Original Article

Do funds follow post-earnings announcement drift?

Received (in revised form): 10th June 2012

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Data Availability: The data used in this study are publicly available from the sources indicated in the text.

ABSTRACT **We show that actively managed US hedge funds, on average, trade on the post-earnings announcement drift anomaly more aggressively than mutual funds. Both mutual and hedge funds that actively trade on drift anomaly face higher arbitrage risk. However, arbitrage risk reduces mutual funds' willingness to buy high-SUE stocks with high return volatility, but not hedge funds.**

Journal of Derivatives & Hedge Funds (2012) **18,** 236–253. doi:10.1057/jdhf.2012.11

Keywords: hedge funds; mutual funds; post-earnings announcement drift; arbitrage risk; mispricing

INTRODUCTION

We investigate whether hedge fund managers trade on the post-earnings announcement drift (hereafter PEAD). Similar to mutual funds, hedge funds are actively managed pools of money that hold investment positions in publicly traded securities. Unlike mutual funds, however, hedge funds are largely unregulated, are subject to far less oversight by regulatory bodies and enjoy a greater level of flexibility in higher risk investment strategies that involve taking undiversified positions. Using hand-collected data on hedge fund holdings and Ali *et al* (2008)'s approach to measure the covariance of fund trading decisions with standardized unexpected earning (hereafter SUE) of the securities, we show that both mutual and hedge funds trade consistent with the PEAD anomaly. Our results indicate that hedge fund managers follow a more aggressive investment strategy based on the PEAD anomaly compared with mutual fund managers.

We show that both mutual and hedge funds actively trading on the PEAD anomaly face higher arbitrage costs, measured by high return volatility. However, arbitrage risk affects mutual and hedge fund investment decisions differently. Arbitrage risk reduces mutual fund managers' willingness to buy high-SUE stocks with high return volatility, but it does not have the same effect on mutual funds.

Our findings are consistent with arguments articulated in Shleifer and Vishny (1997), who provide an insight to evaluate the arbitrage risk differentiation between mutual and hedge funds. In their study, Shleifer and Vishny examine the professional arbitrage whose fundamental feature is an agency relationship that separates the professional/arbitrageur who possesses highly specialized knowledge from outside stakeholders who give their money to the professional to invest. Investors may infer from a poor, short-term return that the professional is not competent and may withdraw their money. Shleifer and Vishny (1997) refer to this investor responsiveness to performance as performance-based arbitrage. Although volatile markets are attractive for arbitrage because high return volatility is associated with more frequent extreme prices, mutual fund professionals avoid these volatile positions owing to the fear of a future outflow of funds in the case of a possible adverse price movement. Performance-induced money outflows are more aggressive for mutual funds than for hedge funds. Hedge funds have contractual restrictions on withdrawals, meaning that investors are not allowed to pull out money for 1–3 years. Because money is locked in their funds, hedge fund professionals are less concerned about the short-term return volatility associated with their investment strategies such as PEAD.

The remainder of the article is organized as follows: The next section describes the sample and variables. The subsequent section explains the research design and provides the main empirical results demonstrating whether mutual and hedge funds trade on the anomaly. We present concluding remarks in the final section.

DATA

Hedge fund sample

We use hand-collected hedge fund stockholding data in our research. Hedge fund holding data are very difficult to construct because hedge funds are not required to disclose their performance. Existing databases report only hedge funds that voluntarily report to data vendors. This introduces three sources of biases: self-selection, survivorship and backfilling (instant history). A self-selection bias exists because funds with good performance are more likely to choose to be included in a database. The survivorship bias arises in the following two cases: (i) data vendors stop disclosing information about liquidated funds and report only information about surviving funds; (ii) successful hedge funds stop voluntary disclosures after reaching a target asset size because they would no longer need to continue advertising. The backfilling bias occurs when hedge funds choose to enter a database only after a good performance, which means that a fund's past performance would impose a selective view of the fund's position. The hand-collected data set we use comes from the mandatory quarterly holding disclosures made to the SEC. Using mandatory disclosures partially addresses the problems of self-selection, survivorship and instant history biases in the data.[1,2]

We follow Aragon and Martin (2009) in constructing the hedge fund holding sample. The sample covers the period from the first quarter of 2001 until the last quarter of 2007. The sample contains 8192 fund-quarter observations of 621 unique hedge funds. The average market value of shares held by the funds is US$321 972 109 throughout the sample period. There is a steady increase in the number of unique hedge funds over the sample period. The number of distinct hedge funds in the sample increased from 163 in 2000 to 564 in 2007. In contrast, the number of unique securities held by hedge funds remains roughly the same over the sample period. The hedge funds bought shares of 3939 different securities in 2001; 3768 different securities in 2002; 4118 different securities in 2003; 4406 different securities in 2004; 4537 different securities in 2005; 4572 different securities in 2006; and 4639 different securities in 2007.

Mutual fund sample

We merge two databases (the CRSP Survivor-Bias-Free US Mutual Fund Database and the Thomson Financial CDA/Spectrum US & Canadian Mutual Funds Holding Database) to create the mutual fund sample. Because the former database does not provide detailed information about fund holdings, the two databases are usually combined following Wermers (2000). After merging these two databases, we delete quarterly observations in which funds have total net assets of <$1 million and where the total market value of reported holdings is either less than half or more than 150 per cent of the total net assets. The merged sample contains 29 886 fund-quarter observations of 1584 unique mutual funds. The number of different mutual funds in the sample has a declining pattern throughout the sample period. The number of distinct mutual funds is 1465 for 2001; 1425 for 2002; 1320 for 2003; 1178 for 2004; 1085 for 2005; 966 for 2006; and 935 for 2007. The number of different securities held by the mutual funds remains roughly the same over the sample period.

In Table 1, we present several common characteristics of hedge and mutual fund sample in order to enhance the level of comparison of the two samples. The market value of securities held by the funds is approximately $1.145 billion for mutual funds and $322 million for hedge funds. The mean number of stocks held in a mutual fund is 228, and the mean is 244 for a hedge fund. The median numbers for a mutual and hedge fund are 154 and 115, respectively.

SUE investing measure (SIM)

Our variable to measure the extent to which a mutual or hedge fund manager trades consistent

Table 1: Comparison table for fund characteristics

	Mutual funds	*Hedge funds*
Number of funds	1584	621
Number of fund-quarter observations	29 186	8192
Market value of holdings	1144.68	321.97
Number of stocks held – Mean	228	244
Number of stocks held – Median	154	115

Note: This table reports summary statistics for mutual and hedge funds samples.

with exploiting the PEAD anomaly relies on the level of covariance of fund manager trading decisions with SUE of the securities. Formally, we compute it by adding the product of standardized SUEs with active changes in fund portfolio weights over N, the total number of unique stocks held by the fund i in quarter t and $t-k$, that is, following Ali *et al* (2008) we define SIM as follows:

$$SIM_{i,t} = \sum_{j=1}^{N} (w_{i,j,t} - \tilde{w}_{i,j,t-k}) \frac{SUE_{j,t} - \mu_t(SUE)}{\sigma_t(SUE)} \quad (1)$$

where

$$SUE_{j,t} = \frac{E_{j,t} - E_{j,t-4} - mean_{j,t}}{\sigma_{j,t}}$$

$E_{j,t}$ and $E_{j,t-4}$ are the quarterly earnings per share reported during quarter t and $t-4$[3]; $mean_{j,t}$ is the time series mean of earnings surprise $(E_{j,t}-E_{j,t-4})$; $\sigma_{j,t}$ is the time-series standard deviation of earnings surprise $(E_{j,t}-E_{j,t-4})$; $\mu_t(SUE_{j,t})$ and $\sigma_t(SUE_{j,t})$ are the cross-sectional mean and standard deviation of SUE; $(w_{i,j,t}-\tilde{w}_{i,j,t-k})$ is the deviation of fund i's portfolio weight on stock j in quarter t from the passive portfolio weight.

A high value of this measure indicates that fund managers actively buy stocks with high unexpected earnings and/or sell stocks with low unexpected earnings. If a fund manager deliberately trades on PEAD, then he or she increases holdings of high-SUE stocks and sells low-SUE stocks. This strategy leads to a high SIM for the fund. To control for the passive weight changes due to price changes and take only the deliberate activity of the fund manager into consideration, from portfolio weight on stock j in quarter t, we deduct $\tilde{w}_{i,j,t-k}$ (passive weight), which is defined as follows:

$$\tilde{w}_{i,j,t-k} = \frac{w_{j,t-k}(1 + R_{j,t-k,t})}{\sum_{j=1}^{N} w_{j,t-k}(1 + R_{j,t-k,t})} \quad (2)$$

where $w_{j,t-k}$ is the portfolio weight at $t-k$ and $R_{j,t-k,t}$ is the return for stock j from quarter $t-k$ to t.

In addition to SIM, following Ali *et al* (2008), to better capture the degree to which the fund managers intentionally trade on the anomaly we also calculate the rolling averages of over quarter $t-3$ to quarter t. We refer to these rolling averages as SIM4. This procedure reduces the likelihood of a fund being classified as one that is actively investing in drift anomaly, if it exhibits a high SIM value in a quarter just by chance.

To calculate PEAD for the 2001–2007 sample period, we take all publicly traded stocks with valid SUE observations at the end of each calculation quarter, Q0. There are 182 151 stock-quarter observations in this main sample. We sort stocks based on SUE in order to form equal-weighted decile portfolios. For each of the subsequent four quarters (expressed as Q1, Q2, Q3 and Q4), we calculate returns to the equal-weighted decile portfolios.[4]

We also create two subsamples from the main sample. The subsamples contain all the stocks actually held by mutual and hedge funds. For the sample period, there are 95 083 and 68 559 stock-quarter observations in these subsamples, successively. Similar to the portfolio creation procedure pursued for the main sample, we assign stocks into equal-weighted decile portfolios based on SUE decile breakpoints calculated earlier for the main sample.

In Table 2, Panel A, we present the average values of SUE and four successive quarterly

Table 2: SUE portfolios and returns

Stock decile	*SUE Q0*	*RET Q1*	*RET Q2*	*RET Q3*	*RET Q4*
Panel A: All stocks					
PORT1	−1.62	−0.30	0.80	0.31	1.36
PORT2	−1.04	−1.28	−0.86	0.01	0.05
PORT3	−0.67	−1.24	−1.17	−0.84	−0.28
PORT4	−0.36	−1.14	−0.90	−0.45	−0.92
PORT5	−0.12	−0.84	−0.90	−0.90	−0.62
PORT6	0.16	0.03	−0.51	−0.27	−0.56
PORT7	0.43	0.53	−0.09	−0.05	0.09
PORT8	0.67	0.76	0.67	0.01	0.11
PORT9	1.01	0.84	1.11	0.64	0.32
PORT10	1.57	1.82	2.59	2.00	1.34
PORT10–PORT1	—	2.12	1.79	1.69	−0.02
		(4.85)	(2.38)	(1.69)	(−0.64)
Panel B: Mutual fund stockholdings					
PORT1	—	0.07	0.82	0.52	1.19
PORT2	—	−1.03	−0.69	−0.01	−0.08
PORT3	—	−1.00	−1.15	−0.74	−0.39
PORT4	—	−1.15	−0.82	−0.46	−0.90
PORT5	—	−0.90	−0.93	−0.89	−0.56
PORT6	—	0.04	−0.39	−0.19	−0.62
PORT7	—	0.46	−0.08	−0.02	0.05
PORT8	—	0.63	0.56	0.07	−0.02
PORT9	—	0.76	1.05	0.43	0.52
PORT10	—	1.92	2.55	1.83	1.09
PORT10–PORT1	—	1.85	1.73	1.31	−0.10
		(3.51)	(2.54)	(1.58)	(−0.70)
Panel C: Hedge fund stockholdings					
PORT1	—	−0.81	−0.21	−0.74	0.16
PORT2	—	−1.42	−1.11	−0.31	−0.53
PORT3	—	−1.25	−1.35	−1.01	−0.3
PORT4	—	−1.16	−1.04	−0.56	−0.84
PORT5	—	−0.83	−0.86	−0.76	−0.57
PORT6	—	0.11	−0.27	−0.24	−0.43
PORT7	—	0.50	−0.07	−0.38	0.11

Table 2 *continued*

Stock decile	*SUE Q0*	*RET Q1*	*RET Q2*	*RET Q3*	*RET Q4*
PORT8	—	0.35	0.34	−0.11	−0.14
PORT9	—	0.26	0.46	0.16	−0.01
PORT10	—	0.54	1.20	0.95	0.82
PORT10–PORT1	—	1.35	1.41	1.69	0.66
		(2.05)	(2.29)	(1.54)	(0.38)

Note: This table reports mean SUE and returns in the subsequent four quarters after portfolio formation, for each SUE-sorted decile within the main sample, the mutual fund subsample, and the hedge fund subsample for the sample period 2001–2007. SUE represents forecast errors from a seasonal random walk with drift and is scaled by estimation-period (preceding eight quarters) standard deviation. A minimum of four valid observations during the estimation period is required in order to compute the time-series mean and standard deviation or earnings. The main sample contains all the securities listed in CRSP/COMPUSTAT merged database with a valid quarter-end price of no less than $1 and with valid SUE observations at the end of each calculation quarter. The mutual fund subsample contains all the stocks actually held by mutual funds in the main sample. The hedge fund subsample contains all the stocks actually held by hedge funds in the main sample. The table also reports the stock return differences between the top (PORT10) and bottom (PORT1) SUE stock deciles. All the *t*-statistics presented are computed following the Newey-West (1987)procedure with a four-quarter lag.

portfolio returns (returns for Q1, Q2, Q3 and Q4) for each equal-weighted stock deciles for the main sample. The average SUE value for the bottom decile portfolio (PORT1) is −1.62, and the value for the top decile portfolio (PORT10) is 1.57. For Q1, the difference between average returns of PORT10 (1.82) and PORT1 (−0.30) portfolios is 2.12 and is statistically significant with a *t*-value of 4.85. The difference stays positive and remains highly significant for Q2 with a difference of 1.79 and a *t*-value of 2.38. In Q3, the positive difference is slightly significant at the 10 per cent significance level, and in Q4 the pattern reverses and a negative but insignificant difference is derived.[5]

For the subsample of stocks held by mutual funds, the return spreads between PORT10 and PORT1 decile portfolios are 1.85 in Q1, 1.73 in Q2, 1.31 in Q3 and −0.10 in Q4, as seen in Table 2, Panel B. The first two spreads, as expected, are positive and significant (*t*-values are 3.51 and 2.54, respectively). The third spread is positive but insignificant (*t*-value is 1.58) and the fourth one is negative and insignificant (*t*-value is −0.70). The analysis using a hedge fund subsample (Table 2, Panel C) exhibits similar results. In Q1, the return spread is 1.35 with a *t*-value of 2.05. Q2 also presents a positive and significant return spread with a value of 1.41 (*t*-value is 2.29). Q3 has a positive and insignificant return spread and Q4 has a positive and insignificant return spread. The spreads are 1.69 and 0.66, in that order, with *t*-values of 1.54 and 0.38, respectively. Evidence in Table 2 results collectively suggest that following PEAD using all stocks and using stocks held by mutual and hedge funds was profitable during the sample period.

RESEARCH DESIGN AND EMPIRICAL RESULTS

Trading based on the PEAD anomaly

In Table 3, we test whether fund managers on average trade on the drift anomaly. To do so, we compute time-series averages of the cross-sectional distributional statistics of SIMs and SIM4s. Table 3, Panel A, shows that for mutual funds the mean and median of SIM is 0.94 and 0.30 per cent, respectively. The mean of SIM is significant with a *t*-value of 11.38. The mean and median of SIM4 are 0.83 per cent ($t = 5.86$) and 0.33 per cent, respectively. SIM and SIM4 values in this table suggest that mutual fund managers, on average, trade consistent with the PEAD anomaly. We get stronger results for hedge funds than for mutual funds. The mean and median of SIM is 1.31 per cent (*t*-value = 4.34) and 0.43 per cent, respectively. The mean of SIM4 is significant (*t*-value = 3.25) with a value of 1.26 per cent. The median value of SIM4 is 0.42 per cent. On average, hedge funds have higher SIM and SIM4 values compared with mutual funds. The mean difference between mutual fund SIM and hedge fund SIM is −0.37 with a *t*-value of −1.79. For SIM4, the mean difference of −0.43 is also significant (*t*-value = −2.05). These results suggest that the covariance of both mutual and hedge trading decisions with SUE of the securities is positive, indicating that both types of fund managers trade on the PEAD anomaly and that hedge fund managers are more aggressive when they are involved in PEAD anomaly-based investment strategies.

Persistence of trading based on the PEAD anomaly

To argue that fund managers actively trade with the drift anomaly in mind and that the

Table 3: Descriptive statistics of SIMs

	5%	*25%*	*Mean*	*Median*	*75%*	*95%*	*STD*
Panel A: Mutual fund							
SIM	−20.15	−3.44	0.94	0.30	4.62	24.41	14.67
			(11.38)				
SIM4	−20.74	−5.33	0.83	0.33	6.64	23.8	13.9
			(5.86)				
Panel B: Hedge fund							
SIM	−30.77	−8.50	1.31	0.43	11.19	34.92	18.93
			(4.34)				
SIM4	−29.96	−8.28	1.26	0.42	10.29	34.48	18.37
			(3.25)				

Note: This table reports the cross-sectional summary statistics for the SUE investing measures, SIM and SIM4, across all funds for the sample period 2001–2007. The summary statistics include mean and median values; values at the 5th, 25th, 75th and 95th percentiles, along with the standard deviation. SIM is the covariance between active weight changes and cross-sectional standardized SUEs. All the *t*-statistics presented are computed following the Newey-West (1987)procedure with a four-quarter lag.

documented results are not merely the consequences of a lucky guess, we further examine the persistence of the trading based on this anomaly. High-SIM4 funds, which intentionally use the PEAD anomaly in their decisions, should experience high SIM values in the subsequent quarters (quarters Q1 through Q4 are considered). We sort funds into deciles based on their SIM4 values at Q0. Top-decile (DECILE10) funds have the highest SIM4 values. In addition, we select one-tenth of the funds with SIM4 values closest to and centered around 0 and refer to them as INACTIVE funds.

In Table 4, Panel A, we document SIM values (in Q1 through Q4) of each of the mutual fund deciles. For the mutual funds, the top-decile fund managers trade persistently on the PEAD anomaly. The average SIM values are 6.11, 6.08, 5.95 and 5.81, respectively, for the subsequent four quarters. The values are significantly >0 in all quarters, suggesting that managers of high SIM4 funds trade deliberately on the drift anomaly.

In Table 4, Panel B, we conduct the same analysis for hedge funds. According to the reported values, top-decile funds persistently follow an investment strategy that is consistent with the PEAD anomaly. In both panels of Table 4, we observe a decline in the value of SIM4 in Q1 for highest-SIM4 decile funds when we consider the subsequent values of SIM in Q1 through Q4. A smaller decline in value for hedge funds (Table 4, Panel B) compared with the mutual funds (Table 4, Panel A) demonstrates that hedge fund managers are more likely to trade on the PEAD anomaly and that the number of fund managers who persistently trade on the drift anomaly is higher for hedge funds. In other words, the higher the value decrease from SIM4 to subsequent SIM values, the higher the number of funds that have higher SIM4 values by chance.

In the analysis we presented up to this point, we do not control for other well-documented anomalies such as momentum, size and book-to-market. If returns to these anomalies are correlated with SUE strategy, omitting covariance of a fund's trading strategies with these anomalies may affect our results. We run the following Fama-MacBeth (1973) regression in order to control for the influence of other market anomalies on our results:

$$SIM_k = \sum_{i=1}^{10} DECILE_{i,0} + BM4 + SIZE4 + MOMENTUM4 + e_i \quad (3)$$

where the dependent variable, SIM_k, is SIM values for subsequent quarters Q1 to Q4. $DECILE_{i,0}$ is the indicator variable that takes a value of one for each decile i created at quarter Q0 and a value of 0 for other deciles. e_i is the error term. This model allows us to get a different intercept for each decile. To control for three market anomalies (price momentum, size and book-to-market), we create three investment measures, BM_0, $SIZE_0$ and $MOMENTUM_0$ as follows:

$$X_{i,t} = \sum_{j=1}^{N} (w_{i,j,t} - \tilde{w}_{i,j,t-k}) \frac{X_{j,t} - \mu_t(X)}{\sigma_t(X)} \quad (4)$$

where X is the book-to-market ratio (BM) or the log of market capitalization ($SIZE$) at Q0, or stock returns 12 months before Q0 ($MOMENTUM$). $\mu_t(X_{j,t})$ and $\sigma_t(X_{j,t})$ are the cross-sectional mean and standard deviation over all stocks included in the sample with valid SUE observations during the calendar quarter of earnings announcement. $(w_{i,j,t} - \tilde{w}_{i,j,t-k})$ is calculated in the same way as in equation (2).

Table 4: Persistence of SIMs

SIM4 decile	*SIM4*	*SIM Q1*	*SIM Q2*	*SIM Q3*	*SIM Q4*
Panel A: Mutual fund					
DECILE1	−22.84	−2.20	−2.04	−2.01	−2.26
	(−11.93)	(−4.41)	(−4.31)	(−4.07)	(−4.38)
DECILE2	−9.67	−1.22	−1.28	−1.37	−1.16
	(−8.30)	(−3.22)	(−3.38)	(−3.50)	(−2.96)
DECILE3	−5.11	−1.24	−1.10	−1.00	−0.95
	(−5.26)	(−3.67)	(−3.06)	(−2.70)	(−2.45)
DECILE4	−2.45	−0.63	−0.55	−0.68	−0.71
	(−2.56)	(−2.07)	(−1.58)	(−1.87)	(−1.91)
DECILE5	−0.56	−0.10	−0.29	−0.25	−0.06
	(−0.73)	(−0.38)	(−0.99)	(−0.74)	(−0.16)
DECILE6	1.24	0.59	0.75	0.43	0.45
	(0.80)	(1.98)	(2.09)	(1.19)	(1.14)
DECILE7	3.35	1.49	1.56	0.78	1.21
	(3.73)	(4.25)	(4.05)	(1.88)	(2.83)
DECILE8	6.46	2.58	2.66	2.25	2.34
	(4.79)	(6.10)	(6.82)	(5.56)	(6.07)
DECILE9	11.74	4.63	4.81	4.54	4.06
	(8.97)	(8.06)	(8.23)	(7.56)	(7.21)
DECILE10	26.00	6.11	6.08	5.95	5.81
	(13.14)	(9.31)	(8.92)	(8.99)	(8.10)
INACTIVE	0.00	0.20	0.56	0.34	0.40
	(−0.20)	(0.18)	(0.32)	(0.16)	(0.30)
Panel B: Hedge fund					
DECILE1	−38.18	−6.86	−6.67	−6.15	−6.44
	(−15.55)	(−3.23)	(−3.46)	(−2.82)	(−3.21)
DECILE2	−24.07	−4.22	−4.34	−4.12	−3.88
	(−15.55)	(−3.28)	(−2.73)	(−2.81)	(−2.38)
DECILE3	−11.7	−3.59	−3.53	−3.76	−3.22
	(−13.26)	(−3.01)	(−2.84)	(−2.06)	(−1.62)
DECILE4	−5.11	−2.36	−2.42	−2.68	−1.96
	(−10.26)	(−2.19)	(−1.90)	(−2.56)	(−1.53)
DECILE5	−1.28	−0.57	−0.40	−0.57	−1.02
	(−3.97)	(−0.82)	(−0.47)	(−0.52)	(−1.00)
DECILE6	1.80	1.35	1.26	1.00	0.32
	(4.70)	(1.15)	(0.92)	(0.69)	(0.23)

Table 4 *continued*

SIM4 decile	*SIM4*	*SIM Q1*	*SIM Q2*	*SIM Q3*	*SIM Q4*
DECILE7	5.99	2.11	1.91	2.56	2.10
	(8.14)	(1.45)	(1.72)	(1.84)	(1.38)
DECILE8	12.88	3.01	3.94	3.31	3.32
	(11.47)	(2.26)	(3.19)	(2.48)	(2.28)
DECILE9	25.37	8.22	7.43	7.98	7.47
	(13.99)	(5.50)	(4.07)	(4.21)	(3.68)
DECILE10	42.53	12.38	11.62	12.77	11.55
	(12.11)	(5.23)	(5.61)	(5.90)	(5.17)
INACTIVE	−0.02	−0.56	0.12	0.17	−0.77
	(1.15)	(−0.52)	(0.07)	(0.08)	(−0.62)

Note: This table reports average SIMs of funds during the subsequent four quarters after the fund ranking quarter for each SIM4-sorted decile. This table also reports SIM4 in the fund ranking quarter. Top-decile (DECILE10) funds have the highest SIM4 values. Ten per cent of the funds with SIM4 values closest to and centered around zero are named as INACTIVE funds. All the *t*-statistics presented are computed following the Newey-West (1987)procedure with a four-quarter lag.

After computing these variables, we take the four-quarter rolling averages and calculate *BM4*, *SIZE4* and *MOMENTUM4*. Results in Table 5 show that, after controlling for the confounding effects of other investment styles, the coefficients of both mutual and hedge funds in the top SIM4 deciles, DECILE9 to DECILE10, are significantly positive from Q1 to Q4.

Estimated transaction costs

We examine the impact of market frictions on the PEAD anomaly by considering two proxies for transaction costs. We refer these proxies as the indirect measures of estimated transaction cost. The first measure is the quarterly cross-sectional percentile rank of the Amihud (2002) illiquidity ratio (ILLIQUIDITY). The daily illiquidity ratio is the ratio of daily absolute stock return to its dollar trading volume. The illiquidity measure is a weighted average over the formation quarter, Q0, across stocks traded by a fund. The absolute dollar value of fund trades during Q0 is used as the weight.
The second measure of transaction costs is INVPRICE. INVPRICE is the inverse of the stock price at the beginning of the quarter.

We use percentile rank scores of illiquidity ratios for ILLIQUIDITY instead of raw measures. To compute the rank score on these given characteristics, we sort all the stocks separately by ILLIQUIDITY during Q0 and then assign a rank score on each characteristic, where rank lies between one (low) and 100 (high). NASDAQ and NYSE/ALTERNEXT define trading volume differently. Thus, we compute percentile ranks for stocks traded on these two stock exchanges separately.

Table 5: Regression of subsequent SIM values

	Mutual fund				*Hedge fund*			
	SIM_1	SIM_2	SIM_3	SIM_4	SIM_1	SIM_2	SIM_3	SIM_4
$DECILE_{1,0}$	−2.736	−4.011	−3.462	−2.819	−2.831	−0.032	−2.159	−3.976
	(−1.41)	(−2.15)	(−1.84)	(−1.57)	(−1.61)	(−0.02)	(−1.91)	(−1.25)
$DECILE_{2,0}$	−2.212	−1.734	−1.902	−1.762	−2.629	−1.866	−2.418	−2.803
	(−1.71)	(−1.51)	(−1.65)	(−1.57)	(−2.06)	(−1.68)	(−1.61)	(−1.56)
$DECILE_{3,0}$	−1.905	−2.078	−1.890	−1.514	−1.557	−2.214	−2.858	−1.799
	(−1.45)	(−1.79)	(−1.33)	(−1.28)	(−1.31)	(−1.52)	(−1.54)	(−1.12)
$DECILE_{4,0}$	−1.385	−1.273	−1.240	−0.121	−0.821	−2.048	−2.247	−1.207
	(−1.72)	(−1.58)	(−1.49)	(−0.08)	(−0.58)	(−1.64)	(−2.09)	(−1.19)
$DECILE_{5,0}$	−0.720	−0.754	−0.850	−0.751	−0.329	−0.374	−1.198	−0.369
	(−1.07)	(−1.14)	(−1.02)	(−0.60)	(−0.38)	(−0.52)	(−1.04)	(−0.31)
$DECILE_{6,0}$	0.060	0.249	−0.810	−2.851	1.210	1.857	2.054	0.933
	(0.11)	(0.29)	(−0.93)	(−1.01)	(1.64)	(1.59)	(1.23)	(0.79)
$DECILE_{7,0}$	0.812	0.762	0.118	0.690	0.694	1.274	0.573	0.757
	(1.66)	(0.75)	(0.14)	(0.64)	(0.53)	(0.99)	(0.39)	(0.38)
$DECILE_{8,0}$	1.629	1.966	1.302	2.176	0.890	2.187	0.551	1.855
	(1.81)	(2.71)	(1.51)	(2.61)	(0.38)	(1.73)	(0.30)	(1.21)
$DECILE_{9,0}$	3.124	3.777	3.662	3.616	2.921	5.597	4.533	5.040
	(3.69)	(8.64)	(6.37)	(4.06)	(0.70)	(2.24)	(2.34)	(1.77)
$DECILE_{10,0}$	4.077	4.484	4.685	4.716	9.193	11.091	9.804	12.003
	(6.01)	(5.57)	(6.00)	(5.41)	(2.82)	(3.26)	(1.70)	(2.51)
BM4	−1.182	−7.188	−14.019	−14.040	18.160	42.470	105.35	67.400
	(−2.54)	(−2.07)	(−3.38)	(−3.93)	(0.44)	(0.49)	(4.02)	(1.11)
SIZE4	−0.223	−0.190	−0.253	−2.481	−1.213	−0.721	−1.283	−0.599
	(−1.83)	(−1.83)	(−2.30)	(−3.10)	(−0.72)	(−0.67)	(−2.08)	(−0.57)
MOMENTUM4	63.670	66.190	32.080	32.930	38.530	12.760	36.641	19.840
	(4.44)	(6.65)	(4.86)	(1.89)	(1.17)	(0.64)	(2.86)	(0.95)
No. of Observations	18 542	16 961	15 711	14 572	4868	4373	3963	3571
Adjusted R^2	0.12	0.13	0.12	0.12	0.06	0.07	0.06	0.05

Note: This table reports the estimated coefficients from Fama-MacBeth (1973)regressions of funds' SIMs in the subsequent four quarters on dummy variables for SIM4 deciles in fund ranking quarter and BM4, SIZE4 and MOMENTUM4. $DECILE_{i,0}$ is the indicator variable that takes a value of one for each decile i created at quarter Q0 and a value of 0 for other deciles. Control variables are for three market anomalies (price momentum, size and book-to-market) and are created similar to SIM4. All the t-statistics presented are computed following the Newey-West (1987)procedure with a four-quarter lag.

Table 6: Transaction cost estimates for funds

SIM4 decile	*Mutual fund*				*Hedge fund*			
	Quarter (Q0) estimates		*Quarter 1 (Q1) estimates*		*Quarter (Q0) estimates*		*Quarter 1 (Q1) estimates*	
	ILLIQUIDITY	*INVPRICE*	*ILLIQUIDITY*	*INVPRICE*	*ILLIQUIDITY*	*INVPRICE*	*ILLIQUIDITY*	*INVPRICE*
DECILE1	24.19	0.046	24.15	0.046	26.55	0.049	26.42	0.049
DECILE2	23.87	0.042	23.77	0.042	22.66	0.046	22.33	0.044
DECILE3	23.95	0.041	23.95	0.041	21.60	0.042	21.44	0.043
DECILE4	22.68	0.04	22.49	0.041	23.55	0.047	23.27	0.046
DECILE5	18.23	0.037	18.36	0.037	18.96	0.038	19.02	0.039
DECILE6	16.79	0.035	16.87	0.036	18.10	0.037	18.70	0.039
DECILE7	20.07	0.038	19.90	0.038	19.77	0.043	19.58	0.042
DECILE8	22.00	0.04	22.15	0.041	20.97	0.046	21.38	0.047
DECILE9	21.73	0.041	21.96	0.041	21.64	0.046	22.38	0.049
DECILE10	21.10	0.043	21.03	0.044	20.51	0.047	19.96	0.049
INACTIVE	20.77	0.039	20.82	0.040	19.12	0.040	19.24	0.04
D10 – INACTIVE	0.33	0.004	0.21	0.004	1.39	0.008	0.72	0.009
	−2.59	−17.79	−1.61	−15.79	−8.49	−18.47	−4.43	−18.89

Note: This table reports the average indirect transaction cost estimates for each SIM4 mutual fund decile for Q0 and Q1. These measures of estimated transaction cost are the quarterly cross-sectional percentile rank of the Amihud (2002) illiquidity ratio and the inverse of the stock price at the beginning of the quarter. All the *t*-statistics presented are computed following the Newey-West (1987)procedure with a four-quarter lag.

Table 6 reports the average indirect transaction cost estimates for each SIM4 mutual fund decile for the fund-ranking quarter (Q0) and the subsequent quarter (Q1). We find a U-shaped relationship between ILLIQUIDITY/INVPRICE and SIM4 deciles for both quarters. According to these two measures, both low- and high-SIM4 mutual funds are actively engaged in costly trading. In addition, taking these two transaction cost measures into consideration, we find that the highest SIM4-decile mutual funds have higher transaction costs than INACTIVE funds and that these differences are significant in almost all cases. In Q0, the differences are 0.33 with a *t*-value of 2.59 and 0.004 with a *t*-value of 17.79 for ILLIQUIDITY and INVPRICE, respectively.

In Table 6, we also show the transaction cost estimates for each SIM4 decile of hedge funds. The U-shaped relationship between the transaction estimates and SIM4 deciles of hedge funds is also observed in Table 6. For Q0 and Q1, the highest SIM4-decile funds show higher values compared with INACTIVE funds; these differences are significant in all cases. In Q0, the differences are 1.39 with a *t*-value of 8.49 and 0.008 with a *t*-value of 18.47 for ILLIQUIDITY and INVPRICE, respectively. The significant differences are 0.72 (*t*-value = 4.43) for ILLIQUIDITY and 0.009 (*t*-value = 18.89) for INVPRICE in Q1.

Arbitrage risk

Ali *et al* (2008) show that mutual funds that deliberately follow the PEAD anomaly in their investment strategies have significantly higher return volatility and a less-diversified investment portfolio than INACTIVE funds. In this section, we investigate whether funds following PEAD anomaly are exposing themselves to higher arbitrage risk. We use four fund characteristics as proxies for arbitrage risk. The first two characteristics are the total number of stocks held by a fund (NUMBER) and the Herfindahl–Hirschman index of portfolio weights (HHI). HHI is calculated as the sum of the squares of the portfolio weights across stocks – expressed as a percentage – held by a fund at the beginning of Q1. These two measures capture the component of arbitrage risk owing to lack of diversification. Both measures are calculated at the beginning of Q1.

We use two measures to measure arbitrage risk due to high return volatility. Our first measure is the annualized average standard deviation of daily returns of stocks held by a fund (STDEV) in Q1, and the second measure is annualized average standard deviation of idiosyncratic daily returns of stocks held by a fund (IDRISK) during Q1. IDRISK is the annualized standard deviation of the residual obtained from the regression of daily stock returns on daily market returns, as well as three-lagged and three-lead market returns. Both stock and market returns are adjusted for risk-free rate. The STDEV and IDRISK of a fund are the averages of STDEV and IDRISK of stocks held by a fund, weighted by fund stockholding weights. A minimum of 20 valid observations during the quarter is required in order to compute the averages of STDEV and IDRISK.

Table 7, Panel A, shows that the highest SIM4-decile mutual funds hold significantly fewer stocks than INACTIVE funds. The time-series means are 63.85 and 147.34 for DECILE10 and INACTIVE funds, respectively. Smaller stock holdings and a significantly lower HHI for DECILE10 mutual funds (6.31 per cent for DECILE10 funds and 4.47 per cent for INACTIVE funds) indicate that

Table 7: Diversification and arbitrage risk proxies

SIM4 DECILE	*NUMBER*	*HHI (%)*	*STDEV (%)*	*IDRISK (%)*
Panel A: Mutual fund				
DECILE1	75.93	6.74	37.64	32.03
DECILE2	84.98	5.83	37.07	31.72
DECILE3	103.70	5.14	36.21	31.03
DECILE4	122.33	4.34	35.26	29.91
DECILE5	128.78	3.93	34.63	29.28
DECILE6	133.58	4.10	34.36	29.23
DECILE7	119.57	4.43	35.15	29.66
DECILE8	99.33	5.15	37.03	31.36
DECILE9	91.94	5.75	37.60	32.18
DECILE10	63.85	6.31	36.07	30.52
INACTIVE	147.34	4.47	34.75	28.41
D10 – INACTIVE	−83.49	1.85	1.32	2.11
	(−10.57)	(6.02)	(18.70)	(24.33)
Panel B: Hedge fund				
DECILE1	164.39	4.75	37.68	33.07
DECILE2	324.54	3.81	37.72	33.14
DECILE3	239.18	3.48	36.87	32.15
DECILE4	288.18	3.15	36.11	31.44
DECILE5	410.60	3.10	34.62	29.88
DECILE6	417.40	2.63	34.19	29.53
DECILE7	408.60	2.53	35.58	30.96
DECILE8	284.85	3.13	35.26	30.66
DECILE9	257.12	4.49	36.23	31.71
DECILE10	199.53	4.59	37.30	32.79
INACTIVE	280.89	3.05	34.36	29.57
D10 – INACTIVE	−81.36	1.54	2.93	3.22
	(−9.71)	(5.42)	(22.51)	(28.97)

Note: This table exhibits time-series means of fund characteristics for each SIM4-decile. Total number of stocks held by a fund (NUMBER) and the HHI of portfolio weights are presented as measures of diversification in hedge fund portfolios. Both measures are calculated at the beginning of the subsequent quarter after the fund ranking quarter. The HHI of portfolio weights measures the fund portfolio concentration and is calculated as the sum of squares of the portfolio weights across stocks – expressed as a percentage – held by a fund. Two measures are addressing high return volatility of stocks held by the funds. They are the annualized average standard deviation of daily returns of stocks held by a fund (STDEV), and the annualized average standard deviation of idiosyncratic daily returns of stocks held by a fund (IDRISK). IDRISK is the annualized standard deviation of the residual obtained from the regression of daily stock returns on daily market returns as well as three-lagged and three-lead market returns. Both stock and market returns are adjusted for risk-free rate. The STDEV and IDRISK of a fund are the averages of STDEV and IDRISK of stocks held by a fund, weighted by fund stockholding weights. All the *t*-statistics presented are computed following the Newey-West (1987)procedure with a four-quarter lag.

the funds that most aggressively follow the drift anomaly-based investment strategy are less diversified. Furthermore, STDEV and IDRISK values of DECILE10 funds are significantly higher than those of INACTIVE funds. The differences are 1.32 per cent with a *t*-value of 18.70, and 2.11 per cent with a *t*-value of 24.33, respectively. These four measures suggest that an active investment strategy based on the PEAD anomaly is exposed to higher arbitrage risk.

Table 7, Panel B, shows that similar to DECILE10 mutual funds, highest SIM4-decile hedge funds show a lack of diversification in their stock holdings and a higher stock return volatility in their portfolios compared with INACTIVE hedge funds. NUMBER is 199.53 for DECILE10 funds as opposed to 280.89 for INACTIVE funds, HHI is 4.59 per cent as opposed to 3.05 per cent, STDEV is 37.30 per cent as opposed to 34.36 per cent and IDRISK is 32.79 per cent as opposed to 29.57 per cent. All of the differences are statistically significant.

An important outcome from Table 7 is the difference between the mutual and hedge fund investment strategies. Mutual funds follow an investment strategy that is more focused. The two columns entitled NUMBER and HHI in Table 7 suggest that mutual funds, on average, carry fewer stocks in their portfolios and that their stock holdings show a higher concentration in terms of the HHI.

Portfolio allocation

In this section, we investigate portfolio allocation decisions taken by highest SIM4-decile (DECILE10) funds based on these market frictions. When we plot the averages of aggregate portfolio weights and weight changes of highest SIM-decile funds (DECILE10 funds) and, for comparison, those of INACTIVE funds for each SUE decile, we find that DECILE10 funds under weight stocks in the lowest SUE deciles and overweigh stocks in the top SUE deciles relative to INACTIVE funds (Table 8). These findings indicate that the aggressiveness of DECILE10 funds in following the PEAD anomaly as an investment strategy.

We further examine portfolio allocation decisions of DECILE10 funds by picking all the highest SUE-decile (PORT10) stocks held and bought by funds in the main sample, and then allocate these stocks into two groups. The first group contains PORT10 stocks – those that are owned or bought by the highest SIM-decile funds – and the other group has the remaining stocks – those that are not owned or bought by DECILE10 funds. We compare two indirect trading cost measures, as well as the return volatility and idiosyncratic return volatility of these two stocks in Table 8. Panel A shows that relative to PORT10 stocks not owned or bought by DECILE10 funds, PORT10 stocks that are owned or bought by DECILE10 funds are significantly liquid (ILLIQUIDITY, INVPRICE) and have lower return volatility (STDEV, IDRISK). Furthermore, Table 8, Panel B shows that PORT10 stocks owned or bought by DECILE10 funds are significantly liquid compared with PORT10 stocks not owned or bought by DECILE10 funds. Similar results for mutual and hedge fund transaction costs are not surprising. As sophisticated investors, fund managers avoid trading costs for higher profits. Contrary to the results presented in Table 8, Panel A, for mutual funds, however, PORT10 stocks that are owned or bought and PORT10 stocks that are not owned or bought by DECILE10 hedge funds do not exhibit significant differences in terms of return volatility.

Table 8: Transaction costs and arbitrage risk characteristics on portfolio allocation

	ILLIQUIDITY	*INVPRICE*	*STDEV* (%)	*IRISK* (%)
Panel A: Mutual fund				
Highest SUE-decile stocks owned versus not owned by DECILE10 funds				
Owned	21.75	0.04	39.92	29.32
Not owned	22.63	0.04	49.04	34.18
Owned – not owned	−0.86	0.00	−8.80	−4.86
	(−3.64)	(−2.05)	(−6.97)	(−4.36)
Highest SUE-decile stocks bought versus not bought by DECILE10 funds				
Bought	21.51	0.05	42.31	28.45
Not bought	22.27	0.04	52.19	33.12
Bought – not bought	−0.76	0.00	−8.90	−4.67
	(−2.14)	(0.77)	(−7.79)	(−2.15)
Panel B: Hedge fund				
Highest SUE-decile stocks owned versus not owned by DECILE10 funds				
Owned	10.15	0.04	36.94	31.32
Not owned	10.88	0.04	36.05	30.76
Owned – not owned	−0.74	−0.01	0.89	−0.56
	(−1.97)	(−1.78)	(1.21)	(−1.41)
Highest SUE-decile stocks bought versus not bought by DECILE10 funds				
Bought	12.82	0.04	35.65	29.11
Not bought	13.29	0.04	35.78	28.62
Bought – not bought	−0.47	−0.01	0.13	−0.49
	(−1.73)	(−1.66)	(0.58)	(1.55)

Note: This table reports the average transaction cost measures and arbitrage risk measures for the stocks in the highest SUE-sorted decile (PORT10) that are owned or bought by DECILE10 funds, and those for PORT10 stocks not owned or bought by DECILE10 funds for the sample period 2001–2007. All the *t*-statistics presented are computed following the Newey-West (1987)procedure with a four-quarter lag.

The skill required of hedge fund managers is to produce α returns (Stulz, 2007). α can be explained as the performance of the investment strategy that cannot be explained by the risk arising from exposure to common market movements. Thus, hedge fund professionals switch more easily to highly volatile markets as long as they have higher α and invest in strategies that may take time to prove profitable. The results presented in Table 8 support the Shleifer and Vishny (1997) argument that hedge funds do not shy away from investing in stocks with high idiosyncratic volatility.

CONCLUDING REMARKS

In this study, we explore whether hedge fund managers trade deliberately on the PEAD anomaly. We use hand-collected hedge fund data compiled from the mandatory quarterly holding disclosure forms submitted to the SEC by the hedge fund managers.

We find that actively managed US hedge and mutual funds follow investment strategies based on the PEAD anomaly. Our findings show that US hedge funds are more aggressive in their drift anomaly-based trading strategies than are mutual funds. We find that active funds continue to employ their investment strategies based on the drift anomaly for the subsequent quarters and following years. More specifically, trading on the PEAD anomaly persists for the top 10 per cent of funds that most actively trade on the drift anomaly. We document that this trading strategy is robust to controlling for other fund-investment strategies, such as size, book-to-market and momentum.

We also document that hedge and mutual fund managers are sophisticated in their investment decisions. They take market frictions into consideration and allocate their trading in the presence of these market frictions. Both mutual and hedge funds that more actively trade on drift anomaly have less-diversified stock holdings and face higher volatility of stock returns in their stock holdings. These features of securities held in fund portfolios induce arbitrage risks and could have a diminishing effect on the fund managers' motivation to exploit drift anomaly more aggressively.

Managers of both types of funds have similar concerns about transaction costs. They attempt to minimize transaction costs in their trading decisions. However, there is a significant difference between mutual and hedge fund managers' arbitrage risk preferences in their portfolio allocation decisions. Mutual fund trades are more in line with minimizing arbitrage risk. A likely reason for this behavior is that mutual funds are more prone to investors' money withdrawals if fund performance is temporarily poor, because these investors may infer fund managers' ability based on short-term performances (Shleifer and Vishny, 1997). In contrast, in hedge funds, investors' funds are locked because of contractual constraints. Thus, hedge funds do not shy away from investing in stocks with high volatility, if these stocks have the potential to provide high abnormal returns in the long run.

NOTES

1. Agarwal and Naik (2005), Fodor *et al* (2009), Stulz (2007) discuss the importance of data-related issues in hedge fund studies. They argue that, other than self-selection and survivorship biases, measurement errors in the databases may undermine the findings in the hedge fund literature. Specifically, they argue that hedge funds may use stale prices for illiquid securities, which leads to difficulties in calculating values. In this study, we focus on fund trading strategies and do not use return and fee information provided by data vendors. Thus, stale price bias is not an issue in this study.
2. Fodor *et al* (2009) document that hedge funds do not pursue a trading strategy consistent with the PEAD anomaly. The findings presented in this study differ from those of Fodor *et al* (2009) for several reasons. Fodor *et al* (2009) uses data that hedge funds voluntarily report. Such data

have several biases (for example, survivorship and backfilling biases). In contrast, we use hand-collected hedge fund stockholding data from the mandatory quarterly holding disclosures made to the Securities and Exchange Commission, and these data partially address the problems of survivorship and instant history biases in the data.

3. We follow Bernard and Thomas (1990) in computing, SUE. Specifically, we use forecast errors from a seasonal random walk with drift and scale it by estimation-period (preceding eight quarters) standard deviation. A minimum of four valid observations during the estimation period is required in order to compute the time-series mean and standard deviation.
4. Following Shumway (1997), we use the CRSP delisting return as the return for the remaining days in the quarter if a security is delisted during that quarter. If the delisting return is missing and the delisting is performance related (that is, delisting codes are 500, 520, 580, 584, or between 551 and 574), then the delisting return is taken as −30 per cent. If delisting codes are anything other than the above-listed codes and the delisting return is missing, we assign zero to the delisting return.
5. To avoid violating the assumption that errors should not be serially correlated, we use heteroskedasticity and autocorrelation consistent errors, and all reported *t*-statistics in this study are computed following the Newey–West (1987) procedure with a lag of four quarters.

REFERENCES

Agarwal, V. and Naik, N.Y. (2005) Hedge funds. *Foundations and Trends in Finance* 1(2): 103–170.

Ali, A., Chen, X., Yao, T. and Yu, T. (2008) Profiting from the PEAD: Mutual Fund Trades, Market Frictions, and Market Efficiency. University of Texas at Dallas, Kansas State University, University of Rhode Island and University of Iowa. Working Paper.

Amihud, Y. (2002) Illiquidity and stock returns: Cross-section and time-series effects. *Journal of Financial Markets* 5(1): 31–56.

Aragon, G.O. and Martin, J.S. (2009) A Unique View of Hedge Fund Derivatives Usage: Safeguard or Speculation? Arizona State University and Carnegie Mellon University. Working Paper.

Bernard, V.L. and Thomas, J.K. (1990) Evidence that stock prices do not fully reflect the implications of current earnings for future earnings. *Journal of Accounting and Economics* 13(4): 305–340.

Fama, E.F. and MacBeth, J. (1973) Risk, return, and equlibrium: Empirical tests. *Journal of Political Economy* 81(3): 607–636.

Fodor, A., Lawson, D. and Peterson, D.R. (2009) Do Hedge Funds Arbitrage Market Anomalies? Ohio University, Gonzaga University and Florida State University. Working Paper.

Newey, W. and West, K. (1987) A simple positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica* 55(3): 703–708.

Shleifer, A. and Vishny, R.W. (1997) The limits of arbitrage. *Journal of Finance* 52(1): 35–55.

Shumway, T. (1997) The delisting bias in CRSP data. *Journal of Finance* 52(1): 327–340.

Stulz, R. (2007) Hedge funds: Past, present, and future. *Journal of Economic Perspectives* 21(1): 175–194.

Wermers, R. (2000) Mutual fund performance: An empirical decomposition into stock-picking talent, style, transactions costs, and expenses. *Journal of Finance* 55(4): 1655–1695.