of price reversals and continuations. The positive and significant coefficients of *AV[0]* and *CAV[−11;−1]* in Panels A.1 and A.2 indicate that stocks with greater abnormal volumes experience larger price reversals. These results provide additional support for the notion that volume increases arising from liquidity trading cause price pressure that subsequently leads to price reversals (Campbell et al., 1993; Conrad et al., 1994; Pritamani & Singal, 2001). In sharp contrast, we observe the opposite relation between trading volumes and the magnitude of abnormal return on Day +1 in the case of price continuations (Panels B.1. and B.2.). Overall, the results support the notion that increased trading volume is likely to reflect a greater demand for stocks. This may originate from informed trading, liquidity-motivated trading, or both (Conrad et al., 1994; Gervais et al., 2001; Karpoff, 1986).

Finally, we investigate the liquidity effect in terms of changes in market microstructure over the last two decades. Specifically, the implementation of decimalization in 2001 decreased bid-ask spreads (Bessembinder, 2003) and improved market efficiency, quality, and liquidity (Blau & Griffith, 2016; Chakravarty et al., 2001; Chakravarty et al., 2004; Chordia et al., 2005; Chordia et al., 2008). Following Fang et al. (2014), we use decimalization in 2001 as a measure of exogenous shock in market liquidity and transaction costs. The results in columns

[11] Note that the difference in signs of the explanatory variables is due to differences in the direction of price reversals and price continuations.

Table 6
Determinants of reversals or continuations after negative one day change.

	Panel A. Price reversals: AR +1						Panel B. Price continuations AR +1					
	Panel A.1. Large price decline			Panel A.2. Large price increase			Panel B.1. Large price decline			Panel B.2. Large price increase		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log of Size	−0.266**		−0.225**	0.095*		0.107*	0.175**		0.088	−0.372**		−0.341**
	[5.84]		[4.74]	[1.99]		[2.06]	[3.99]		[1.88]	[6.54]		[5.58]
Ownership		−1.902**			0.948**			0.970**			−2.184**	
		[7.68]			[4.08]			[3.88]			[6.96]	
Decimalization			−0.391**			1.075**			0.875**			−0.252*
			[2.68]			[7.80]			[5.86]			[2.28]
BM	0.076	0.161*	0.101	−0.173*	−0.151	−0.212**	0.148	0.104	0.113	−0.509**	−0.413**	−0.499**
	[0.92]	[1.98]	[1.28]	[2.18]	[1.92]	[2.66]	[1.87]	[1.33]	[1.38]	[4.88]	[4.28]	[4.76]
AR[0]	−0.201**	−0.197**	−0.198**	−0.139**	−0.140**	−0.141**	−0.123**	−0.125**	−0.122**	−0.172**	−0.266**	−0.172**
	[13.31]	[13.10]	[13.12]	[25.01]	[23.88]	[25.51]	[7.81]	[7.84]	[7.78]	[25.34]	[26.18]	[25.36]
CAR[−11;−1]	0.731**	0.384**	0.782**	−3.837**	−3.814**	−3.902**	2.608**	2.323**	2.589**	−2.775**	−1.955**	−2.812**
	[2.68]	[2.38]	[2.86]	[10.82]	[10.44]	[11.06]	[12.21]	[10.38]	[12.16]	[5.28]	[3.78]	[5.34]
AV[0]	0.062**	0.058**	0.059**	−0.059**	−0.064**	−0.057**	0.044**	0.047**	0.041**	−0.103**	−0.069**	−0.103**
	[6.96]	[6.72]	[6.86]	[8.04]	[8.68]	[7.82]	[3.76]	[3.94]	[3.52]	[8.84]	[5.92]	[8.83]
CAV[−11;−1]	0.012**	0.012**	0.012**	−0.037**	−0.039**	−0.037**	−0.001	−0.004	−0.001	−0.029**	−0.035**	−0.028**
	[2.96]	[2.94]	[2.88]	[4.66]	[5.04]	[4.62]	[0.06]	[0.66]	[0.12]	[4.62]	[5.38]	[4.52]
Intercept	3.814**	3.226**	3.799**	−2.955**	−3.382**	−2.903**	−3.77**	−3.193**	−3.658**	3.717**	1.103**	3.688**
	[11.82]	[13.34]	[11.80]	[11.42]	[21.01]	[11.28]	[11.31]	[12.64]	[10.98]	[10.84]	[4.52]	[10.72]
N	6516	6004	6516	8001	7678	8001	5410	5010	5410	5971	5428	5971
R^2	5.00%	5.10%	5.10%	14.10%	13.80%	15.10%	8.80%	7.00%	9.60%	17.60%	18.20%	17.60%

This table reports the results of regressing the magnitudes of reversals (Panel A) or continuations (Panel B) on control variables for the cases where significant decreases in stock prices are observed on event Day 0. Panels A.1 and B.1 report results for stocks that experience negative price shocks. Panels A.2 and B.2 report results for stocks that experience positive price shocks. The dependent variable is abnormal market-adjusted returns on Day +1. The independent variables include *Log of Size*, *Ownership*, *Decimalization*, *Book-to-Market (BM)*, *AR[0]*, *CAR[−11;−1]*, *AV[0]*, and *CAV[−11;−1]*. *Decimalization* is an indicator variable which equals one if the period follows 01/29/2001 for NYSE stocks, 01/29/2001 for AMEX stocks, and 04/09/2001 for NASDAQ stocks. The description of remaining explanatory variables is defined in the Table 5. The table reports coefficient estimates, *t*–statistics, and adjusted R^2 of the pooled regressions. The sample period is from January 1986 to December 2015.

** Denotes statistical significance at the 1% level.

* Denotes statistical significance at the 5% level.

(3), (6), (9), and (12) of Table 6 show the negative effect of decimalization on the magnitudes of reversals and continuations. This result is consistent with the argument that the greater liquidity provision enabled by decimalization and the associated reduction in trading costs negatively affects the magnitudes of reversals and continuations on Day +1. Diminished magnitudes of reversals and continuations in the post-decimalization period suggest greater market efficiency than before decimalization (Bessembinder, 2003; Chakravarty et al., 2004; Chakravarty, Van Ness, & Van Ness, 2005; Furfine, 2003).

4.2.3. Extended price reversal and continuation horizons

Thus far, our main analysis is based on one-day price reactions following large one-day price shocks. We focus on price reversals and continuations from the day after a large price shock because a substantial portion of price reversals and continuations occur on Day +1 (Tables 3 and 4).[12] In this section, we extend our analysis and examine magnitudes of price reversals and continuations over different horizons. Specifically, we use cumulative abnormal returns over 3 (*CAR[+1, +3]*), 5 (*CAR[+1, +5]*), and 10 days (*CAR[+1, +10]*) as our dependent variables and estimate the regression using Eq. (8). Table 7 reports the results for price reversals and price continuations in Panels A and B, respectively. Following the structure in Table 6, we disaggregate the analysis in Panels A and B into large one-day price declines (Panel A1 or Panel B1) and large one-day price increases (Panel A2 or Panel B2).

Consistent with the liquidity hypothesis, we find that across all panels, the magnitudes of price reversals and continuations are larger for less liquid stocks (i.e., smaller firms and firms with greater institutional ownership).[13] In addition, reversals and continuations are smaller in the post-decimalization period. In columns (1)–(3) of Panel A1, we find that for stocks that experience negative price shocks, *AR[0]*, *CAR[−11;−1]*, *AV[0]*, and *CAV[−11;−1]* are positively related to the magnitudes of price reversals, consistently with the overreaction hypothesis. However, columns (1) through (3) show that market overreaction to private information, i.e., event-day price changes and abnormal trading volume, wane over the subsequent ten days, particularly after the fifth day following the event day. This finding aligns with Cox and Peterson (1994), who find that market liquidity partially explains price reversals over longer horizons following large price declines. On the other hand, for reversal stocks that experience positive price shocks on event Day 0 in Panel A2, the coefficients of *AR[0]*, *CAR[−11;−1]*, *AV[0]*, and *CAV[−11;−1]* remain significant throughout columns (4) through (6). For the sample of stocks that experience price continuations in Panel B we once again find that the magnitudes of price continuations decrease in response to an increase in initial price change and abnormal trading volume. Overall, the findings presented in Table 7 are consistent with our earlier results.

5. Conclusion

In this study, we extend prior literature and concurrently test the liquidity, under-, and overreaction hypotheses for both price reversals and continuations following large one-day market-adjusted returns,

[12] For example, for price reversals following a large one-day price decrease (increase) in Table 3 (Table 4), price reversal in Day +1 constitutes 76% (5.02%/6.60%) (85% (−4.13%/−4.87%)) of cumulative abnormal return earned during the following 10 days, Day [+1, +10]. Similarly, for price continuations following a large one-day price decrease (increase), over 84% of the cumulative abnormal return during the 10 days is earned on Day +1.

[13] While not reported for brevity, the magnitudes of price reversals and continuations are larger for stocks with lower institutional ownership. This is consistent with our earlier results.

Table 7
Determinants of reversals or continuations after positive one day change.

	Panel A. Price reversals						Panel B. Price continuations					
	Panel A.1. Large price decline			Panel A.2. Large price increase			Panel B.1. Large price decline			Panel B.2. Large price increase		
	CAR [+1, +3]	CAR [+1, +5]	CAR [+1, +10]	CAR [+1, +3]	CAR [+1, +5]	CAR [+1, +10]	CAR [+1, +3]	CAR [+1, +5]	CAR [+1, +10]	CAR [+1, +3]	CAR [+1, +5]	CAR [+1, +10]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log of Size	−0.287*	−0.309**	−0.401**	0.309**	0.305**	0.406**	0.167	0.278**	0.323**	−0.399**	−0.458**	−0.506**
	[2.16]	[3.24]	[3.42]	[3.88]	[3.18]	[3.66]	[1.18]	[2.99]	[2.74]	[3.01]	[4.32]	[3.18]
Decimal.	−0.756**	−1.081**	−1.217**	1.173**	1.904**	1.728**	0.877**	1.811**	1.806**	−0.988**	−1.117**	−1.292**
	[3.00]	[3.54]	[4.44]	[4.02]	[5.32]	[4.26]	[2.86]	[4.86]	[5.46]	[2.90]	[4.96]	[4.48]
BM	0.119	0.116	0.041	−0.858**	−0.899**	−0.963**	0.103	0.107	0.412	−0.923**	−1.492**	−1.298**
	[0.72]	[1.52]	[0.18]	[5.88]	[5.10]	[4.74]	[0.62]	[0.78]	[1.68]	[5.08]	[6.54]	[4.76]
AR[0]	−0.184**	−0.172*	−0.885	−0.128**	−0.112**	−0.103**	−0.183**	−0.256**	−0.309**	−0.178**	−0.182**	−0.183**
	[2.82]	[2.06]	[0.77]	[7.54]	[4.91]	[3.96]	[5.74]	[6.52]	[6.54]	[17.64]	[14.92]	[12.96]
CAR[−11;−1]	0.798**	0.683*	0.598	−0.069**	−0.059**	−0.044**	1.266*	3.663**	4.205**	−3.632**	−5.446**	−9.247**
	[2.56]	[2.37]	[1.48]	[10.82]	[7.66]	[5.16]	[1.98]	[6.88]	[9.74]	[3.10]	[3.70]	[5.26]
AV[0]	0.671**	0.500*	0.393	−0.070**	−0.056**	−0.043*	0.029**	0.036**	0.005	−0.071**	−0.132**	−0.181**
	[3.88]	[2.34]	[1.62]	[5.26]	[3.48]	[2.32]	[2.74]	[2.76]	[0.32]	[3.44]	[5.29]	[5.94]
CAV[−11;−1]	0.054**	0.042*	0.036	−0.028**	−0.018*	−0.006	−0.011	−0.044	−0.054	−0.016**	−0.010*	−0.005
	[3.18]	[2.22]	[1.68]	[2.94]	[2.24]	[0.52]	[0.48]	[1.48]	[1.52]	[2.82]	[2.06]	[1.64]
Intercept	6.456**	7.409**	5.884**	−3.493**	−3.085**	−3.087**	−0.964	−0.626	−0.378	5.679**	5.342**	5.725**
	[10.06]	[9.42]	[6.61]	[7.42]	[5.49]	[4.76]	[1.44]	[0.76]	[0.38]	[9.52]	[7.14]	[6.42]
N	6516	6516	6516	8001	8001	8001	5410	5410	5410	5971	5971	5971
R^2	0.60%	0.70%	0.50%	9.00%	6.30%	7.20%	4.10%	3.00%	3.20%	1.30%	2.10%	2.20%

This table reports the results of regressing the magnitudes of reversals (Panel A) or continuations (Panel B) on control variables for the cases where significant increases in stock prices are observed on event Day 0. Panels A.1 and B.1 report results for stocks that experience negative price shocks. Panels A.2 and B.2 report results for stocks that experience positive price shocks. The dependent variable is abnormal market-adjusted returns on over 3 (CAR[+1,+3]), 5 (CAR[+1,+5]), and 10 days (CAR[+1,+10]). The description of explanatory variables is defined in Tables 5 and 6. The table reports coefficient estimates, *t*–statistics, and adjusted R^2 of the pooled regressions. The sample period is from January 1986 to December 2015.

** Denotes statistical significance at the 1% level.

* Denotes statistical significance at the 5% level.

both positive and negative, from 1986 to 2015. We provide support for price reversal explanations based on temporary liquidity pressure (i.e., liquidity shocks) and overreaction. Consistent with the liquidity hypothesis, small stocks and stocks with lower institutional ownership are more likely to experience reversals following a large one-day price drop or increase. Consistent with the overreaction hypothesis, we show that stock prices tend to revert for firms with larger price shocks on and prior to the event day. The presence of relevant information is also shown to have a significant effect on price reversals versus continuations. Specifically, we find that firm-specific information regarding earnings announcements has a significant effect on price continuations. Consistent with the underreaction explanation, the probability of continuation is greater when a large price shock is accompanied by earnings announcements. Furthermore, the magnitudes of reversals and continuations are larger for smaller firms and firms with lower institutional ownership. Consistent with Daniel et al. (1998), we also find that the magnitude of price reversals is greater when one-day price shocks and cumulative returns prior to the event day are larger. These results suggest that markets underreact to news about firms' fundamentals and overreact to non-information-based price movements. Finally, the decrease in the magnitudes of reversals and continuations in the post-decimalization period suggests that greater market liquidity in that period has improved market efficiency.

The results in this study have several important implications. First, it contributes to the debate about underlying reasons of observed price reversals and continuations. Second, our results can be useful for regulatory authorities examining the impact of decimalization on financial markets. Our findings present several promising avenues for future research. For example, future studies can investigate the role of transaction costs in price reversals and continuations by using intraday bid-ask spreads. Future research can also study whether contrarian trading strategies based on short-term price reversals have economically significant returns.

Appendix A. Macroeconomic news announcements

Announcement	Original source
Real activity	
GDP	Bureau of Economic Analysis (BEA)
Initial unemployment claims	US Department of Labor
Nonfarm employment	Bureau of Labor Statistics (BLS)
Unemployment rate	Bureau of Labor Statistics (BLS)
ADP employment	ADP (Automatic Data Processing, Inc./Macroeconomic Advisers, LLC)
Advance retail sales	Bureau of the Census (BC)
Existing home sales	National Association of Realtors (NAR)
Industrial production	Federal Reserve Board (FRB)
Capacity utilization	Federal Reserve Board (FRB)

Personal income	Bureau of Economic Analysis (BEA)
Consumer credit	Federal Reserve Board (FRB)
Consumption	
New home sales	Bureau of the Census (BC)
Personal spending	Bureau of Economic Analysis (BEA)
Investment	
Durable goods orders	Bureau of the Census (BC)
Construction spending	Bureau of the Census (BC)
Factory orders	Bureau of the Census (BC)
Wholesale inventories	Bureau of the Census (BC)
Government purchases	
Government budget	U.S. Department of Treasury (USDT)
Net exports	
Trade balance	Bureau of Economic Analysis (BEA)
Prices	
Consumer price index	Bureau of Labor Statistics (BLS)
Producer price index	Bureau of Labor Statistics (BLS)
Forward looking	
ISM manufacturing	Institute for Supply Management (ISM)
ISM non-manufacturing	Institute for Supply Management (ISM)
Consumer confidence	Conference Board (CB)
U. of Michigan Conf-Prelim	Thomson Reuters and University of Michigan
U. of Michigan Conf-Final	Thomson Reuters and University of Michigan
Housing starts	Bureau of the Census (BC)
Pending home sales	National Association of Realtors (NAR)
Building permits	Bureau of the Census (BC)
Empire manufacturing	Federal Reserve Bank of New York (FRBNY)
Philadelphia fed business Outlook	Federal Reserve Bank of Philadelphia (FRBP)
Chicago purchasing manager index	National Association of Purchasing Management (NAPM)
Index of leading indicators	Conference Board (CB)

The table lists 33 scheduled macroeconomic news announcements that are obtained from Bloomberg Terminal.

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