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## ANOTHER LOOK AT IDIOSYNCRATIC VOLATILITY AND EXPECTED RETURNS

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*We conduct comprehensive analyses of the return characteristics of stock portfolios sorted by idiosyncratic volatility. We show that the relationship between idiosyncratic volatility and expected stock returns depends on whether the portfolio is composed of stocks with extreme performance and whether the returns are computed over January and non-January months. The dominance of loser stocks in December and a reversal effect in the subsequent month lead to a positive relation between idiosyncratic volatility and portfolio returns in January. Whereas for other months, the impact of past winner stocks dominates and a negative relation is observed due to the return reversal of these winner stocks. Our study contributes to the understanding of how January effect and short-term return reversal can lead to different relation between idiosyncratic volatility and expected returns.*



### 1 Introduction

The relation between idiosyncratic volatility and stock returns has been extensively analyzed by

the past studies.<sup>1</sup> On the firm level, i.e., in the cross-section of stock returns, the positive relation has been well-documented and confirmed by Malkiel and Xu (2002), Spiegel and Wang (2006), Chua *et al.* (2010), Fu (2009), and Huang *et al.* (2010). For portfolios sorted by idiosyncratic volatility, however, there are different findings between the portfolio idiosyncratic volatility and subsequent returns. Ang *et al.* (2006) find that portfolios with high idiosyncratic volatility in the current month yield low value-weighted (henceforth VW) returns in the following month. Ang *et al.* (2009) also confirm this negative relation in international markets. Bali and Cakici (2008), however, report that this negative relation

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is not robust under different choices of data frequency, weighting scheme, and breakpoints in the construction of idiosyncratic volatility-sorted portfolios.

In a recent study, Doran *et al.* (2008) and George and Hwang (2009) present an interesting addition to this debate. They observe that the negative relation between idiosyncratic volatility and stock returns, regardless of the weighting scheme, is limited to only nonJanuary months. For months of January, however, they find a positive relation between the two, in either value- or equal-weighted (henceforth EW) portfolios.

In this paper, we examine the relation between idiosyncratic volatility and expected returns at the portfolio level to provide a unifying understanding of the different results in the previous studies. Two recent papers explain the reason for the negative relation reported in Ang *et al.* (2006). Fu (2009) suggests that Ang *et al.*'s findings are driven by using realized idiosyncratic volatility as the proxy and he finds that a positive relation arises when conditional idiosyncratic volatility is estimated from the exponential GARCH models. Huang *et al.* (2010) provide evidence that the omission of stock return in the previous month can cause a negative bias in the relation between idiosyncratic risk and expected return. The negative relation disappears after return reversals are controlled for. However, these two papers do not examine the seasonality of the relation, i.e., whether this relation varies in different calendar months. In this paper, we examine the past performance and subsequent returns in January and nonJanuary months for the stocks in different portfolios sorted by idiosyncratic volatilities.

We find that the negative relation between realized idiosyncratic volatility and future stock returns in Ang *et al.* (2006) is nonmonotonic and driven mostly by the highest idiosyncratic volatility portfolio. Therefore, understanding the price behavior

of the portfolio with the highest idiosyncratic risk seems to be the key to uncovering the true relation between these two variables. Indeed, we find that a high concentration of both best performing and worst performing stocks in the portfolio with the highest idiosyncratic volatility. Consistent with Jegadeesh (1990) finding that there is significantly negative first-order autocorrelation in monthly stock returns, these stocks with extreme performance experience the strongest return reversal over the subsequent month. Because winner stocks have relatively greater market value than loser stocks in the portfolio formation month, their return reversals drive down the VW returns on the highest idiosyncratic risk portfolio in the subsequent 1-month holding period. As a result, the holding-month VW return on the highest idiosyncratic risk portfolio is significantly lower than that on the lowest idiosyncratic risk portfolio.

We conduct further analyses at the portfolio level. We find that after controlling for both firm size and past returns using a triple-sorting approach, the VW average return differences between the high and the low idiosyncratic volatility portfolios are no longer significant. However, after controlling for firm size and idiosyncratic volatility in the same triple-sorting approach, VW return on the highest quintile portfolio sorted by formation-month return (past winners portfolio) is significantly lower than the return on the lowest quintile portfolio (past losers portfolio). These results further confirm that return reversals cause the negative relation between idiosyncratic risk and VW portfolio returns.

More importantly, we document the seasonal effect of the relation. We find that the relation between idiosyncratic volatility and subsequent stock returns is conditional on whether stocks are losers or winners in portfolio formation month and whether their subsequent returns are computed over January and nonJanuary months.

Consistent with the limits of arbitrage explanation in Shleifer and Vishny (1997) and the short-sale constraint explanation in Boehme *et al.* (2009), we show that a positive relation exists between idiosyncratic risk and stock returns for past loser stocks over all months, while a negative one holds for past winners. When the idiosyncratic volatility sorted portfolios are constructed in December, there are significantly more loser stocks than winner stocks. Driven by the return reversal of these loser stocks, there is a significantly positive relation between idiosyncratic volatility and portfolio returns in January. For other months, the impact of past winner stocks dominates and there is a negative relation due to the return reversal of these winner stocks. Overall, return reversal of winner stocks in nonJanuary months are attributable to the negative relation between idiosyncratic volatility and subsequent stock returns across all months.

The remainder of the paper is organized as follows. We describe the data and our measure for idiosyncratic volatility in Section 2. In Section 3, we examine the portfolios sorted by idiosyncratic volatility and the portfolios sorted by past returns to explore reasons behind the idiosyncratic volatility puzzle and whether the January effect plays a role. In Section 4, we conduct further robustness analysis to show that it is return reversal that drives the negative relation between realized idiosyncratic volatility and subsequent stock returns. Section 5 summarizes and concludes.

## 2 Data and the measure of idiosyncratic volatility

Our sample includes all common stocks listed on the NYSE, AMEX, and NASDAQ from July 1963 to December 2007. We obtain daily and monthly returns on individual stocks from the Center for Research in Security Prices (CRSP)

and accounting information from COMPUSTAT. We use the VW return (includes distributions) of all common stocks in NYSE, AMEX, and NASDAQ as the market return and one-month Treasury bill rate as the proxy for the risk-free rate.

To facilitate comparison, we measure idiosyncratic volatility following the same approach as in Ang *et al.* (2006, 2009), Bali and Cakici (2008), and Doran *et al.* (2008). For each month, we calculate the daily residual relative to the Fama–French (1993) three-factor model for firms that have at least 17 daily return observations in that month<sup>2</sup>:

$$r_{t,d}^i = \alpha_t^i + \beta_{MKT}^i \cdot MKT_{t,d} + \beta_{SMB}^i \cdot SMB_{t,d} + \beta_{HML}^i \cdot HML_{t,d} + \varepsilon_{t,d}^i, \quad (1)$$

where  $r_{t,d}^i$  is stock *i* excess return,  $MKT_{t,d}$  is the market excess return,  $SMB_{t,d}$  and  $HML_{t,d}$  are the returns on portfolios formed to capture size and book-to-market effects, respectively, and  $\varepsilon_{t,d}^i$  is the resulting residual at day *d* in month *t*. The realized monthly idiosyncratic volatility is calculated by multiplying the standard deviation of daily residuals by the square root of the number of trading days in a month. For robustness check, we also use the standard deviation of the residuals from the capital asset pricing model and the raw returns to measure idiosyncratic volatility.<sup>3</sup>

## 3 Portfolio analyses

### 3.1 Characteristics of idiosyncratic volatility-sorted portfolios

To conduct portfolio level analysis, we construct quintile portfolios based on the ranking of the idiosyncratic volatility of each individual stock in the formation month and hold these portfolios for the subsequent month. Portfolio IV1 (IV5) is the portfolio of stocks with the lowest (highest) idiosyncratic volatility. We rebalance portfolios

**Table 1** Characteristics of portfolios sorted by idiosyncratic volatility.

Portfolio	VW return	EW return	Formation period return	VW-IV	Size	MKT share percentage	Price
IV1	1.01	1.17	1.07	3.88	5.15	54.22	47.39
IV2	1.06	1.41	1.66	6.56	4.97	26.80	27.25
IV3	1.12	1.44	2.21	9.48	4.33	11.76	18.81
IV4	0.67	1.25	2.94	13.51	3.67	5.27	12.85
IV5	−0.03	1.05	7.77	23.20	2.74	1.96	7.07
IV5–IV1	−1.04 (−2.71)	−0.12 (−0.35)	6.70 (10.13)				

*Note:* This table reports the characteristics of five portfolios sorted by idiosyncratic volatility. Portfolios are formed every month based on idiosyncratic volatility computed using standard deviation of daily residuals over the previous month, where the residuals are generated from the Fama and French (1993) model. Portfolio IV1 (IV5) is the portfolio of stocks with the lowest (highest) idiosyncratic volatilities. VW (EW) Return is the value (equal)-weighted average monthly return measured in percentage terms in the month following the portfolio formation period. Formation Period Return is the value-weighted average monthly portfolio return during the previous 1-month formation period. The VW-IV is the value-weighted idiosyncratic volatility of each portfolio in the formation period. The weights in the VW return, the formation period return, and VW-IV are based upon the market capitalization of the component stocks at the end of the previous month. Size is the simple average of the log market capitalization of firms within the portfolio. Market share percentage measures the market value of a portfolio relative to total market value of all stocks. Price is the simple average price at the end of previous month. The row “IV5–IV1” refers to the difference in monthly returns between portfolio IV5 and portfolio IV1. Newey–West (1987) robust *t*-statistics are reported in parentheses. The sample period is from July 1963 to December 2007.

each month. Our procedure here is the same as that of Ang *et al.* (2006) except that our sample extends from July 1963 to December 2007, whereas their sample period ends in December 2000.

In the second column of Table 1, we report VW average returns for the five portfolios in the 1-month holding period (month  $t + 1$ ) immediately following the portfolio formation month  $t$ . The weights depend on the market capitalization of the component stocks at the end of month  $t$ . Average returns increase from 1.01% per month for portfolio IV1 (low volatility stocks) to 1.06% for portfolio IV2, and further to 1.12% per month for portfolio IV3. The differences in average returns across these three portfolios are not significant. However, as we move toward the higher volatility stocks, average returns drop substantially: portfolio IV5, which contains stocks with the highest idiosyncratic volatility, has an average return of only −0.03% per month. The

difference in monthly returns between portfolio IV5 and portfolio IV1 is −1.04% per month with a robust *t*-statistic of 2.71. A negative relation emerges between idiosyncratic volatility and expected stock returns if we focus only on the lowest and the highest idiosyncratic volatility portfolios. If we exclude portfolio IV5, which contains the stocks with the highest idiosyncratic volatility, the return differences between the other four portfolios are not that large. This result indicates that the negative relation is mostly driven by those stocks with extremely high idiosyncratic volatility. It can be also seen from the last three columns of Table 1 that the stocks from the highest idiosyncratic volatility portfolio are on average small cap and low priced. The market value of this portfolio accounts for only about 2% of total market.

Since portfolio IV5 largely contains small cap and low-priced stocks, we compute the EW average returns for each of the idiosyncratic

volatility-sorted portfolios in the same holding period. The results are reported in the third column. The monthly EW return difference between portfolio IV5 and portfolio IV1 is not significant. The EW average monthly return of portfolio IV1 is 1.17%, while that of portfolio IV5 is 1.05%. In fact, the EW average returns of all five idiosyncratic volatility-sorted portfolios are close. We also find that there is a huge difference between the EW and VW returns of portfolio IV5: the former is 1.05% while the latter is only  $-0.03\%$ . However, the differences between the EW and VW returns of the other four portfolios are much smaller than that of portfolio IV5. This suggests that the VW return difference between portfolios IV5 and IV1 is likely to be driven by the stocks with *relatively* larger market capitalization rather than smaller-sized stocks *within* the highest idiosyncratic volatility portfolio, IV5.<sup>4</sup>

To verify how portfolio returns may have changed from the formation period to the holding period, we compute each portfolio's VW average return in the portfolio formation month. As in column 2, the weights are again dependent on the market capitalization at the end of portfolio formation month  $t$ . The VW average returns during the portfolio formation month  $t$  reported in column 4 indicate that they increase monotonically from portfolios IV1 through IV5. Since the idiosyncratic volatility portfolio is constructed based on the daily returns in the portfolio formation month  $t$ , this result confirms that the contemporaneous relation between stock returns and idiosyncratic volatility is actually positive [Duffee (1995)]. The most important observation is the significant difference between the VW average formation period return of portfolio IV5 and its VW average holding period return. The former is at 7.77% per month, while the latter is only  $-0.03\%$ . This implies that some of the high idiosyncratic volatility stocks are likely to be winners in the portfolio formation period, but experience strong return reversals to

become loser stocks in the holding period. We will further investigate this possibility in the following sections.

Considering the abnormal return pattern for the month of January, we next examine whether idiosyncratic volatility portfolios have different return patterns across all the months, especially between January and nonJanuary months. Table 2 reports the returns of idiosyncratic volatility sorted portfolios for January and nonJanuary months. Consistent with Doran *et al.* (2008) and George and Hwang (2009), we find that in January both VW and EW portfolio returns increase with their idiosyncratic volatility. The VW return of the highest idiosyncratic volatility portfolio IV5 is 4.10% higher than that of the lowest

**Table 2** Returns of portfolios sorted by idiosyncratic volatility.

Portfolio	VW return		EW return	
	January	NonJanuary	January	NonJanuary
IV1	1.60	0.95	3.01	1.00
IV2	2.15	0.96	4.12	1.16
IV3	3.14	0.94	5.56	1.07
IV4	3.52	0.41	7.70	0.67
IV5	5.70	-0.55	12.81	-0.01
IV5-IV1	4.10 (3.32)	-1.50 (-3.73)	9.80 (5.66)	-1.01 (-2.98)

*Note:* This table reports the returns of five portfolios sorted by idiosyncratic volatility in January and nonJanuary months. Portfolios are formed every month based on idiosyncratic volatility computed using standard deviation of daily residuals over the previous month, where the residuals are generated from the Fama and French (1993) model. Portfolio IV1 (IV5) is the portfolio of stocks with the lowest (highest) idiosyncratic volatilities. VW (EW) Return is the value (equal)-weighted average monthly return measured in percentage terms in the month following the portfolio formation period. The weights in the VW return are based upon the market capitalization of the component stocks at the end of the previous month. The row "IV5-IV1" refers to the difference in monthly returns between portfolio IV5 and portfolio IV1. Newey-West (1987) robust  $t$ -statistics are reported in parentheses. The sample period is from July 1963 to December 2007.

idiosyncratic volatility portfolio IV1, while the EW return of portfolio IV5 is 9.80% higher in January. By contrast, portfolio returns in nonJanuary months exhibit a different pattern: a negative relation emerges between idiosyncratic volatility and stock returns, regardless of the weighting scheme.<sup>5</sup> This result suggests that the January effect cannot be the reason for the negative difference between VW returns of high and low idiosyncratic volatility sorted portfolios. Indeed, excluding the month of January would strengthen the negative relation. Furthermore, we notice that similar to Table 1, VW portfolio return is less than EW portfolio return in each idiosyncratic volatility sorted portfolio, which indicates that on average stocks with higher returns in the portfolio holding month ( $t + 1$ ) are relatively smaller than lower return stocks when portfolios are formed in the previous month ( $t$ ). This motivates our investigation of stock return changes in the portfolio formation and holding months.

### 3.2 Short-term return reversals

The empirical regularity that individual stock returns exhibit negative serial correlation over a short horizon has been well-known for a long time [Jegadeesh (1990) and Lehmann (1990)]. Jegadeesh (1990) finds that the negative first-order correlation in monthly stock returns is highly significant; winner stocks with higher returns in the past month (formation period) tend to have lower returns in the current month (holding period) while loser stocks with lower returns in the past month tend to have higher returns in the current month. He reports profits of about 2% per month from a contrarian strategy that buys loser stocks and sells winner stocks based on their prior-month returns and holds them 1 month. Similarly, Lehmann (1990) finds that the short-term contrarian strategy based on a stock's 1-week return generates positive profits. The findings compiled by these studies are generally regarded

as evidence of short-term return reversals of individual stocks.

Winner stocks and loser stocks often have high volatility and experience strong return reversals in the subsequent month. If the VW return on the highest volatility portfolio is dominated by winner stocks in the month in which the portfolio is formed, it will be low in the following 1-month holding period due to return reversals. Thus, the negative relation between idiosyncratic volatility and subsequent VW portfolio return should be caused by return reversals of winner stocks rather than idiosyncratic volatility itself. Loser stocks cannot have a role in this negative relation because loser stocks in the same highest idiosyncratic volatility portfolio will experience return reversals and hence have high returns in the holding month, which may partially offset this negative relation. To verify this possibility, we examine the characteristics of ten portfolios constructed by sorting stock returns in the same manner as Jegadeesh (1990). Specifically, we calculate the VW and EW average returns for ten portfolios formed based on the rankings of formation period stock returns, with P1 containing past losers and P10 containing past winners. The portfolios are then rebalanced each month. Table 3 reports the results.

Consistent with Jegadeesh's (1990) findings, the average holding period returns exhibit a strong pattern of return reversals. Panel A shows that P10, the past winners portfolio, becomes losers in the following month, with returns declining from 24.36% to 0.86% (VW) and 0.29% (EW), while P1, the past losers portfolio, beats past winners, with returns increasing from -18.07% in the formation period to 1.14% (VW) and 3.01% (EW) in the holding period. Furthermore, as shown in column 5, the average idiosyncratic volatilities in the formation period are much higher in two extreme loser/winner portfolios (P1 and P10),

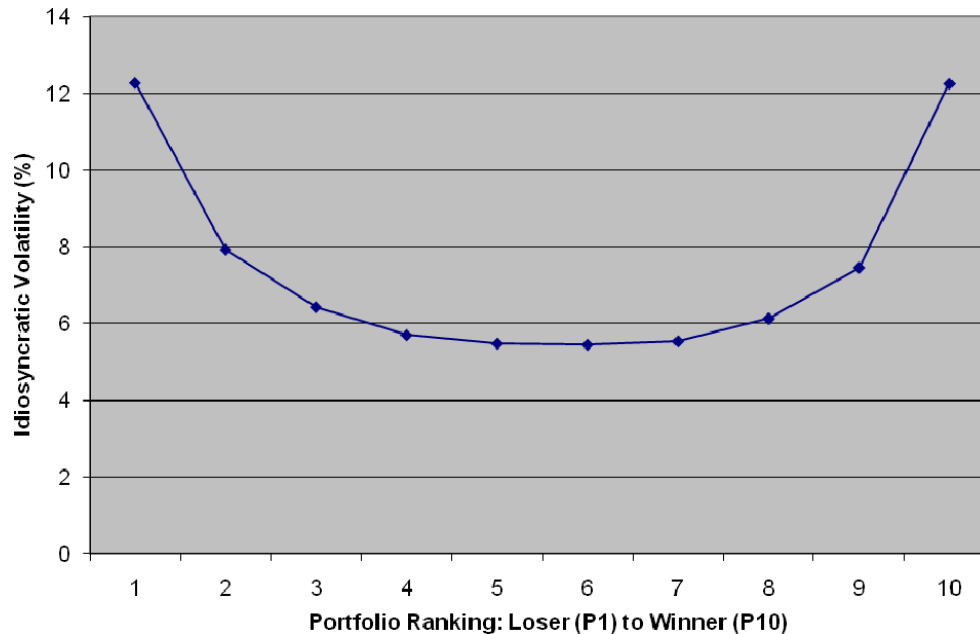
**Table 3** Characteristics of portfolios sorted by past 1 month returns.

Portfolio	Formation period return	VW holding period return	EW holding period return	VW-IV	Size	Price
<i>Panel A: All months</i>						
P1	-18.07	1.14	3.01	12.28	3.14	9.58
P2	-9.99	0.96	1.49	7.93	3.88	15.59
P3	-6.02	1.31	1.28	6.43	4.19	22.33
P4	-3.25	1.24	1.21	5.70	4.38	23.75
P5	-0.96	1.09	1.25	5.48	4.52	29.40
P6	1.29	0.89	1.19	5.45	4.59	29.71
P7	3.76	0.95	1.18	5.54	4.64	29.96
P8	6.93	0.93	1.08	6.13	4.61	26.94
P9	11.75	0.91	0.91	7.46	4.40	24.98
P10	24.36	0.86	0.29	12.26	3.74	16.65
<i>Panel B: January only</i>						
P1	-18.54	5.78	15.78	14.21	2.77	8.15
P2	-10.00	3.13	9.22	8.78	3.66	13.46
P3	-5.65	3.55	7.04	6.74	4.14	18.89
P4	-2.91	3.18	6.49	5.99	4.34	19.95
P5	-0.52	2.65	5.64	5.47	4.42	32.62
P6	1.63	1.78	4.73	5.56	4.63	29.66
P7	4.10	2.00	4.78	5.63	4.71	42.58
P8	7.37	1.54	4.49	6.14	4.69	24.14
P9	12.06	1.68	4.19	7.53	4.48	21.37
P10	24.80	1.43	4.33	12.36	3.81	16.52

*Note:* This table reports the characteristics of ten portfolios in all months (Panel A) and January (Panel B) sorted by the previous 1-month stock returns. Portfolios are formed at the end of each month and held for next 1 month. P1 through P10 represent losers/winners portfolios, with P1 containing past losers and P10 containing past winners. Formation Period Returns are the value-weighted average returns during the formation period. VW and EW Holding Period Returns are the value- and equal-weighted average returns during the following 1-month holding period. Both are measured in monthly percentage terms. The VW-IV is the value-weighted idiosyncratic volatility of the component stocks in the portfolio formation period, measured in percentages. The individual stock's idiosyncratic volatility is relative to the Fama and French (1993) model and is computed based on daily returns in the formation month. Size is the simple average log market capitalization of firms within the portfolio. Price is the simple average price at the end of the formation month. The sample period is from July 1963 to December 2007.

and lower in the middle portfolios (P5 and P6).<sup>6</sup> For example, the average idiosyncratic volatilities of P1 and P10 are both over 12%, while the average idiosyncratic volatilities of P5 and P6 are less than 5.50%. Figure 1 illustrates a U-shaped curve for the idiosyncratic volatility of the

ten portfolios sorted by the past returns. Clearly, both the “winners” and “losers” have significantly higher idiosyncratic volatilities in the portfolio formation month. Finally, we observe from the last two columns of Table 3 that although past winner portfolio (P10) and loser portfolio (P1) have



**Figure 1** Idiosyncratic volatility for past performance sorted portfolios.

This figure plots the value-weighted average percentage level of the idiosyncratic volatility for the portfolios sorted by return performance in the previous 1-month formation period. P1 (P10) is the loser (winner) portfolio. The idiosyncratic volatility of a portfolio is the value-weighted average of the idiosyncratic volatilities of all the stocks within the portfolio.

similar idiosyncratic volatility, the average size and price of the past winner stocks are greater than those of loser stocks in the portfolio formation period.

Panel B of Table 3 reports the January only returns as well the idiosyncratic volatility of portfolios sorted by the December returns. On average stocks in each decile have higher returns in January than nonJanuary months. Idiosyncratic volatility of the ten portfolios exhibits a similar U-shaped curve in December as in other months, though it is higher than the idiosyncratic volatility of the corresponding portfolio in the rest of a year. Both winner and loser stocks are small, low-priced with high idiosyncratic volatility. However, loser stocks are much smaller in December than in other months. We also notice that winner and loser stocks still exhibit return reversals in January, but loser stocks show a much stronger intensity and experience abnormally high returns

in January. For example, Panel B shows that the past loser portfolio P1 becomes winners, with returns increasing from  $-18.54\%$  in the previous December to  $5.78\%$  (VW) and  $15.78\%$  (EW) in the following January. In contrast, the return reversal of winner stocks is less dramatic in January than nonJanuary months as implied by Panel A. Panel B of Table 3 shows that the past winner portfolio P10 becomes losers with a return of  $1.43\%$  (VW) and  $4.33\%$  (EW) in January, compared to  $0.86\%$  (VW) and  $0.29\%$  (EW) for all months in Panel A. In sum, extreme winners and losers, which are mostly small-cap stocks with very high idiosyncratic volatility, exhibit strong return reversals in January. It is more dramatic for the losers than the winners. This finding is consistent with the evidence in Branch (1977), Reinganum (1983), and Jegadeesh (1990), who find that the size effect can explain part of the empirical anomaly in the month of January.

### 3.3 *Distribution of past returns among idiosyncratic volatility-sorted portfolios*

To highlight the role of return reversal in each of the five idiosyncratic volatility-sorted portfolios, we form two-pass independently sorted portfolios based on each stock's performance and idiosyncratic volatility in the portfolio formation month. We first sort all stocks into five portfolios based on idiosyncratic volatility, with portfolio IV1 (IV5) representing the lowest (highest) idiosyncratic volatility portfolio. We also sort stocks into ten portfolios based on returns in the formation month, with portfolio P1 (P10) representing the extreme loser (winner) portfolio. We then allocate stocks from each portfolio IV1 through IV5, to one of the ten groups, P1 through P10. The breakpoints for past stock returns sorting are independent of the idiosyncratic volatility sorting, and therefore the sequence of these two sortings does not matter. This procedure creates 50 idiosyncratic volatility-past return portfolios with unequal number of stocks as illustrated in Table 4.

Panel A of Table 4 presents the number of stocks within each portfolio. The total number of common stocks assigned to the two extreme loser portfolio (P1) and winner portfolio (P10) amounts to 978 ( $= 490 + 488$ ). Of them, the mass majority is the stocks with high idiosyncratic volatility. Only 28 ( $= 13 + 15$ ) or 3% of 978 stocks are either past winners (15) or past losers (13) in the lowest idiosyncratic volatility portfolio (IV1). In contrast, among these 978 past winners and losers, nearly one-half ( $461 = 224 + 237$ ) of them belong to the highest idiosyncratic volatility portfolio (IV5). Furthermore, extreme winners and losers (a total of 461) are also almost one-half of all the stocks within the highest idiosyncratic volatility portfolio, IV5 (the number of all the stocks in IV5 is 973). This suggests that stocks with extreme price movements are associated with high idiosyncratic volatility.<sup>7</sup> Interestingly,

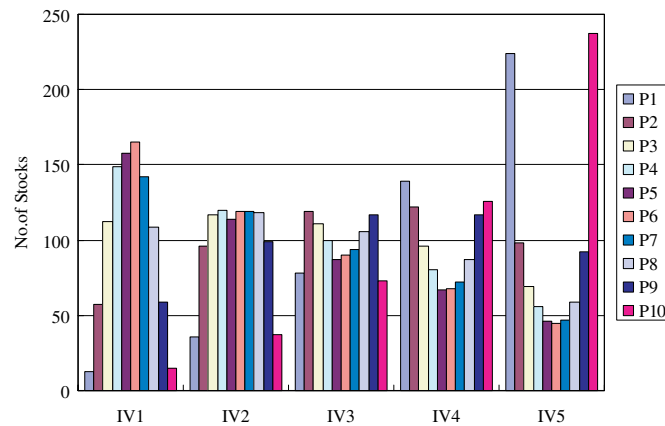
for each idiosyncratic volatility-sorted portfolio, the number of winner stocks in portfolios P6 to P10 is roughly the same as that of loser stocks in portfolios P1 through P5. Panel A of Figure 2 shows a graphical illustration of the symmetric distribution of past returns in each idiosyncratic volatility-sorted quintile portfolio.

Panels B and C of Table 4 report the EW monthly average returns in the 1-month formation period and in the subsequent holding period for each of the 50 portfolios sorted independently by idiosyncratic volatility and past return.<sup>8</sup> The two panels clearly illustrate the dramatic return reversals. Loser portfolio P1 and winner portfolio P10 have much stronger return reversals than other portfolios, especially for the highest idiosyncratic volatility portfolios. In particular, the return of past loser portfolio (P1) with the highest idiosyncratic volatility (IV5) changes from  $-23.97\%$  to  $3.95\%$ , while the return of the past winner portfolio (P10) with the highest idiosyncratic volatility (IV5) changes from  $37.61\%$  to  $-0.62\%$ . Panel B of Figure 2 illustrates the average return difference between the holding period and the formation period for these 50 portfolios. In general, we find that higher idiosyncratic volatility stocks usually have stronger short-term return reversals.

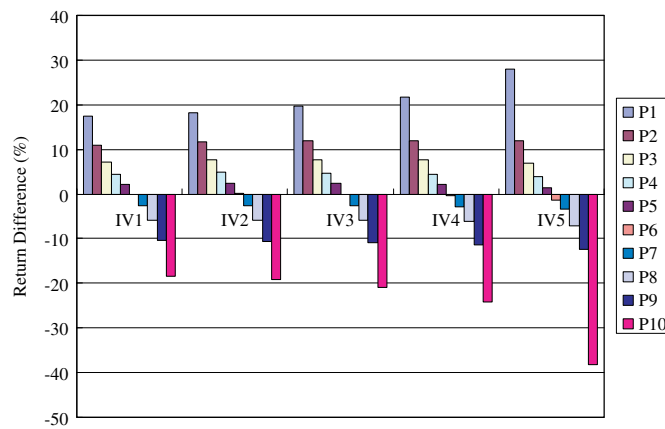
Panel C of Table 4 also shows that the average returns on IV5 in the holding period are less than the returns on IV1 from P3 to P10. In contrast, for the two extreme loser portfolios, P1 and P2, the return on IV5 is actually higher than the return on IV1. This indicates that the holding-month return on the highest idiosyncratic risk is not always lower than that on the lowest idiosyncratic volatility and the negative relation between idiosyncratic volatility and future returns does not hold for all portfolios.

Panel D reports the average market capitalization for each of the 50 portfolios. The information

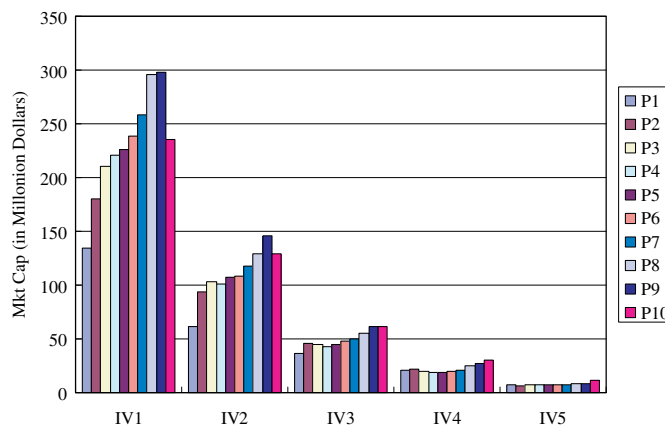
Panel A: The number of stocks in 50 portfolios sorted on idiosyncratic volatility and previous 1-month return.



Panel B: Return difference between formation period and holding period for 50 portfolios sorted by idiosyncratic volatility and previous 1-month return.



Panel C: The average market capitalization (in million dollars) of 50 portfolios sorted by idiosyncratic volatility and the previous 1-month return.



**Figure 2** The characteristics of idiosyncratic volatility-sorted portfolio and past 1 month return-sorted portfolios.

This figure shows the average number of stocks (Panel A), the difference between the average 1-month holding period return and the average 1-month formation period return (Panel B), and the average market capitalization (Panel C) for each of the 50 portfolios sorted independently by idiosyncratic volatility and previous 1-month (formation period) return.

**Table 4** Portfolios sorted by idiosyncratic volatility and past 1 month returns (all months).

Portfolio	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
<i>Panel A: The average number of stocks within each portfolio</i>										
IV1	13	57	112	149	158	165	142	109	59	15
IV2	36	96	117	120	114	119	119	118	99	37
IV3	78	119	111	100	87	90	94	106	117	73
IV4	139	122	96	80	67	68	72	87	117	126
IV5	224	98	69	56	46	45	47	59	92	237
Total	490	492	505	505	472	487	474	479	484	488
<i>Panel B: The average monthly returns during formation periods</i>										
IV1	-15.07	-9.58	-5.89	-3.16	-0.90	1.31	3.75	6.80	11.12	18.95
IV2	-16.22	-9.99	-6.04	-3.23	-0.91	1.32	3.82	6.97	11.69	19.90
IV3	-17.42	-10.21	-6.08	-3.25	-0.91	1.34	3.85	7.02	12.05	21.97
IV4	-19.23	-10.31	-6.15	-3.22	-0.89	1.38	3.89	7.11	12.28	24.98
IV5	-23.97	-10.38	-6.13	-3.22	-0.89	1.41	3.92	7.17	12.41	37.61
<i>Panel C: The average monthly returns during holding periods</i>										
IV1	2.32	1.43	1.28	1.23	1.15	1.16	1.10	0.95	0.82	0.59
IV2	1.99	1.71	1.62	1.56	1.40	1.41	1.30	1.11	1.04	0.73
IV3	2.26	1.76	1.64	1.42	1.58	1.33	1.20	1.23	1.05	1.04
IV4	2.36	1.52	1.39	1.22	1.32	1.03	1.08	0.97	0.79	0.70
IV5	3.95	1.61	0.80	0.68	0.54	0.05	0.53	0.10	-0.10	-0.62
<i>Panel D: The average market capitalization during formation periods</i>										
IV1	134.40	180.27	209.91	220.71	225.81	238.96	258.75	295.41	298.20	235.23
IV2	61.31	93.52	103.25	101.20	107.42	108.71	117.72	129.15	145.56	129.68
IV3	36.59	45.54	44.47	42.91	44.59	47.72	50.24	55.03	61.75	61.64
IV4	20.72	21.84	19.71	18.24	18.48	20.22	20.91	24.57	27.50	29.80
IV5	7.61	6.66	6.86	6.91	7.11	7.58	6.88	8.09	8.74	11.20

*Note:* This table reports the characteristics of 50 portfolios sorted independently by idiosyncratic volatility and previous 1 month stock returns. At the beginning of each month, we sort all of stocks into five portfolios based on idiosyncratic volatility computed using daily data over the previous one month. Portfolio IV1 (IV5) is the portfolio of stocks with the lowest (highest) idiosyncratic volatility. The stocks are also independently allocated to ten portfolios based on their previous 1-month returns. P1 through P10 represent winners/losers portfolios, with P1 containing past losers and P10 containing past winners. The intersections of the idiosyncratic volatility-sorted portfolios and previous month return-sorted portfolios are then used to create 50 idiosyncratic volatility- and past return-sorted portfolios. Panel A reports the average number of stocks in each of the 50 portfolios and the total number of stocks in each past return sorted portfolios. Panel B shows the simple average monthly returns measured in percentage terms in the portfolio formation period. Panel C reports the simple average monthly returns measured in percentage terms in the 1-month holding period. Panel D reports the average of market capitalization (in million dollars) of firms within the portfolio in the portfolio formation period. The sample period is from July 1963 to December 2007.

gleaned from Panel D is important for our subsequent analyses given the interrelation among firm size, idiosyncratic volatility, and return reversals. A strong negative relation exists between

firm size and idiosyncratic volatility within each of return-based ten-decile portfolios (P1 through P10): idiosyncratic volatility increases monotonically when firm size decreases. The highest

idiosyncratic volatility portfolio is dominated by small-sized stocks, while the lowest idiosyncratic volatility portfolio is associated with large-sized stocks. In addition, within each of the five idiosyncratic volatility-sorted portfolios (IV1 through IV5), the market capitalization of past winner stocks is much larger on average than that of loser stocks. In particular, in the highest idiosyncratic volatility portfolio, the market capitalization of winner stocks is around 50% larger than that of loser stocks (\$11.20 million vs. \$7.61 million) although both of them belong to small-cap stocks among all stocks. A graphical illustration is presented in Panel C of Figure 2.

To further examine the portfolio characteristics in the month of January, we sort stocks by idiosyncratic volatility and stock returns in the month of December. Table 5 reports the same set of portfolio characteristics as in Table 4. The general pattern is broadly consistent with Table 4 in which the results are based on all months. However, there are three notable differences. First, Panel A shows that there are many more loser stocks in high idiosyncratic volatility portfolios in the month of December, the portfolio formation period. For example, among the 983 stocks in the highest idiosyncratic volatility portfolio (IV5),  $443 (= 248 + 110 + 85)$  stocks belongs to the bottom three deciles (P1, P2, and P3), while only  $349 (= 54 + 82 + 213)$  stocks are in the top three deciles (P8, P9, and P10). The number of loser stocks is about 30% more than that of winner stocks. Second, Panels B and C indicate that the reversals for loser stocks in January are extremely strong especially for high idiosyncratic volatility portfolios. For example, for stocks in IV5, the previous loser stocks (P1) earn 20.71% in January, which is in striking contrast to their return of -24.64% in December. The reversal in January is significantly stronger than the average of all months (change from -23.97%

to 3.95% as shown in Table 4). Third, although there are significant return reversals for winner stocks in January, the reversal is much weaker than in other months. For example, winner stocks in high idiosyncratic volatility portfolios still earn a relatively high return of 6.15% in January even though it is down from 38.40%. This is consistent with the small-firm-in-January effect documented in the literature, given the fact that both winners and losers are typically small-cap stocks. Overall, the results in Table 5 show that the impact of return reversal would be stronger for the negative relation between idiosyncratic volatility and portfolio returns if the month of January is excluded.

Combining the findings from Tables 3, 4 and 5, we can now explain underlying reasons for the observed differences in VW and EW returns reported in Tables 1 and 2. Both past winner and past loser stocks have high idiosyncratic volatility in the formation month, but the winner stocks earn low returns while the loser stocks earn high returns in the following month due to return reversals. On average, the number of winner stocks and the number of loser stocks are roughly equal in the high idiosyncratic volatility portfolio in all months. Therefore, the EW average return of the high idiosyncratic volatility portfolio will not be significantly lower than that of other portfolios since the high returns of past loser stocks are offset by the low returns of past winner stocks in the holding month. However, because there is a large concentration of both winner stocks and loser stocks in the highest idiosyncratic volatility portfolio, and the average size of winner stocks is substantially larger than that of loser stocks in the portfolio formation period, winner stocks thus dominate the VW high idiosyncratic volatility portfolio. The high idiosyncratic volatility portfolio will earn higher VW returns in the formation period but significantly lower VW returns in the holding period due

**Table 5** Portfolios sorted by idiosyncratic volatility and past 1 month returns (January only).

Portfolio	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
<i>Panel A: The average number of stocks within each portfolio</i>										
IV1	10	42	114	146	163	177	149	119	64	14
IV2	29	87	126	122	110	117	120	125	109	49
IV3	69	121	124	106	84	84	92	104	119	84
IV4	138	133	109	84	66	63	70	84	108	131
IV5	248	110	85	55	52	42	42	54	82	213
Total	494	493	558	513	475	483	473	486	482	491
<i>Panel B: The equal-weighted average monthly returns in December</i>										
IV1	-15.30	-9.53	-5.64	-2.81	-0.47	1.64	4.08	7.17	11.60	19.01
IV2	-16.56	-10.06	-5.81	-2.91	-0.52	1.68	4.13	7.37	11.94	20.91
IV3	-17.81	-10.34	-5.89	-2.93	-0.50	1.66	4.16	7.40	12.31	22.63
IV4	-19.61	-10.46	-5.90	-2.92	-0.49	1.69	4.19	7.48	12.52	26.04
IV5	-24.64	-10.55	-5.89	-2.91	-0.40	1.77	4.21	7.55	12.62	38.40
<i>Panel C: The equal-weighted average monthly returns in January</i>										
IV1	8.00	4.90	4.13	4.00	3.46	2.93	2.34	1.84	1.38	3.41
IV2	8.15	6.15	5.57	5.25	4.69	4.34	3.76	3.25	2.25	1.61
IV3	9.47	7.76	6.93	6.54	6.03	5.07	4.89	4.59	3.60	2.75
IV4	12.22	9.95	8.50	8.77	7.62	7.10	7.06	6.39	5.01	3.49
IV5	20.71	14.54	11.26	11.92	10.40	9.06	10.48	8.44	8.06	6.15
<i>Panel D: The average market capitalization in December</i>										
IV1	395.30	177.31	249.80	208.09	218.33	264.31	251.81	332.08	292.34	165.36
IV2	81.18	104.20	102.86	91.99	93.91	118.80	118.53	136.32	136.26	134.91
IV3	31.78	42.11	37.80	43.30	37.51	53.85	44.36	52.09	60.68	59.03
IV4	16.64	27.04	21.27	13.63	12.69	19.41	18.86	24.55	23.32	31.46
IV5	4.80	4.73	5.20	4.94	4.45	9.29	5.31	6.74	6.75	8.70

*Note:* This table reports the characteristics of 50 portfolios sorted independently by idiosyncratic volatility and monthly stock returns in December. At the beginning of each January, we sort all of stocks into five portfolios based on idiosyncratic volatility computed using daily data over the previous December. Portfolio IV1 (IV5) is the portfolio of stocks with the lowest (highest) idiosyncratic volatility. The stocks are also independently allocated to ten portfolios based on their returns in December. P1 through P10 represent winners/losers portfolios, with P1 containing past losers and P10 containing past winners. The intersections of the idiosyncratic volatility-sorted portfolios and previous December return-sorted portfolios are then used to create 50 idiosyncratic volatility- and past return-sorted portfolios. Panel A reports the average number of stocks in each of the 50 portfolios and the total number of stocks in each past return sorted portfolios. Panel B shows the simple average monthly returns measured in percentage terms in the previous December. Panel C reports the simple average monthly returns measured in percentage terms in the following January. Panel D reports the average of market capitalization (in million dollars) of firms within the portfolio in the previous December. The sample period is from July 1963 to December 2007.

to strong return reversals. Therefore, as Table 1 shows, the high idiosyncratic volatility portfolios earn significantly lower VW return than the low idiosyncratic volatility portfolios in the portfolio

holding period, but the EW portfolio returns do not record this difference. Similarly, this return reversal can also be seen from the fact that the highest idiosyncratic volatility portfolio realizes

the highest return during the portfolio formation period.

We can also explain why both VW and EW returns of high idiosyncratic volatility portfolios are significantly higher than the returns of low idiosyncratic volatility portfolios in January as reported in Table 2. This happens because there are more loser stocks than winner stocks in December for the highest idiosyncratic volatility portfolio, and both of them are small-sized stocks. Although loser stocks are still smaller than winner stocks, loser stocks experience much stronger return reversals than winner stocks in January, which leads to higher return on the portfolio with the highest idiosyncratic volatility (IV5) than the portfolio with the lowest idiosyncratic volatility (IV1). In addition, return reversals imply that the VW return of each idiosyncratic volatility-sorted portfolio is lower than its EW return, as Table 2 shows.

## 4 Robustness analyses

### 4.1 Portfolio returns under different formation and holding periods

We have thus far found that the negative relation between idiosyncratic volatility and VW portfolio returns is driven by the short-term return reversals. Since the short-term return reversals may not be persistent [see Jegadeesh (1990)], an important question is whether this negative relation holds over the long run. To examine the performance of idiosyncratic volatility-sorted portfolios over the long run, we form four different trading strategies similar to Ang *et al.* (2006). The trading strategies can be described by an  $L$ -month initial formation period, an  $M$ -month waiting period, and then an  $N$ -month holding period. At month  $t$ , we form portfolios based on the idiosyncratic volatility over a  $L$ -month period from the end of month  $t - L - M$  to the end of month  $t - M$ , and then we hold these portfolios from month  $t$  to month

$t + N$  for  $N$  months. To control for microstructure noises and ensure that we only use the information available at time  $t$  to form portfolios, we skip  $M$  ( $> 0$ ) months between the formation period and the holding period. For example, for the 12/1/12 strategy, we sort stocks into quintile portfolios based on their idiosyncratic volatility over the past 12 months; we skip 1 month and hold these EW or VW portfolios for the next 12 months. The portfolios are rebalanced each month.<sup>9</sup> Using this procedure, we form four trading strategies, namely, 1/1/1, 1/1/12, 12/1/1, and 12/1/12. We report the EW and VW average returns on these portfolios in Table 6.

Table 6 indicates that, when a 1-month waiting period is imposed between the formation period and the holding period, the return difference between portfolio IV5 and portfolio IV1 is no longer significant under all four strategies, regardless of whether the portfolio returns are computed using EW or VW schemes.<sup>10</sup> For portfolios formed based on the idiosyncratic volatility 2 months ago, the negative return difference between IV5 and IV1 declines when the holding period increases. For example, the return difference declines from  $-0.55\%$  for 1/1/1 strategy to  $-0.05\%$  for 1/1/12 strategy. The EW returns of idiosyncratic volatility portfolio IV5 from 1/1/12, 12/1/1, and 12/1/12 even have the highest returns among the five idiosyncratic volatility-sorted quintile portfolios, although the differences are insignificant at the 5% level.

In Table 7, we examine the long-run performance of the idiosyncratic volatility-sorted quintile portfolios constructed in Table 1. We compare the EW and VW returns of these five portfolios in the following 12 months after they are formed. The difference between these 12-month holding period returns and the returns on  $L/M/N$  strategy is that we do not rebalance the portfolios in

**Table 6** Portfolios sorted by idiosyncratic volatility for  $L/M/N$  strategies.

Strategy		IV1	IV2	IV3	IV4	IV5	IV5–IV1
1/1/1	VW	0.92	1.05	1.10	0.93	0.37	–0.55 (–1.70)
	EW	1.28	1.36	1.37	1.23	1.19	–0.09 (–0.29)
1/1/12	VW	0.76	1.01	1.02	0.92	0.71	–0.05 (–0.24)
	EW	1.09	1.27	1.29	1.27	1.46	0.37 (1.62)
12/1/1	VW	0.89	1.05	1.13	1.08	1.01	0.12 (0.45)
	EW	1.12	1.20	1.23	1.30	1.60	0.49 (1.71)
12/1/12	VW	0.79	1.08	1.05	0.76	0.64	–0.15 (–0.65)
	EW	1.02	1.26	1.29	1.23	1.59	0.57 (1.76)

*Note:* The table reports EW (equal-weighted) and VW (value-weighted) average returns of five idiosyncratic volatility portfolios under  $L/M/N$  strategies described in Section 3. At month  $t$ , we form quintile portfolios based on the idiosyncratic volatility over the  $L$ -month period from month  $t - L - M$  to month  $t - M$ , then hold these portfolios for  $N$  months from month  $t$ . To take short-term return reversals into account, we skip the middle  $M$  months. The column “IV5–IV1” refers to the difference in monthly returns between portfolio IV5 and portfolio IV1. Newey–West (1987) robust  $t$ -statistics are reported in parentheses. The sample period is from July 1963 to December 2007.

the holding period once they are formed, i.e., the components of the portfolios are unchanged over the holding period. Statistical tests indicate that the EW return difference between IV5 and IV1 are insignificant in any of the 12 months. For brevity, we only report VW returns of IV sorted portfolios in Table 7. We find that the return difference between IV5 and IV1 is significant only in the first month of holding period but it is no longer significant from month 2 to month 12. For example, in month 2, the return difference between IV5 and IV1 is merely  $-0.42\%$  with a  $t$ -statistic of  $-1.31$ . VW returns on all five idiosyncratic volatility-sorted portfolios are very close in magnitude when the holding period gets longer than 2 months.

Overall, our evidence again suggests that the negative relation between idiosyncratic volatility and portfolio returns does not hold under different formation and holding periods that are longer than 1 month. The negative relation between idiosyncratic volatility and VW portfolio returns in the subsequent month is caused by both short-term return reversals and the larger firm size of the past winners in the highest idiosyncratic volatility portfolio.

#### 4.2 Interrelation among size, idiosyncratic volatility and past returns

If return reversals and the larger firm size of the past winners are the driving force behind the VW

**Table 7** Post-formation returns of portfolios sorted by idiosyncratic volatility.

Portfolio	1st month	2nd month	3rd month	4th month	5th month	6th month	7th month	8th month	9th month	10th month	11th month	12th month
IV1	1.01	0.69	0.71	0.71	0.61	0.62	0.73	0.77	0.80	0.80	0.74	0.92
IV2	1.06	1.04	1.11	0.98	1.06	1.02	1.02	1.01	1.00	0.97	1.00	0.97
IV3	1.12	1.20	0.98	1.19	1.11	1.04	1.05	0.93	0.96	0.90	0.95	1.03
IV4	0.67	0.82	1.09	0.87	0.87	1.05	0.96	0.76	0.91	0.97	0.89	0.95
IV5	-0.03	0.27	0.56	0.49	0.49	0.50	0.74	0.94	0.97	0.85	0.89	0.89
IV5-IV1	-1.04	-0.42	-0.15	-0.22	-0.12	-0.12	0.01	0.17	0.17	0.05	0.15	-0.03
	(-2.71)	(-1.31)	(-0.49)	(-0.70)	(-0.37)	(-0.40)	(0.04)	(0.55)	(0.57)	(0.15)	(0.48)	(-0.08)

*Note:* This table reports the value-weighted monthly returns during the 12-month post formation period of five portfolios sorted by idiosyncratic volatility relative to the Fama and French (1993) model. Portfolios are formed every month based on idiosyncratic volatility computed using daily data over the previous month and held for 12 months after formation. Portfolio IV1 (IV5) is the portfolio of stocks with the lowest (highest) idiosyncratic volatilities. The weights are based upon a stock's market capitalization at the end of the formation period. The row "IV5-IV1" refers to the difference in monthly returns between portfolio IV5 and portfolio IV1. Newey-West (1987) robust *t*-statistics are reported in parentheses. The sample period is from July 1963 to December 2007.

return difference in idiosyncratic volatility-sorted portfolios, this negative relation between idiosyncratic volatility and future VW portfolio returns might disappear after past stock returns and size effect are properly controlled for. In this section, we examine this conjecture. Ang *et al.* (2006) conduct a dependent double-sorting to investigate the effect of past returns on the negative relation. They first sort stocks based on the formation month return, then within each past return sorted portfolio, they sort stocks based on idiosyncratic volatility. They find that the VW return on the highest idiosyncratic volatility portfolio is still significantly lower.<sup>11</sup>

The double sort with controlling for past returns does not necessarily control for the size effect. Because firm size plays a critical role in determining the VW returns, the size distribution in different portfolios may have an influence on the negative relation between idiosyncratic volatility and future VW portfolio returns, even after we control for past returns and have similar past returns among all five idiosyncratic volatility-sorted portfolios. The efficacy of the double-sorting method can be limited when a third variable is strongly correlated with the two sorting variables. To explore the interrelation among size, idiosyncratic volatility and past returns, and evaluate the relative importance of the volatility effect and reversal effect, we use a triple-sorting approach that simultaneously controls for firm size and the previous 1-month return to evaluate this negative relation between idiosyncratic volatility and portfolio returns.

Under this triple-sorting approach, we first sort stocks into five portfolios based on stock size each month. Then, within each size quintile we sort stocks into five subgroups based on the previous 1-month return of stocks. This two-way sorting yields 25 portfolios. Finally, within each of these 25 portfolios, we sort stocks based on

idiosyncratic volatility. The five idiosyncratic volatility portfolios are then constructed by averaging over each of the 25 portfolios that have the same idiosyncratic volatility ranking. Hence, the resulting portfolios represent idiosyncratic volatility quintile portfolios after firm size and past returns are simultaneously controlled for.

Panel A of Table 8 reports the VW average returns for idiosyncratic volatility quintile portfolios after controlling for firm size and past returns. The average return difference between the two extreme portfolios is very small. The VW average 1-month holding period return on portfolio IV1 is 0.98%, while the return on portfolio IV5 is 0.73%. The return difference between portfolio IV5 and portfolio IV1 is only  $-0.25\%$ , which is insignificant. This result indicates that the negative relation between idiosyncratic volatility and portfolio returns does not hold once we control for both firm size and past returns.<sup>12</sup> The results suggest that controlling for past returns alone cannot control for the size effect simultaneously, i.e., it may lead to different size distributions among idiosyncratic volatility-sorted portfolios. Although conventional two-way sorting indicates that the volatility effect largely remains after controlling for past returns, it does not reveal the real reason behind the negative relation and is insufficient in the current scenario since it ignores the important role of firm size in determining the VW portfolio returns.

If, indeed, it is the return reversal rather than idiosyncratic volatility that causes the VW return difference in idiosyncratic volatility-sorted portfolios, the return difference between the past return-sorted portfolios should remain significant even after we control for firm size and idiosyncratic volatility. In Panel B of Table 8, we perform another triple-sorting based on firm size, idiosyncratic volatility, and past returns. We first control for firm size and idiosyncratic volatility, and then form quintile portfolios based on the stock returns

**Table 8** Characteristics of portfolios sorted by idiosyncratic volatility (past returns) controlling for size and past returns (size and idiosyncratic volatility).

Portfolios	VW holding period return	VW formation period return	VW-IV	Size
<i>Panel A: Idiosyncratic volatility-sorted portfolios</i>				
IV1	0.98	1.64	3.57	4.22
IV2	1.10	1.47	5.09	4.29
IV3	1.04	1.44	6.41	4.20
IV4	0.99	1.51	8.17	4.13
IV5	0.73	2.17	12.63	4.02
IV5-IV1	-0.25 (-1.17)			
<i>Panel B: Past return-sorted portfolios</i>				
P1	1.27	-7.87	6.36	4.09
P2	1.03	-2.38	6.06	4.11
P3	0.96	1.15	6.02	4.20
P4	0.82	4.80	6.04	4.27
P5	0.76	11.25	6.32	4.22
P5-P1	-0.51 (-3.82)			

*Note:* In Panel A (Panel B), we first sort stocks based on size and then, within each size quintile, we sort stocks into five portfolios based on the formation month return (idiosyncratic volatility). This yields 25 size-past return (size-idiosyncratic volatility) portfolios. Finally, within each size-past return (size-idiosyncratic volatility) portfolio, we sort stocks based on idiosyncratic volatility (formation month returns). The five idiosyncratic volatility (past return-sorted) portfolios are then averaged over each of the 25 size-past return (size-idiosyncratic volatility) portfolios. Portfolio IV1 (IV5) is the portfolio of stocks with the lowest (highest) idiosyncratic volatility. P1 contains past losers and P5 contains past winners. VW Holding Period Return denotes value-weighted average monthly returns measured in percentage terms during the holding period. VW Formation Period Return is value-weighted average formation month returns. The VW-IV is the value-weighted idiosyncratic volatility of each portfolio in the formation period. The weights are based upon the stock's market capitalization at the end of the previous month. Size is the average of log market capitalizations of firms within each portfolio in the formation month. The row "IV5-IV1" ("P5-P1") refers to the difference in monthly returns between portfolio IV5 and portfolio IV1 (portfolio P5 and portfolio P1). Newey-West (1987) robust *t*-statistics are reported in parentheses. The sample period is from July 1963 to December 2007.

in the previous month. The five past return-sorted portfolios are constructed from each of the 25 size- and idiosyncratic volatility-sorted portfolios that have the same ranking on the past 1-month returns.

Panel B of Table 8 shows the VW average returns for the five previous return-sorted portfolios after controlling for firm size and idiosyncratic volatility. Although firm size and idiosyncratic

volatility are roughly the same across all five portfolios, the VW average holding month return decreases monotonically from 1.27% in portfolio P1 (the portfolio of past loser stocks) to 0.76% in portfolio P5 (the portfolio of past winner stocks). The difference in monthly returns between portfolio P5 and portfolio P1 is -0.51%, which is significant. This finding again confirms that the negative relation between idiosyncratic volatility and subsequent VW portfolio returns are driven by

return reversals rather than idiosyncratic volatility itself.

### 4.3 Cross-sectional evidence

Our portfolio analyses have confirmed that across the portfolios sorted on idiosyncratic risk, there is a negative relation between realized idiosyncratic volatility in the portfolio formation month and VW portfolio returns in the portfolio holding month. The relation is not significant if we use EW portfolio returns instead. Short-term return reversals play an important role in understanding these different relations. In this subsection, we investigate the relation between the realized idiosyncratic volatility and future stock returns for the cross-section of stocks.<sup>13</sup> Different from Huang *et al.* (2010), in which they conduct cross-sectional regression with idiosyncratic volatility estimated from different models and examine how the magnitude of the omitted variable bias varies with different idiosyncratic risk measures, we run cross-sectional regressions for winner and loser stocks separately, and furthermore, we investigate whether there is variation in the relation between

idiosyncratic volatility and future stock returns for the month of January and for other months.

For this purpose, we run Fama–MacBeth (1973) regressions of the cross-section of stock returns on realized idiosyncratic volatility and other explanatory variables month-by-month and calculate time-series averages of the coefficients:

$$R_{i,t+1} = X_{i,t}\beta_t + \gamma_t\sigma_t(\varepsilon_{i,t}) + \varepsilon_{i,t+1}, \quad (2)$$

where  $R_{i,t+1}$  is stock  $i$ 's return in month  $t + 1$ , and  $X_{i,t}$  is a vector of firm characteristics that are observable or measurable in month  $t$ . The first element in this vector is a constant.  $\sigma_t(\varepsilon_{i,t})$  is the monthly realized idiosyncratic volatility for stock  $i$  in month  $t$ , calculated from the standard deviation of daily residuals as in Eq. (1). Using these regressions, we evaluate how idiosyncratic risk is related to future stock returns and the impact of previous stock returns on this relation, in addition to beta, firm size, and book equity to market equity ratio as identified by Fama and French (1992). We also consider the effect of other variables such as momentum, liquidity, and idiosyncratic skewness.<sup>14</sup> In Table 9, we report the results for

**Table 9** Relation between idiosyncratic risk and expected returns: cross-sectional evidence.

Stocks	Intercept	Beta	Size	B/M	IV	Ret(−1)
<i>Panel A: All months</i>						
All stocks	2.17	0.05	−0.16	0.23	−0.02	
	(7.55)	(0.49)	(−4.13)	(3.47)	(−3.02)	
	1.77	0.03	−0.09	0.30	−0.01	−0.08
	(6.38)	(0.23)	(−2.42)	(4.19)	(−0.73)	(−13.58)
Losers	−0.85	5.07	−0.47	0.08	0.03	
	(−0.21)	(1.08)	(−4.05)	(0.50)	(1.60)	
	−2.38	4.84	−0.39	0.25	−0.05	−0.13
	(−0.59)	(1.02)	(−3.17)	(1.00)	(−1.28)	(−2.81)
Winners	1.47	−2.04	0.26	0.17	−0.10	
	(1.19)	(−1.33)	(0.68)	(0.78)	(−2.00)	
	1.94	−2.29	0.22	0.54	−0.02	−0.04
	(1.57)	(−1.48)	(0.57)	(1.30)	(−0.24)	(−1.61)

**Table 9** (Continued)

Stocks	Intercept	Beta	Size	B/M	IV	Ret(-1)
<i>Panel B: January</i>						
All stocks	8.67	1.13	-1.31	0.43	0.10	
	(6.88)	(3.00)	(-5.23)	(1.48)	(1.79)	
	7.17	1.27	-1.02	0.61	0.12	-0.17
	(6.92)	(3.30)	(-5.21)	(2.21)	(2.12)	(-8.46)
Losers	11.33	0.23	-1.93	-0.00	0.18	
	(5.03)	(0.11)	(-4.24)	(-0.00)	(2.07)	
	6.92	0.15	-1.68	0.12	0.14	-0.26
	(3.62)	(0.07)	(-4.24)	(0.32)	(1.67)	(-4.64)
Winners	7.61	0.77	-1.01	-0.91	-0.24	
	(5.52)	(1.67)	(-3.56)	(-0.62)	(-0.95)	
	8.99	0.13	-1.02	-0.01	-0.13	-0.11
	(8.15)	(0.19)	(-3.94)	(-0.02)	(-0.69)	(-2.23)
<i>Panel C: NonJanuary months</i>						
All stocks	1.59	-0.05	-0.05	0.22	-0.04	
	(5.67)	(-0.44)	(-1.49)	(3.04)	(-4.31)	
	1.29	-0.09	-0.00	0.27	-0.02	-0.07
	(4.67)	(-0.75)	(-0.14)	(3.69)	(-2.11)	(-11.98)
Losers	-1.96	5.51	-0.34	0.08	0.02	
	(-0.45)	(1.07)	(-2.75)	(0.50)	(0.91)	
	-3.23	5.27	-0.27	0.26	-0.07	-0.11
	(-0.74)	(1.02)	(-2.07)	(0.97)	(-1.57)	(-2.30)
Winners	0.92	-2.29	0.37	0.27	-0.09	
	(0.72)	(-1.41)	(0.91)	(1.41)	(-1.80)	
	1.31	-2.51	0.33	0.59	-0.01	-0.04
	(1.02)	(-1.52)	(0.80)	(1.32)	(-0.12)	(-1.42)

*Note:* This table reports the average coefficients in the Fama–MacBeth cross-sectional regressions for all NYSE/AMEX/NASDAQ individual stocks, loser stocks, and winner stocks over the period from July 1963 to December 2007. In each panel, we further report regression coefficients in all months (Panel A), in January (Panel B) and nonJanuary months (Panel C), respectively. Loser (Winner) stocks are defined as stocks with the bottom (top) 20% returns in the portfolio formation month. Intercept is the constant item in the regressions. Beta is estimated using the 100 size/beta double-sorted portfolios following Fama and French (1992). Size is the log of market capitalization and B/M is the log of book-to-market in the previous month as defined in Fama and French (1992). IV is the realized idiosyncratic volatility, computed using standard deviation of daily residuals over the previous month, where the residuals are generated from the Fama and French (1993) model. Ret(-1) is the individual stock return during the previous month. Returns and idiosyncratic volatilities are in percentages. We run cross-sectional regressions every month and report the time-series averages of the coefficients. The *t*-statistics are reported in parentheses. The *t*-statistics for beta are adjusted using the Shanken (1992) correction factor. The *t*-statistics for the other variables are Newey–West (1987) consistent.

both winners and losers stock portfolios and for January and nonJanuary months.

Panel A reports the time-series averages of the estimated coefficients over all months. For the cross-section of all stocks, there is a significantly negative relation between realized idiosyncratic volatility and stock returns in the next month. However, the negative relation becomes insignificant after stock return in the past month is controlled for. This result, based on the sample period from July 1963 to December 2007, is consistent with the evidence in Huang *et al.* (2010), whose sample period is between July 1963 and December 2004. However, this relation is different between winner and loser stock portfolios. While the negative relation holds for winner stocks (stocks in the top 20% returns in the formation month), for loser stocks (stocks in the bottom 20% returns in the formation month), there is a positive relation between idiosyncratic risk and stock returns. Furthermore, for winner stocks as well as for all stocks, the negative relation between realized idiosyncratic risk and stock returns in the subsequent month become insignificant once we control for previous month stock returns. The result suggests that the return reversal of winner stocks is a crucial contributing factor to the negative relation.

Panels B and C of Table 9 report the results for January and nonJanuary months. The results for January and nonJanuary months are strikingly different. For January, we observe a significantly (at the 10% level) positive relation between realized idiosyncratic volatility and stock returns for all stocks. This significantly positive relation holds after the past 1-month return is controlled for. A further analysis of winner and loser stock portfolios suggests that the positive relation is caused by the loser stocks because for winner stocks, there is a weakly negative relation. Consistent with the January size effect in previous literature,

we document an extremely strong size effect in January as the coefficients on size variable are much larger when compared with other months. As for nonJanuary months in Panel C, on the other hand, there is a negative relation between realized idiosyncratic volatility and stock returns for all stocks. The *t*-statistic of the coefficient on idiosyncratic risk is much smaller, but it is still significant after the past 1-month return is controlled for. Similarly, results for winners and losers indicate that the negative relation is driven by the winner stocks because for loser stocks the relation is weakly positive.

Overall, these results suggest that the relation between realized idiosyncratic volatility and stock returns in the subsequent month is conditional on whether stocks are losers or winners in the portfolio formation month and whether the returns are over the month of January or other months. In spite of these different findings, Panels B and C show that for both losers and winners in January and nonJanuary months realized idiosyncratic risk is no longer related to future stock returns after we control for stock returns in the previous month. This is consistent with what we find in Panel A.

To examine the robustness of the results, we also investigate the relation over different subsamples and sample periods. First, we include only NYSE/AMEX stocks. Panel A of Table 10 shows that when stock return in the previous month is included in the regression to capture the effect of return reversals, the negative relation is much weaker between realized idiosyncratic volatility and future stock returns.<sup>15</sup> As in Table 9, we find that the negative relation is driven by winners rather than losers. However, the relation is insignificant for winner stocks once we control for previous month stock returns.

Second, we examine the relation across business cycles. We conduct the same regression

**Table 10** Relation between idiosyncratic risk and expected returns: subsamples.

Stocks	Intercept	Beta	Size	B/M	IV	Ret(−1)
<i>Panel A: NYSE/AMEX stocks only</i>						
All stocks	1.99 (7.29)	0.04 (0.36)	−0.11 (−3.19)	0.21 (3.24)	−0.04 (−4.19)	
	1.65 (6.29)	0.05 (0.42)	−0.06 (−1.71)	0.26 (3.80)	−0.02 (−2.27)	−0.07 (−11.30)
Losers	−1.01 (−0.25)	5.03 (1.07)	−0.34 (−2.98)	0.09 (0.60)	−0.00 (−0.15)	
	−1.82 (−0.45)	4.78 (1.01)	−0.30 (−2.49)	0.21 (0.85)	−0.07 (−1.76)	−0.08 (−1.71)
Winners	0.54 (0.44)	−1.91 (−1.25)	0.39 (1.02)	0.18 (0.84)	−0.10 (−1.99)	
	1.03 (0.84)	−2.13 (−1.37)	0.34 (0.90)	0.56 (1.35)	−0.02 (−0.27)	−0.04 (−1.53)
<i>Panel B: NBER contraction periods</i>						
All stocks	2.18 (2.46)	−0.17 (−0.51)	−0.12 (−1.06)	0.32 (2.14)	−0.04 (−1.55)	
	1.55 (1.90)	−0.16 (−0.41)	−0.02 (−0.14)	0.45 (2.84)	−0.01 (−0.59)	−0.10 (−7.23)
Losers	2.87 (2.40)	0.36 (1.02)	−0.43 (−2.47)	0.27 (1.28)	0.05 (1.76)	
	−0.85 (−0.65)	0.27 (0.79)	−0.29 (−1.73)	0.45 (2.26)	−0.00 (−0.14)	−0.21 (−5.12)
Winners	2.02 (1.73)	−0.52 (−1.16)	0.05 (0.35)	0.55 (3.09)	−0.10 (−4.79)	
	2.32 (1.93)	−0.63 (−1.48)	0.05 (0.35)	0.47 (2.36)	−0.08 (−3.25)	−0.01 (−0.40)
<i>Panel C: NBER expansion periods</i>						
All stocks	2.17 (7.34)	0.08 (0.77)	−0.16 (−4.00)	0.22 (3.01)	−0.02 (−2.61)	
	1.80 (6.26)	0.05 (0.46)	−0.10 (−2.52)	0.28 (3.59)	−0.01 (−0.55)	−0.08 (−12.14)
Losers	3.32 (4.55)	0.32 (0.68)	−0.48 (−3.65)	0.05 (0.30)	0.03 (1.34)	
	2.08 (2.55)	0.07 (0.10)	−0.40 (−2.92)	0.23 (0.80)	−0.06 (−1.28)	−0.11 (−2.28)
Winners	1.39 (0.99)	−2.26 (−1.29)	0.29 (0.67)	0.11 (0.47)	−0.11 (−1.77)	
	1.89 (1.35)	−2.53 (−1.43)	0.24 (0.55)	0.55 (1.16)	−0.01 (−0.12)	−0.05 (−1.58)

*Note:* This table reports the average coefficients in the Fama–MacBeth cross-sectional regressions for all stocks, loser stocks, and winner stocks in different subsamples. The sample period is from July 1963 to December 2007. Panel A is for NYSE/AMEX stocks only. Panels B and C are for NBER contraction and expansion periods, classified according to NBER's dating of business cycles. Loser (Winner) stocks are defined as stocks with the bottom (top) 20% returns in each subsample in the portfolio formation month. All variables are defined the same as in Table 9. The *t*-statistics are reported in parentheses. The *t*-statistics for beta are adjusted using the Shanken (1992) correction factor. The *t*-statistics for the other variables are Newey–West (1987) consistent.

analysis over NBER contraction and expansion periods, where the classification follows the NBER's dating of business cycles. Results are reported in Panels B and C of Table 10. During the sample period from July 1963 to December 2007, there are 65 contraction months and 469 expansion months. Our results show that in contraction periods, the relation between realized idiosyncratic volatility and stock returns in the subsequent month is insignificant for all stocks and losers, regardless of whether previous stock returns are included. The negative relation only happens to the winner stocks. It is weaker with past stock returns included, though still significant. In expansion periods, we document the negative relation for all stocks and winners. Consistent with our results in Table 9, the negative relation is no longer significant after we control for stock returns in the previous month.

A fundamental question is that why the relation between realized idiosyncratic volatility and future stock returns depends on stock performance in the previous month. One potential explanation is the limits of arbitrage explanation proposed by Shleifer and Vishny (1997) who suggest that idiosyncratic risk is a large cost for risk-averse arbitrageurs. Pontiff (2006) demonstrates that idiosyncratic risk is the single largest cost faced by arbitrageurs. In particular, they face higher cost of buying and selling stocks with high idiosyncratic risk. Han and Kumar (2010) show that the negative relation is stronger among stocks with higher arbitrage costs. Our portfolio analyses show that the stock portfolio with the highest idiosyncratic risk contains both extreme winners and losers. Their idiosyncratic risk deters arbitrageurs from buying past losers and short selling past winners. Therefore, we find that there is a positive relation between idiosyncratic risk and stock returns for losers, while the relation is negative for winners.

Our results are also consistent with the short-sale constraint explanation in Boehme *et al.* (2009). They show that when short-sale constraints are present, there is a negative relation between realized idiosyncratic volatility and future stock returns; and when short-sale constraints are absent, the relation is positive. Similarly, Duan *et al.* (2010) show that the negative relation holds among stocks with high short interest. Since past winner stocks are on average overvalued and they may face short-sale constraint in practice, their high idiosyncratic risk leads to low returns in the future. In contrast, past loser stocks generally are undervalued and therefore do not have the short-sale constraint, their future returns increase with their idiosyncratic risk.<sup>16</sup>

## 5 Conclusion

The relation between idiosyncratic volatility and stock returns remains an interesting topic for financial economists. On the firm level, the positive relation has been confirmed by Malkiel and Xu (2002), Spiegel and Wang (2006), Chua *et al.* (2010), Fu (2009), and Huang *et al.* (2010). On the portfolio level, however, the relation between the two remains unresolved. Ang *et al.* (2006, 2009) document that portfolio with high monthly idiosyncratic volatility delivers low VW average return in the next 1 month, suggesting a negative relation between idiosyncratic risk and stock returns. Bali and Cakici (2008), however, find no robust, significant relation between idiosyncratic volatility and portfolio returns. Furthermore, they find that the relation is not consistent under different choices of weight schemes in computing portfolio returns. Doran *et al.* (2008) show that the negative relation holds only in nonJanuary months. While these results identify an interesting "puzzle," the cause of the different relations is unknown.

In this paper, we demonstrate that both the negative relation between idiosyncratic volatility and

VW portfolio returns and no relation between idiosyncratic volatility and EW portfolio returns are driven by short-term return reversals. In particular, we observe that nearly half of the stocks in the portfolio with the highest idiosyncratic volatility are either winner stocks or loser stocks. The winners are relatively larger cap stocks than the losers in the portfolio formation period. Both winner and loser stocks experience significant return reversals, which drive down the VW return on the portfolio in the following month and cause the negative relation to appear. In contrast, there is no significant difference between the EW idiosyncratic volatility-sorted portfolio returns because return reversals experienced by winner and loser stocks offset each other.

More importantly, we document the seasonality of the relation. We find that there are more loser stocks than winner stocks in the highest idiosyncratic volatility portfolio formed in December. Loser stocks experience extremely strong return reversals in January. Returns on previous winner stocks are not low in January due to the small-firm-in-January effect. These effects combined together leads to the positive relation between idiosyncratic volatility and portfolio returns in January.

In the absence of return reversals for longer holding periods, there is no negative relation between idiosyncratic volatility and portfolio returns, regardless of VW or EW portfolio returns. Our evidence from idiosyncratic volatility-sorted portfolios that control for both size and past returns also suggest that negative VW return difference is driven by short-term return reversals of the stocks in the highest idiosyncratic volatility portfolio, rather than idiosyncratic volatility itself.

Further results based on cross-sectional regressions indicate that the relation between realized idiosyncratic volatility and future stock returns

is conditional on stock returns in the previous month and the months when the relation is investigated. For past loser stocks, their future returns increase with idiosyncratic risk, while for past winner stocks, the relation is negative. However, for both stock groups in January and nonJanuary months, the relation is not significant after we control for past month stock returns. These findings are consistent with the costly arbitrage or short-sale constraint explanations in the literature.

In sum, our study highlights the role of short-term return reversals in explaining the mixed empirical evidence on the relation between stock returns and idiosyncratic risk at the portfolio level. Further research needs to be done on the economic sources of return reversals toward a better understanding of the role of idiosyncratic risk in asset pricing.

## Notes

- <sup>1</sup> In this study and the papers cited, idiosyncratic volatility is used as the proxy for idiosyncratic risk and we use the term “volatility” to denote standard deviation instead of variance.
- <sup>2</sup> We thank Kenneth French for making the data on FF three factors available.
- <sup>3</sup> We obtain qualitatively similar results when we use the standard deviation of the residuals from the capital asset pricing model and the raw returns to measure idiosyncratic volatility. Results are not reported for brevity but available upon request.
- <sup>4</sup> Bali and Cakici (2006) call the largest stocks in the tenth sub-quintile of the highest idiosyncratic volatility quintile portfolio as “biggest of small stocks” and find that their returns are much lower than those of the “smallest of small stocks” in the first sub-quintile of the same quintile portfolio.
- <sup>5</sup> Further analysis shows that the VW return of the highest idiosyncratic volatility quintile portfolio (IV5) is lower than that of lowest idiosyncratic volatility quintile portfolio (IV1) in each of the nonJanuary months. The difference is negatively significant in 8 months, except in January, February, August, and November. The EW return of IV5 is lower than that of IV1 in most of the months, except in January and February. However,

the return difference is negatively significant only in 4 months (June, July, October, and December). These results are available upon request.

- <sup>6</sup> This is more obvious if we use the volatility of the raw returns as the measure of idiosyncratic volatility. In this case, idiosyncratic volatility is simply the standard deviation of stock returns and “high volatility” means very positive returns or very negative returns, that is, winners or losers.
- <sup>7</sup> Jiang and Lee (2006) find that on average, idiosyncratic volatility is about 85% of total stock return volatility. Since winner and loser stocks often have larger total volatility, it is not surprising to find the large presence of both of them in the highest idiosyncratic volatility portfolio.
- <sup>8</sup> We report the simple (equal-weighted) average monthly returns in Panels B and C. This implies that we treat the stocks within each of the 50 idiosyncratic volatility-past return sorted portfolios as the same, and differentiate the stocks from different portfolios.
- <sup>9</sup> For the 12/1/12 strategy, each quintile portfolio changes 1/12th of its composition each month, where each 1/12th part of the portfolio consists of a value-weighted portfolio or equal-weighted portfolio. The first (fifth) quintile portfolio consists of 1/12th of the lowest (highest) idiosyncratic stocks from 1 month ago until from 12 months ago.
- <sup>10</sup> Ang *et al.* (2006) document that the negative relation between past idiosyncratic volatility and future returns still holds for a long horizon when they compare the difference in Fama–French three-factor (FF-3) alphas between value-weighted portfolio IV5 and portfolio IV1 of the above four strategies. Our analysis is based on the value-weighted or equal-weighted return difference of portfolio IV5 and portfolio IV1 over the long run.
- <sup>11</sup> Ang *et al.* (2006) show that after controlling for past returns, the difference in alphas of value-weighted portfolios sorted on idiosyncratic volatility is still significantly negative. We examine the raw return difference. We find that the equal-weighted return difference between IV5 and IV1 is insignificant, while the value-weighted return difference is significantly negative after controlling for previous-month stock returns. For idiosyncratic volatility-sorted portfolios, the average size is monotonically decreasing with idiosyncratic volatility. These results are available upon request.
- <sup>12</sup> We also conduct a triple sort based on stock price, past returns, and idiosyncratic volatility, and find qualitatively similar results, that is, the average return difference between portfolio 5 and portfolio 1 remains insignificant. This is not surprising given the high correlation (0.76) between stock price and firm size. These results are available upon request.
- <sup>13</sup> As we point out in the introduction, there is a positive relation between conditional idiosyncratic volatility and expected returns for the cross-section of stocks. This has been documented in Malkiel and Xu (2002), Spiegel and Wang (2006), Chua *et al.* (2009), Fu (2009), and Huang *et al.* (2010). In this subsection we still use realized idiosyncratic volatility as the proxy for idiosyncratic risk as in the portfolio analyses.
- <sup>14</sup> We also include other control variables such as momentum and liquidity, etc. in the regressions and our results are qualitatively similar. In particular we consider the effect of idiosyncratic skewness proposed in Mitton and Vorkink (2007). They argue that some investors prefer stocks with positive skewness so that they choose to hold less than well-diversified portfolios in equilibrium. Our empirical results indicate that idiosyncratic skewness is not significantly related to stock returns and it does not change the relation between realized idiosyncratic volatility and future stock returns. These results are available upon request.
- <sup>15</sup> Huang *et al.* (2010) find that the negative relation becomes insignificant after stock return in the past month is controlled for with the NYSE/AMEX stocks in the sample period from July 1963 to December 2004. Our results show that the negative relation becomes much weaker, though still significant when NASDAQ stocks are excluded in the extended sample period till December 2007.
- <sup>16</sup> There are some other explanations to the negative relation documented in Ang *et al.* (2006). For example, Jiang *et al.* (2009) suggest that it is induced by the information of future earnings contained in idiosyncratic volatility; Boyer *et al.* (2010) show that the expected idiosyncratic skewness explains the negative relation; George and Hwang (2009) demonstrate that the negative relation exists only among stocks with low analyst coverage. Our focus in this section is to understand why different relations hold for winner and loser stocks with high idiosyncratic volatility.

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