



# Delisted firms and momentum profits<sup>☆</sup>

Assaf Eisdorfer<sup>\*</sup>

*University of Connecticut, School of Business, Storrs, CT 06269, USA*

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## Abstract

I find that approximately 40 percent of the momentum profit is generated by delisting returns. Most of the delisting-profit is derived from bankrupt firms, while merged firms have a minor effect on the momentum profitability. I further show that ex-ante, firms with high likelihood to go bankrupt exhibit stronger momentum, and firms with high likelihood to be merged exhibit weaker momentum; and that almost the entire profits of these bankruptcy- and merger-candidates strategies are generated by delisting returns. These findings have implications on the size and the implementability of momentum.  
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## 1. Introduction

A typical momentum strategy requires investments in hundreds of firms each month. Specifically, 20 percent of the firms traded on the market are included in the momentum portfolio (the top decile in a long position and the bottom decile in a short position). Many of these firms are delisted from the market during the holding period. Hence, the strategy profit is composed of returns from ‘surviving firms’ (firms that still exist in the market at the end of the holding period) and returns from ‘delisted firms’ (firms that exit the market prior to the end of the holding period). This partition raises questions regarding the role of delisted firms in the momentum puzzle.

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<sup>\*</sup> Tel.: +1 860 486 4485.

*E-mail address:* [Assaf.Eisdorfer@business.uconn.edu](mailto:Assaf.Eisdorfer@business.uconn.edu)

Since Jegadeesh and Titman (1993) first documented the momentum anomaly, many studies have explored factors that affect the source and size of momentum. These include trading volume (Lee and Swaminathan, 2000), analyst coverage (Hong, Lim, and Stein, 2000), size and book-to-market (Lewellen, 2002), business cycle (Chordia and Shivakumar, 2002), industry (Grinblatt and Moskowitz, 1999), and credit rating (Avramov, Chordia, Jostova, and Philipov, 2007). While the latter study shows that ex-ante, firms with high bankruptcy risk exhibit stronger momentum, the effect of stocks that ex-post were delisted from the market has not been addressed. This study contributes to the literature by decomposing the momentum anomaly to surviving firms and delisted firms, and examining the differences between these two sub-groups in terms of profitability and mispricing.

There are two main causes for firms to be delisted from the market—merger and bankruptcy. In both cases delisted firms are expected to have a positive effect on the momentum profits. A firm that is delisted from the market due to merger typically experiences a period of abnormal positive returns prior to the merger date. This means that merged firms<sup>1</sup> are more likely to enter the top decile in the period prior to delisting (and thus be held in a long position in the momentum portfolio). Since merged firms also usually have large positive delisting returns, they are expected to generate a positive profit for the momentum portfolio. A firm that is delisted from the market due to bankruptcy naturally experiences a period of negative abnormal returns prior to the delisting date. That is, bankrupt firms are more likely to enter the bottom decile (and thus be held in a short position). As bankrupt firms usually have large negative delisting returns, they are expected to generate a positive profit as well.

The main result of the paper is that about 40 percent of the momentum profit is generated by delisting returns, mostly the negative returns of firms that go bankrupt during the holding period. The positive delisting returns of firms that are merged however have a minor effect on the momentum profit. I offer an explanation for this difference that is based on different characteristics of the pre-delisting price movements of merged and bankrupt firms.

I also examine the profitability of momentum portfolios that contain stocks with high likelihood to be delisted. First, consistent with Avramov, Chordia, Jostova, and Philipov (2007), I find that firms with high likelihood to go bankrupt exhibit stronger momentum, and I further find that firms with high likelihood to be merged exhibit weaker momentum. Second, and most interestingly, I show that almost the entire positive profits of these bankruptcy- and merger-candidates portfolios are generated by the delisting returns.

Although delisting does not fully explain momentum, finding that a significant portion of the momentum profit is driven by delisted stocks can enhance our understanding of the phenomenon. First, the momentum pattern in stock returns might not be as strong as it is perceived in the literature, as a large proportion of the momentum strategies' profits is not coming from a monotone return pattern during the regular life cycle of a firm, but rather from a final price drift before the firm is delisted and a relatively large final delisting return of the same sign.

Second, the results might have implications on the implementability of momentum strategies. A significant part of the profit is driven by the negative delisting returns of stocks of bankrupt firms, which are held in short positions in the momentum portfolio. Thus, common restriction on short positions when approaching delisting (i.e., all short

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<sup>1</sup>Throughout the paper 'merged firms' refers to targets in merger transactions.

positions must close out during a period prior to delisting) can limit the ability of the momentum investor to enjoy the profits generated by the delisting returns.

The remainder of the paper is organized as follows. The next section reviews the literature. Section 3 describes the trading strategies. Section 4 examines the contribution of delisted firms to the momentum profit. Section 5 addresses the effect of the likelihood of delisting on momentum. Section 6 discusses the implications of the results, and Section 7 concludes.

## 2. Related literature

Many studies show that past returns have predictive ability over future returns. [Jegadeesh and Titman \(1993\)](#) examine whether an investor can use return momentum (both positive and negative) to create abnormal positive profits. They find that a strategy based on buying past winners (the stocks with the highest past returns) and selling past losers (the stocks with the lowest past returns) generates a positive profit of approximately 1 percent per month in the short run. Similar results were documented ever since by other studies (see, e.g., [Chan, Jegadeesh, and Lakonishok, 1996](#); [Lee and Swaminathan, 2000](#); and [Jegadeesh and Titman, 2001](#)). [Rouwenhorst \(1998\)](#) tests the same phenomenon in European stock markets, and finds that momentum strategies work in 11 out of the 12 countries examined.

Several researchers (e.g., [Conrad and Kaul, 1998](#)) argue that the momentum profit compensates for risk, i.e., that the positive returns of momentum strategies are driven by cross-sectional differences and not by time-series predictions. However, most researchers dismiss the idea of risk premium as a source of the momentum profitability. [Fama and French \(1996\)](#), [Jegadeesh and Titman \(2001\)](#), and others have shown that the significance of the momentum profitability survives after controlling for risk premium.

The momentum anomaly has attracted the attention of many researchers who tried to identify variables that contain information about the momentum profitability. [Grinblatt and Moskowitz \(1999\)](#) conclude that momentum is not a single firm characterization, but rather one of a whole industry. They find that strategies of buying stocks that belong to past-prosperous industries and selling stocks belonging to past-depressed industries generate abnormal positive returns, while within an industry, strategies of buying (selling) past winners (losers) do not lead to any significant profits. [Lewellen \(2002\)](#) shows that size and book-to-market portfolios exhibit momentum as strong as that in individual stocks and industries, and therefore concludes that momentum must be due to macroeconomic factors and not firm-specific returns. Consistent with this notion, [Chordia and Shivakumar \(2002\)](#) document that momentum profit is positively related to the market conditions.

[Lee and Swaminathan \(2000\)](#) find that trading volume predicts momentum's existence and strength. They show that a strategy of buying past winners with low trading volume and selling past losers with high trading volume outperforms standard momentum strategies by 2–7 percent a year. Their explanation is based on two ideas. First, they conjecture that trading volume is an indicator of the level of interest that investors have in a firm. Second, they claim that stock returns of “neglected” firms tend to increase in the short run, while stock returns of “popular” firms tend to decrease in the short run. Therefore, by combining these two notions, the investor can improve the performance of the momentum strategy.

[Hong, Lim, and Stein \(2000\)](#) find that momentum is stronger in firms with lower analyst coverage. This result is explained by the relatively slow release of new information about

these firms, which generates a continuous response of investors to the information. Recently, and most related to this study, Avramov, Chordia, Jostova, and Philipov (2007) link momentum to credit rating. They show that firms with low bond ratings exhibit a significantly stronger momentum than firms with high bond ratings.

Other studies offer behavioral explanations for the momentum phenomenon that are based on investor judgment biases such as conservatism, over-confidence, self-attribution, and inconsistency (see Barberies, Shleifer, and Vishny, 1998; Daniel, Hirshleifer, and Subramanyam, 1998; and Hong and Stein, 1999). These studies model two possible explanations for momentum. The first is underreaction of investors to new information. This explanation suggests that new information about a firm is not reflected immediately in its stock price, but rather gradually over time. Therefore, when new information arrives, the firm enters a period with a sequence of returns in the same direction (i.e., momentum). The second explanation is continued overreaction of investors. This explanation suggests that although new information about the firm is reflected immediately in the returns, the stock price continues to drift in the same direction in the near future. That is, the continued overreaction of investors to the same piece of information creates a monotone sequence of returns over time, which is the price momentum.

### 3. Trading strategies

As in Jegadeesh and Titman (1993), I construct strategies with four different horizons of the formation period (3, 6, 9 and 12 months) and four different horizons of the holding period (3, 6, 9 and 12 months). Thus, there are 16 strategies distinguished by different formation and holding period combinations. For the representative strategy  $J$ – $K$ , each month all stocks are ranked according to their cumulative return in the last  $J$  months and are divided into ten deciles. The profit of the strategy is the difference between the equally weighted average returns of stocks in the top and the bottom deciles during the next  $K$  months. The momentum profit for every month  $t$  is then computed by averaging the returns generated in that month by the  $K$  separate strategies implemented from month  $t$ – $K$  to  $t$ –1. ‘Delisted firms’ refer to all firms whose stocks are delisted from the market during the holding period. Using CRSP data, I apply these strategies to monthly returns of all stocks listed on NYSE, Amex, and Nasdaq, between January 1975 and December 2005.

Table 1 summarizes the average monthly profits generated by each of the 16 strategies. The results are comparable with those of Jegadeesh and Titman (1993). The strategies generate an average monthly return of around 1 percent, where strategy 3–3 is the only one that has no significant evidence of a positive profit (average monthly return of 0.30 percent with a  $t$ -statistic of 1.16). In all other strategies the results are significant at any common level.

### 4. The effect of delisted firms on the momentum profit

#### 4.1. The proportion of delisted firms in the momentum portfolio

There are two main causes for firms to be delisted from the market—merger and bankruptcy. Both of these causes are associated with pre-delisting price drifts. Naturally, a bankrupt firm experiences a period of negative abnormal returns prior to the delisting date. In contrast, a merged firm is more likely to experience a period of abnormal positive returns prior to the merger date (see Schwert, 1996).

Table 1

## Returns of momentum strategies

At the end of each month all stocks are ranked into ten deciles according to their returns in the past  $J$  months (the formation period). The top decile is labeled as the winners portfolio and the bottom decile is labeled as the losers portfolio. The profit of the strategy is the difference between the equally weighted average returns of stocks in the winners and the losers portfolios in the next  $K$  months (the holding period). The momentum profit for every month  $t$  is then computed by averaging the returns generated in that month by the  $K$  separate strategies implemented from month  $t-K$  to  $t-1$ . The table reports the average monthly return of the winners and the losers portfolios, the average momentum profit (the difference between the winners' and the losers' returns), and its  $t$ -statistics of all 16 strategies, computed over the period 1975–2005. Hence, each observation of any  $J-K$  strategy starts at the  $J$ th month of 1975 and ends at the  $(12-K)$ th month of 2005.

		$K = 3$	$K = 6$	$K = 9$	$K = 12$
$J = 3$	<i>Winners</i>	0.0146	0.0160	0.0171	0.0172
	<i>Losers</i>	0.0116	0.0081	0.0079	0.0085
	<i>Winners-Losers</i>	0.0030	0.0079	0.0092	0.0087
	<i>T-statistic</i>	1.16	3.97	5.60	5.34
$J = 6$	<i>Winners</i>	0.0188	0.0195	0.0195	0.0181
	<i>Losers</i>	0.0091	0.0067	0.0065	0.0081
	<i>Winners-Losers</i>	0.0097	0.0129	0.0130	0.0100
	<i>T-statistic</i>	3.17	5.45	6.00	4.26
$J = 9$	<i>Winners</i>	0.0211	0.0206	0.0190	0.0174
	<i>Losers</i>	0.0088	0.0061	0.0068	0.0089
	<i>Winners-Losers</i>	0.0122	0.0145	0.0122	0.0085
	<i>T-statistic</i>	3.73	5.60	4.43	2.80
$J = 12$	<i>Winners</i>	0.0204	0.0189	0.0174	0.0162
	<i>Losers</i>	0.0077	0.0067	0.0081	0.0102
	<i>Winners-Losers</i>	0.0128	0.0121	0.0093	0.0061
	<i>T-statistic</i>	3.83	4.15	3.15	2.03

Fig. 1 depicts the cumulative average pre-delisting market-adjusted returns of all merged and bankrupt firms traded on NYSE, Amex, and Nasdaq between 1975 and 2005.<sup>2</sup> As expected, merged firms have a positive pre-delisting drift (a cumulative average return of approximately 71 percent in the 24 months prior to the delisting date), and bankrupt firms have a negative pre-delisting drift (a cumulative average decrease of 66 percent).

Note further that the delisting returns capture significant portions of the pre-delisting drifts. The delisting return is the return on the stock after it is delisted. It is computed by comparing the value of the stock after delisting and its price on the last trading day.<sup>3</sup> The delisting return for firms that went bankrupt captures 10 percent of the cumulative negative return in the last 24 months prior to delisting, 27 percent of the cumulative return in the last 12 months, and 52 percent of the cumulative return in the last 6 months. For merged firms, the delisting return captures 11 percent of the cumulative positive return in

<sup>2</sup>The market-adjusted return is the difference between the raw return and the CRSP value-weighted portfolio of NYSE, Amex, and Nasdaq stocks. Although CRSP has a specific code for bankruptcy, I include all the delisting categories associated with poor performance such as 'liquidation' and 'dropping due to bad performances' in the bankruptcy group.

<sup>3</sup>See Shumway (1997) for more information on the delisting returns in CRSP.

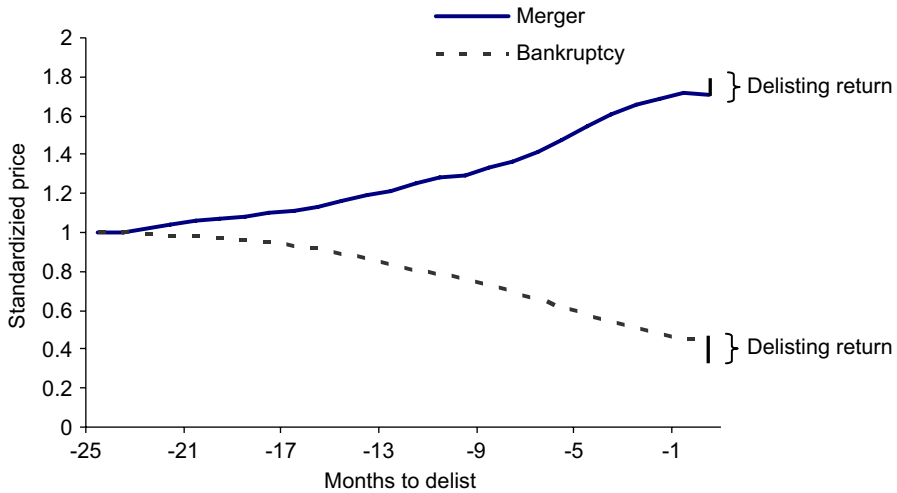


Fig. 1. Pre-delisting drifts of mergers and bankruptcies. The figure shows the cumulative average market-adjusted returns of all merged and bankrupt firms during the 24 months prior to the delisting date, as well as the final delisting returns, over the period January 1975 to December 2005. The market-adjusted return is the difference between the raw return and the CRSP value-weighted portfolio of NYSE, Amex, and Nasdaq stocks. The solid line represents the cumulative returns of all merged firms from month -24 to the delisting date, and the dashed line represents the equivalent cumulative returns of all bankrupt firms.

the last 24 months prior to delisting, 15 percent of the cumulative return in the last 12 months, and 26 percent of the cumulative return in the last 6 months.

These patterns imply that if the delisting occurs during the holding period of a momentum strategy, then the pre-delisting drift is reflected both in the formation period and in the holding period, until the delisting month. As a result, an ex-post merged firm has a higher probability to be included in the top decile than that of the average firm, and therefore to be purchased by the investor. In the same way, an ex-post bankrupt firm has a higher probability to be included in the bottom decile than that of the average firm, and therefore to be sold by the investor. Following this analysis, the proportion of delisted firms in the momentum portfolio is expected to be higher than the proportion of delisted firms in the entire market, where there is an asymmetry between the top and the bottom deciles—more mergers in the top decile and more bankruptcies in the bottom decile.

Table 2 presents the distribution of merged and bankrupt firms in the entire market, in the momentum portfolio, and in the top and the bottom deciles separately, for two representative strategies, 6–6 and 12–12. While the proportion of delisted firms during an interval of 6 (12) months is 3.4 (6.9) percent, the proportion of delisted firms in the momentum portfolio is significantly higher; 10.0 (16.1) percent of the firms included in the momentum portfolio are delisted during the holding period for the 6–6 (12–12) strategy.<sup>4</sup> As expected, there is a significant difference between the delisting distribution in the top and the bottom deciles. Delisted firms in the top decile are mostly merged firms in both 6–6 and 12–12 strategies (84.0 and 83.1 percent, respectively), while delisted firms in the bottom

<sup>4</sup>Chi-square tests for the differences between the proportions of delisted firms in the momentum portfolio and in the entire market generate extremely low *p*-values.

Table 2

## Delisting proportions

The table shows the proportions of delisted firms in the entire market and in the momentum portfolio for two representative strategies, 6–6 and 12–12. The first column in the upper box of the table presents the proportions of the average frequencies of surviving and delisted firms, as well as the delisting causes (bankruptcy, merger, and other) frequencies, during an interval of 6 months between 1975 and 2005, where the numbers in parenthesis in the second column are the frequencies within the delisted firms' population. The third column presents the frequencies of the surviving and the delisted firms in the two extreme deciles, (i.e., the momentum portfolio). The remaining columns of the upper box present the specific frequencies of the top and the bottom deciles. The lower box of the table contains the equivalent statistics for the strategy 12–12.

	General	Two extreme deciles		Top decile		Bottom decile		
<i>Strategy 6–6</i>								
<i>Surviving</i>	96.6%		90.0%		91.7%		88.4%	
<i>Delisted</i>	3.4%		10.0%		8.3%		11.6%	
<i>Bankruptcy</i>	1.4%	(41.1%)	5.4%	(54.7%)	1.1%	(13.7%)	9.7%	(84.1%)
<i>Merger</i>	1.9%	(53.7%)	4.2%	(42.1%)	7.0%	(84.0%)	1.4%	(11.9%)
<i>Other</i>	0.2%	(5.2%)	0.3%	(3.3%)	0.2%	(2.3%)	0.5%	(4.0%)
<i>Strategy 12–12</i>								
<i>Surviving</i>	93.1%		83.9%		89.2%		78.5%	
<i>Delisted</i>	6.9%		16.1%		10.8%		21.5%	
<i>Bankruptcy</i>	2.8%	(41.1%)	9.4%	(58.0%)	1.6%	(14.4%)	17.2%	(80.0%)
<i>Merger</i>	3.7%	(53.7%)	6.3%	(38.9%)	9.0%	(83.1%)	3.6%	(16.6%)
<i>Other</i>	0.4%	(5.2%)	0.5%	(3.1%)	0.3%	(2.6%)	0.7%	(3.3%)

decile are mostly bankrupt firms (84.1 and 80.0 percent). Overall, this evidence supports the prediction that relative to the average firm, ex-post merged firms tend to enter the top decile, ex-post bankrupt firms tend to enter the bottom decile, and as a result, the proportion of delisted firms in the momentum portfolio significantly exceeds that in the entire market.

#### 4.2. The profitability of delisted firms

I examine whether delisted firms generate higher momentum profits than surviving firms. A merged firm (which typically enters the top decile) is likely to experience a positive return in the holding period, as well as a large positive delisting return. However, surviving firms in the top decile also experience (on average) a positive return in the holding period. Therefore, the effect of merged firms on the momentum profit would be positive only if the average of the returns of merged firms during the holding period, including the delisting returns, is higher than that of surviving firms in the top decile. In a similar way, bankrupt firms (which typically enter the bottom decile) would increase the momentum profit only if the average of their returns during the holding period, including the large negative delisting returns, is lower than that of surviving firms in the bottom decile. To examine the effect of delisted firms on the momentum profit, I calculate the average profits after excluding the returns of the delisted firms.

Table 3 shows the average profits when excluding only delisting returns, when excluding the entire holding period returns of delisted firms, and when including only delisted firms. In all 16 strategies the profit decreases when excluding the delisted firms' returns, where the reduction is mostly driven by the delisting returns. Consider the strategy 6–6, for example,

Table 3

The delisting-effect on the profit of equal-weighted momentum portfolios

The table shows the effect of delisted firms on the profits of the 16 equal-weighted momentum strategies over the period 1975–2005. For each strategy I report the average monthly profits and their *t*-statistics when: (i) all returns are included (as shown in Table 1), (ii) excluding the delisting returns, (iii) excluding the entire returns of the delisted firms, and (iv) including only the returns of the delisted firms. The final number in each strategy is the *t*-statistic of the difference between the average returns of the surviving firms and the delisted firms.

			<i>K</i> = 3	<i>K</i> = 6	<i>K</i> = 9	<i>K</i> = 12	
<i>J</i> = 3	<i>All</i>	<i>Average monthly return</i>	0.0030	0.0079	0.0092	0.0087	
		<i>T</i> -statistic	1.16	3.97	5.60	5.34	
	<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0001	0.0049	0.0064	0.0059	
		<i>T</i> -statistic	0.04	2.54	3.86	3.07	
	<i>Without delisted firms</i>	<i>Average monthly return</i>	−0.0004	0.0044	0.0062	0.0059	
		<i>T</i> -statistic	−0.13	1.96	3.19	3.09	
	<i>Only delisted firms</i>	<i>Average monthly return</i>	0.0594	0.0408	0.0294	0.0234	
		<i>T</i> -statistic	6.79	8.30	7.94	7.33	
		<i>T</i> -statistic ( <i>difference</i> )	6.44	6.73	5.57	4.71	
	<i>J</i> = 6	<i>All</i>	<i>Average monthly return</i>	0.0097	0.0129	0.0130	0.0100
			<i>T</i> -statistic	3.17	5.45	6.00	4.26
		<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0061	0.0094	0.0095	0.0061
<i>T</i> -statistic			1.92	3.71	3.61	2.29	
<i>Without delisted firms</i>		<i>Average monthly return</i>	0.0055	0.0088	0.0092	0.0060	
		<i>T</i> -statistic	1.69	3.30	3.57	2.32	
<i>Only delisted firms</i>		<i>Average monthly return</i>	0.0696	0.0472	0.0356	0.0285	
		<i>T</i> -statistic	8.11	8.65	8.27	7.54	
		<i>T</i> -statistic ( <i>difference</i> )	6.97	6.31	5.25	4.89	
<i>J</i> = 9		<i>All</i>	<i>Average monthly return</i>	0.0122	0.0145	0.0122	0.0085
			<i>T</i> -statistic	3.73	5.60	4.43	2.80
		<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0084	0.0105	0.0079	0.0036
	<i>T</i> -statistic		2.34	3.98	2.55	1.10	
	<i>Without delisted firms</i>	<i>Average monthly return</i>	0.0077	0.0100	0.0077	0.0037	
		<i>T</i> -statistic	2.15	3.35	2.18	1.14	
	<i>Only delisted firms</i>	<i>Average monthly return</i>	0.0757	0.0518	0.0387	0.0309	
		<i>T</i> -statistic	7.80	9.57	7.77	6.85	
		<i>T</i> -statistic ( <i>difference</i> )	6.57	6.75	5.08	4.91	
	<i>J</i> = 12	<i>All</i>	<i>Average monthly return</i>	0.0128	0.0121	0.0093	0.0061
			<i>T</i> -statistic	3.83	4.15	3.15	2.03
		<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0085	0.0074	0.0041	0.0003
<i>T</i> -statistic			2.44	2.17	1.20	0.07	
<i>Without delisted firms</i>		<i>Average monthly return</i>	0.0078	0.0070	0.0040	0.0003	
		<i>T</i> -statistic	2.13	1.96	1.11	0.09	
<i>Only delisted firms</i>		<i>Average monthly return</i>	0.0822	0.0545	0.0407	0.0328	
		<i>T</i> -statistic	9.73	9.78	8.04	7.82	
		<i>T</i> -statistic ( <i>difference</i> )	8.08	7.20	5.92	5.90	

the average monthly profit decreases from 1.29 to 0.94 percent without the delisting returns, and to 0.88 percent without the entire holding period returns of the delisted firms. For the strategy 12–12, the average profit decreases from 0.61 to 0.03 percent without delisting returns, and it remains at 0.03 percent without the entire returns of delisted firms.



Considering all strategies, the average profit is reduced from 1.01 to 0.62 percent without delisting returns, and to 0.59 percent without the entire returns of delisted firms. That is, about 40 percent of the momentum profit is generated by the delisting returns of firms that exit the stock market during the holding period. Consistent with these results, the returns of delisted firms are significantly higher than those of surviving firms (averages of 4.63 and 0.59 percent, respectively), where the *t*-statistics of the differences between delisted and surviving firms' returns range between 4.71 and 8.08.<sup>5</sup> Note however that the positive momentum profits generally remain significant without the delisting returns.

Finding that the positive effect of the delisted firms is driven almost entirely by their delisting returns is not surprising given the large magnitude of delisting returns (as shown in Fig. 1). In addition, this finding might indicate that the price drift prior to delisting, not including the delisting return, is of the same magnitude of the standard price momentum of surviving firms.

Momentum profits are often computed with a one week or one month lag between the formation and holding periods, in order to eliminate potential effects of bid-ask bounce and short-term return reversal. I examine the results in Table 3 with a one month lag. The results reported in Table 4 indicate that the strong effect of delisting on momentum profits remains robust; the average monthly profit is reduced from 1.13 to 0.74 percent without delisting returns, and to 0.73 percent without the entire returns of delisted firms.

The average profits in Table 3 are based on equal-weighted momentum portfolios. For robustness, I examine the effect of delisting using average value-weighted returns.<sup>6</sup> The results are reported in Table 5. The average profits are reduced significantly in the value-weighted portfolios as well, yet by a lower magnitude than that of the equal-weighted portfolios. Considering all strategies, the average monthly profits is reduced from 1.81 to 1.40 percent without delisting returns, and to 1.52 percent without the entire returns of delisted firms. That is, delisting returns contribute approximately 23 percent to the value-weighted momentum profits, compared to 40 percent to the equal-weighted portfolios. This result is expected as delisted firms, both bankrupt firms and merger targets, are typically smaller than surviving firms.

### 4.3. Mergers and bankruptcies

#### 4.3.1. Merger and bankruptcy profits

I examine the separate effects of merged and bankrupt firms on the momentum profit. Panel A of Table 6 presents the average profits of strategies 6–6 and 12–12 with and without delisted firms, with and without bankrupt firms, and with and without merged firms. As shown in the previous section, in both strategies the profit significantly decreases when excluding the delisted firms as one group. This table shows that the reduction in the profit is derived almost solely from bankrupt firms. Without bankruptcies the profit of the strategy 6–6 decreases from 1.29 to 0.93 percent, while without mergers, the profit hardly changes (increases from 1.29 to 1.30 percent). A similar pattern is observed in the strategy 12–12. Consistent with these results, the average return of bankrupt firms is

<sup>5</sup>The results in Table 3 remain robust after adjusting the momentum profits to risk by the Fama and French (1993) three-factor model.

<sup>6</sup>Value-weighted momentum portfolios also generate abnormal profits (see, for example, Grinblatt and Moskowitz, 1999; Korajczyk and Sadka, 2004).

Table 4

The delisting-effect on momentum profits with one-month lag

The table shows the effect of delisted firms on the profits of the 16 equal-weighted momentum strategies with a one month lag between the formation and holding periods, over the period 1975–2005. For each strategy I report the average monthly profits and their *t*-statistics when: (i) all returns are included, (ii) excluding the delisting returns, (iii) excluding the entire returns of the delisted firms, and (iv) including only the returns of the delisted firms. The final number in each strategy is the *t*-statistic of the difference between the average returns of the surviving firms and the delisted firms.

			<i>K</i> = 3	<i>K</i> = 6	<i>K</i> = 9	<i>K</i> = 12	
<i>J</i> = 3	<i>All</i>	<i>Average monthly return</i>	0.0096	0.0116	0.0116	0.0093	
		<i>T</i> -statistic	3.71	5.83	6.67	5.04	
	<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0068	0.0088	0.0089	0.0064	
		<i>T</i> -statistic	2.60	4.41	5.11	3.40	
	<i>Without delisted firms</i>	<i>Average monthly return</i>	0.0065	0.0086	0.0089	0.0065	
		<i>T</i> -statistic	2.48	4.27	4.99	3.30	
	<i>Only delisted firms</i>	<i>Average monthly return</i>	0.0595	0.0401	0.0292	0.0237	
		<i>T</i> -statistic	9.16	9.07	8.35	7.52	
		<i>T</i> -statistic (difference)	7.56	6.49	5.19	4.62	
	<i>J</i> = 6	<i>All</i>	<i>Average monthly return</i>	0.0146	0.0154	0.0134	0.0093
			<i>T</i> -statistic	4.90	6.43	5.42	3.50
		<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0112	0.0120	0.0098	0.0053
<i>T</i> -statistic			3.70	4.95	3.89	1.93	
<i>Without delisted firms</i>		<i>Average monthly return</i>	0.0109	0.0118	0.0098	0.0054	
		<i>T</i> -statistic	3.59	4.81	3.78	1.85	
<i>Only delisted firms</i>		<i>Average monthly return</i>	0.0702	0.0471	0.0355	0.0285	
		<i>T</i> -statistic	10.27	9.19	8.26	7.26	
		<i>T</i> -statistic (difference)	7.94	6.20	5.12	4.73	
<i>J</i> = 9		<i>All</i>	<i>Average monthly return</i>	0.0161	0.0149	0.0112	0.0074
			<i>T</i> -statistic	5.08	5.23	3.63	2.27
		<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0123	0.0108	0.0068	0.0024
	<i>T</i> -statistic		3.83	3.73	2.14	0.73	
	<i>Without delisted firms</i>	<i>Average monthly return</i>	0.0120	0.0107	0.0068	0.0026	
		<i>T</i> -statistic	3.72	3.60	2.06	0.71	
	<i>Only delisted firms</i>	<i>Average monthly return</i>	0.0763	0.0517	0.0384	0.0306	
		<i>T</i> -statistic	10.86	10.65	8.56	7.56	
		<i>T</i> -statistic (difference)	8.31	7.22	5.68	5.19	
	<i>J</i> = 12	<i>All</i>	<i>Average monthly return</i>	0.0134	0.0110	0.0078	0.0047
			<i>T</i> -statistic	4.02	3.51	2.32	1.32
		<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0091	0.0062	0.0026	−0.0010
<i>T</i> -statistic			2.68	1.93	0.75	−0.26	
<i>Without delisted firms</i>		<i>Average monthly return</i>	0.0087	0.0060	0.0025	−0.0010	
		<i>T</i> -statistic	2.55	1.81	0.68	−0.24	
<i>Only delisted firms</i>		<i>Average monthly return</i>	0.0826	0.0539	0.0403	0.0323	
		<i>T</i> -statistic	11.43	10.22	8.78	7.80	
		<i>T</i> -statistic (difference)	9.24	7.69	6.46	5.77	

the highest (7.82 and 5.22 percent for strategies 6–6 and 12–12, respectively), compared to lower returns of merged firms (1.27 and 0.65 percent) and surviving firms (0.88 and 0.03 percent).

Table 5

The delisting-effect on the profit of value-weighted momentum portfolios

The table shows the effect of delisted firms on the profits of the 16 value-weighted momentum strategies over the period 1975–2005. For each strategy I report the average monthly profits and their  $t$ -statistics when: (i) all returns are included (as shown in Table 1), (ii) excluding the delisting returns, (iii) excluding the entire returns of the delisted firms, and (iv) including only the returns of the delisted firms. The final number in each strategy is the  $t$ -statistic of the difference between the average returns of the surviving firms and the delisted firms.

			$K = 3$	$K = 6$	$K = 9$	$K = 12$	
$J = 3$	<i>All</i>	<i>Average monthly return</i>	0.0146	0.0144	0.0135	0.0120	
		<i>T-statistic</i>	3.72	4.90	5.65	5.87	
	<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0102	0.0120	0.0110	0.0103	
		<i>T-statistic</i>	2.98	4.21	4.98	5.19	
	<i>Without delisted firms</i>	<i>Average monthly return</i>	0.0108	0.0126	0.0119	0.0115	
		<i>T-statistic</i>	2.63	4.01	4.34	4.24	
	<i>Only delisted firms</i>	<i>Average monthly return</i>	0.0841	0.0295	0.0164	0.0106	
		<i>T-statistic</i>	10.47	5.87	4.03	3.28	
		<i>T-statistic (difference)</i>	8.12	2.85	0.91	-0.20	
	$J = 6$	<i>All</i>	<i>Average monthly return</i>	0.0199	0.0201	0.0189	0.0152
			<i>T-statistic</i>	4.63	5.91	6.65	6.22
		<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0153	0.0157	0.0153	0.0120
<i>T-statistic</i>			3.76	5.03	5.78	5.35	
<i>Without delisted firms</i>		<i>Average monthly return</i>	0.0152	0.0173	0.0171	0.0137	
		<i>T-statistic</i>	3.42	4.74	5.08	4.22	
<i>Only delisted firms</i>		<i>Average monthly return</i>	0.1015	0.0389	0.0237	0.0162	
		<i>T-statistic</i>	13.65	6.98	5.65	4.11	
		<i>T-statistic (difference)</i>	9.97	3.25	1.23	0.48	
$J = 9$		<i>All</i>	<i>Average monthly return</i>	0.0231	0.0234	0.0193	0.0147
			<i>T-statistic</i>	4.92	6.25	6.09	5.40
		<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0182	0.0194	0.0154	0.0112
	<i>T-statistic</i>		4.05	5.39	5.24	4.56	
	<i>Without delisted firms</i>	<i>Average monthly return</i>	0.0190	0.0208	0.0173	0.0126	
		<i>T-statistic</i>	3.84	5.10	4.61	3.40	
	<i>Only delisted firms</i>	<i>Average monthly return</i>	0.0932	0.0445	0.0272	0.0199	
		<i>T-statistic</i>	12.03	8.56	5.90	4.88	
		<i>T-statistic (difference)</i>	8.07	3.59	1.67	1.32	
	$J = 12$	<i>All</i>	<i>Average monthly return</i>	0.0264	0.0228	0.0179	0.0133
			<i>T-statistic</i>	5.41	5.87	5.39	4.61
		<i>Without delisting returns</i>	<i>Average monthly return</i>	0.0201	0.0183	0.0122	0.0077
<i>T-statistic</i>			4.48	4.98	4.49	3.72	
<i>Without delisted firms</i>		<i>Average monthly return</i>	0.0211	0.0195	0.0144	0.0087	
		<i>T-statistic</i>	4.21	4.60	3.63	2.18	
<i>Only delisted firms</i>		<i>Average monthly return</i>	0.1026	0.0463	0.0321	0.0248	
		<i>T-statistic</i>	13.36	8.18	6.84	5.80	
		<i>T-statistic (difference)</i>	8.89	3.80	2.89	2.73	

Panel B of the table shows the  $t$ -statistics of the differences between the three sub-groups of the momentum portfolio. Bankrupt firms' returns are significantly higher than those of merged and surviving firms ( $t$ -statistics between 4.67 and 6.44), while the differences between the merged and the surviving firms' average returns are not significant ( $t$ -statistics of 0.56 and 0.92).

Table 6

## Bankruptcy and merger effects

The table presents the specific effects of merged and bankrupt firms on the momentum profit. Panel A shows the average monthly return (and their *t*-statistics) of two representative strategies, 6–6 and 12–12, with and without delisted firms, with and without merged firms, and with and without bankrupt firms, over the period 1975–2005. Panel B shows the differences (and their *t*-statistics) among the average returns of the three sub-groups.

		Strategy 6–6	Strategy 12–12
<i>Panel A: Separate profits</i>			
<i>All firms</i>	Average return	0.0129	0.0061
	<i>T</i> -statistic	5.45	2.03
<i>Without Delisting</i>	Average return	0.0088	0.0003
	<i>T</i> -statistic	3.30	0.09
<i>Without Bankruptcies</i>	Average return	0.0093	0.0013
	<i>T</i> -statistic	3.62	0.34
<i>Without Mergers</i>	Average return	0.0130	0.0061
	<i>T</i> -statistic	5.48	1.75
<i>Only Delisting</i>	Average return	0.0472	0.0328
	<i>T</i> -statistic	8.65	7.82
<i>Only Bankruptcies</i>	Average return	0.0782	0.0522
	<i>T</i> -statistic	7.49	6.59
<i>Only Mergers</i>	Average return	0.0127	0.0065
	<i>T</i> -statistic	2.01	1.14
<i>Panel B: Differences tests</i>			
<i>Only Bankruptcies–Only Surviving</i>		0.0693	0.0519
<i>T</i> -statistic		6.44	5.97
<i>Only Bankruptcies–Only Mergers</i>		0.0655	0.0457
<i>T</i> -statistic		5.37	4.67
<i>Only Mergers–Only Surviving</i>		0.0039	0.0062
<i>T</i> -statistic		0.56	0.92

## 4.3.2. Pre-delisting correlations

A possible explanation for the difference between the effects of merged and bankrupt firms on the momentum profit is that the correlation between the formation and the holding period excess returns within the pre-delisting drift (including the delisting return) of merged firms is lower than that of bankrupt firms.<sup>7</sup> Fig. 2 illustrates this point. The solid lines represent the observed pre-delisting average drifts of merged and bankrupt firms. Although the average drifts are quite symmetric, they are composed of different structures of individual drifts (represented by the dashed lines). The main difference between these structures is that within the mergers drifts the correlation between the formation and the holding period returns is negative, while within the bankruptcies drifts the correlation is positive. Consider two merged firms ( $M1, M2$ ) and two bankrupt firms ( $B1, B2$ ). Out of the

<sup>7</sup>The excess return of a merged (bankrupt) firm is the difference between the raw return and the average return of all merged (bankrupt) firms. That is, this argument implies the following:  $\text{corr}(R_{bi}^f - \bar{R}_b^f, R_{bi}^h - \bar{R}_b^h) > \text{corr}(R_{mj}^f - \bar{R}_m^f, R_{mj}^h - \bar{R}_m^h)$ , where  $R_{bi}^{f(h)}$  is the formation (holding) period return of bankrupt firm  $i$ ,  $\bar{R}_b^{f(h)}$  is the average formation (holding) period return of all bankrupt firms,  $R_{mj}^{f(h)}$  is the formation (holding) period return of merged firm  $j$ , and  $\bar{R}_m^{f(h)}$  is the average formation (holding) period return of all merged firms.

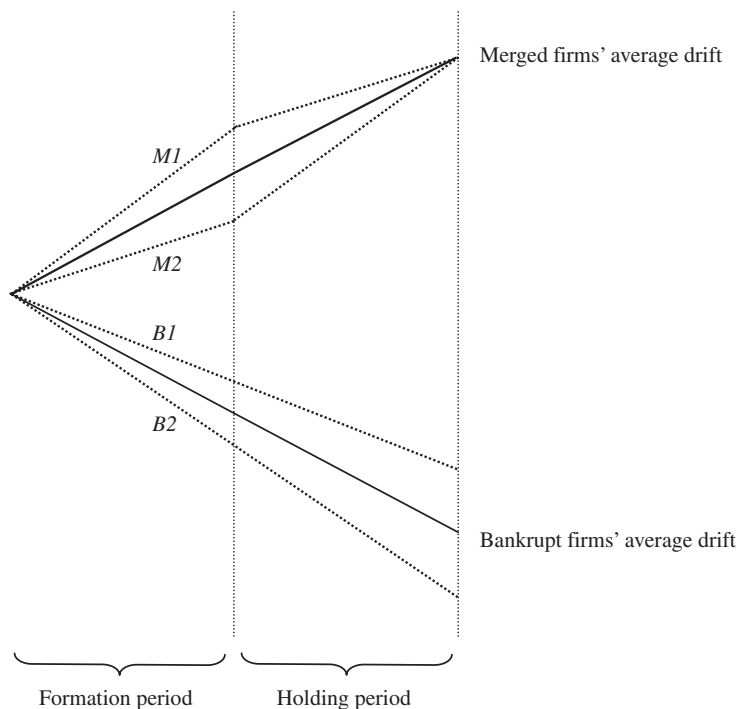


Fig. 2. Correlations of pre-delisting drifts. The figure describes correlation structures between the formation period and the holding period returns. The merged firms ( $M1, M2$ ) drifts have a negative correlation, where the firms with the highest (lowest) returns in the formation period have the lowest (highest) returns in the holding period. The bankrupt firms ( $B1, B2$ ) drifts have a positive correlation, where the firms with the highest (lowest) returns in the formation period have also the highest (lowest) returns in the holding period.

two merged firms, firm  $M1$  has the higher return in the formation period and is therefore more likely to enter the top decile. Out of the two bankrupt firms, firm  $B2$  has the lower return in the formation period and is therefore more likely to enter the bottom decile. However, due to the negative correlation of merged firms returns, firm  $M1$  generates relatively low profit in the holding period, while due to positive correlation of bankrupt firms' returns, firm  $B2$  generates relatively high profit in the holding period (low return in short position). Hence, the contribution of bankrupt firms to the momentum profit is higher than that of merged firms.

The correlation structures can be tested by applying the momentum strategy separately to merged firms and bankrupt firms, where the higher the correlation, the higher the expected profit. This can be illustrated using the same example. Within the bankrupt firms' momentum, firm  $B1$  enters the top decile (and is purchased by the investor), and firm  $B2$  enters the bottom decile (and is sold by the investor). This strategy will generate a positive profit since the return of firm  $B1$  in the holding period is higher than that of firm  $B2$ . Within the merged firms' momentum, firm  $M1$  enters the top decile (and is purchased by the investor), and firm  $M2$  enters the bottom decile firms (and is sold by the investor); however, this strategy will generate a negative profit since the return of firm  $M1$  in the holding period is lower than that of firm  $M2$ . Hence, if the correlation between the formation and the holding period returns within bankrupt firms is higher than that within

Table 7

## Bankruptcy and merger momentum

The table presents the average monthly profits (and the  $t$ -statistics) of the 16 strategies applied separately to merged and bankrupt firms, over the period 1975–2005. For strategy  $J-K$  I consider only firms that were merged (bankrupt) during the next  $K$  months, and divide them into five quintiles. The profit of the strategy is the difference between the equally weighted average returns of stocks in the top and the bottom quintiles, where the return of each stock counts until the delisting date. The momentum profit of each month is computed by averaging the returns generated in that month by the past  $K$  separate strategies.

		$K = 3$	$K = 6$	$K = 9$	$K = 12$
$J = 3$	<i>Only bankruptcies</i>	0.0165	0.0114	0.0076	0.0054
	<i>T-statistic</i>	1.62	1.68	1.66	1.53
	<i>Only mergers</i>	-0.0217	-0.0298	-0.0252	-0.0192
	<i>T-statistic</i>	-5.79	-9.14	-10.17	-6.71
$J = 6$	<i>Only bankruptcies</i>	0.0233	0.0182	0.0131	0.0097
	<i>T-statistic</i>	2.30	2.37	2.26	1.94
	<i>Only mergers</i>	-0.0245	-0.0343	-0.0282	-0.0220
	<i>T-statistic</i>	-5.73	-9.38	-8.44	-7.06
$J = 9$	<i>Only bankruptcies</i>	0.0292	0.0207	0.0159	0.0122
	<i>T-statistic</i>	2.74	2.89	2.78	2.00
	<i>Only mergers</i>	-0.0245	-0.0335	-0.0287	-0.0222
	<i>T-statistic</i>	-5.63	-9.26	-6.47	-7.12
$J = 12$	<i>Only bankruptcies</i>	0.0372	0.0260	0.0177	0.0128
	<i>T-statistic</i>	3.46	3.71	3.05	2.18
	<i>Only mergers</i>	-0.0234	-0.0333	-0.0280	-0.0222
	<i>T-statistic</i>	-5.42	-9.69	-6.25	-6.97

merged firms, then the average profit of the bankrupt firms' strategy is expected to exceed that of the merged firms' strategy.<sup>8</sup>

Table 7 shows the average profits of momentum strategies when applied separately to bankrupt firms and merged firms. In order to maintain a sufficient number of firms in the momentum portfolio I divide the firms into five quintiles instead of the standard ten deciles. The results show that in each of the 16 horizons the profit of the bankruptcies momentum is positive ( $t$ -statistics between 1.53 and 3.71), while the profit of the mergers momentum is significantly negative (all  $t$ -statistics are lower than  $-5$ ). That is, the results indicate not only that the correlation of bankrupt firms' returns is higher than that of merged firms' returns, but also that the correlation of merged firms' returns is negative. These results strongly support the hypothesis that the difference in the effect of bankrupt and merged firms on the momentum profit is derived from different correlation structures within the two groups.

The difference in the correlation structure of bankrupt and merged firms' returns can be explained by the pre-delisting processes of the two groups. The market price of firms that approach bankruptcy typically declines gradually overtime, with no particular reason for extreme jumps at specific dates. Therefore, the typical pre-delisting drift of bankrupt firms is roughly linear, which is associated with a positive correlation (as described in Fig. 2).

<sup>8</sup>Note that the profit of a momentum strategy that is applied to delisted firms only is different from the average profit of delisted firms as a part of the standard momentum strategy.

Merged firms, however, are characterized by different structure of pre-delisting drift, where a significant price change is concentrated in relatively short interval around the bid announcement. Schwert (1996) shows that most of the pre-delisting price change of merged firms occurs during the 21 trading days prior to the first bid announcement date. This pattern suggests that merged firms that are included in the top decile are more likely to be those that already had the first bid, and therefore to have relatively low return in the holding period, including the delisting return. Merged firms that are not included in the top decile, however, are more likely to have the first bid during the holding period, and therefore to have relatively high return in that period. This implies a negative correlation between the formation period and the holding period returns within merged firms, resulting in a lower contribution to the momentum profit than that of bankrupt firms.

## 5. The effect of the likelihood of delisting on the momentum profit

### 5.1. Ex-post delisted firms and ex-ante delisting-candidates

The evidence that ex-post delisted firms, mainly bankrupt firms, generate a higher profit than surviving firms in the momentum portfolio raises the questions of whether ex-ante ‘delisting-candidates’ (firms with high probability to exit the market in the short run) are relatively mispriced. Based on the results so far, we cannot draw a clear conclusion regarding the relative accuracy of the pricing of delisting-candidates. This is because we observe only firms that ex-post left the market, and we do not observe firms that had high likelihood to be delisted, but eventually survived. In this section I address the profitability of momentum portfolios that contain ex-ante delisting-candidates, and the effect of ex-post delisted firms on their performance.

### 5.2. Delisting-candidates momentum

#### 5.2.1. Bankruptcy-candidates portfolio

Avramov, Chordia, Jostova, and Philipov (2007) examine the momentum profitability of firms with high default risk. They compute the average momentum profits for different groups of firms based on S&P long-term bond credit ratings, and find that low-graded firms exhibit significantly stronger momentum profits than high-graded firms. I reexamine the results in Avramov, Chordia, Jostova, and Philipov (2007) using a different criterion for the likelihood of bankruptcy, and furthermore, assess the effect of the delisted firms on these bankruptcy-candidates momentum profits.

The criterion I use for measuring bankruptcy risk is based on Altman’s Z-score (see Altman (1968)), a widely used model of bankruptcy prediction.<sup>9</sup> According to the model, the lower the Z-score, the higher the bankruptcy risk, where a Z-score below 1.81 indicates high bankruptcy risk. I thus divide all firms each month into two sub-groups. The first one,

<sup>9</sup>Altman’s Z-score model for predicting bankruptcies is:  $Z = 1.2(\text{working capital}/\text{total assets}) + 1.4(\text{retained earnings}/\text{total assets}) + 3.3(\text{earnings before interest and taxes}/\text{total assets}) + 0.6(\text{market value of equity}/\text{book value of total liabilities}) + 0.999(\text{sales}/\text{total assets})$ .

The inputs of the model are computed from COMPUSTAT, where for each month, the relevant variables are taken from the previous quarter. For instance, the inputs for any of the months between January 98 and March 98 are computed from the last quarter of 1997, the inputs for any of the month between April 98 and June 98 are computed from the first quarter of 1998, and so on.

Table 8

## Bankruptcy-candidates portfolios

Based on the Altman's (1968) model for predicting bankruptcies, firms each month are divided into two sub-groups: the 'low Z-score' includes all firms with Z-scores below 1.81 (i.e., bankruptcy-candidates) and the 'high Z-score' includes all firms with Z-scores above 1.81 (i.e., no bankruptcy-candidates). The momentum is performed separately for these two sub-groups of firms. The table presents the average monthly returns (and their *t*-statistics) of the standard, the low Z-score, and the high Z-score strategies for horizons 6–6 and 12–12, with and without the returns of the delisted firms, over the period 1975–2005.

	6–6			12–12		
	All firms	Low Z-score	High Z-score	All firms	Low Z-score	High Z-score
Including delisting returns						
<i>Winners</i>	0.0195	0.0178	0.0204	0.0162	0.0168	0.0154
<i>Losers</i>	0.0067	0.0037	0.0086	0.0102	0.0069	0.0120
<i>Winners–Losers</i>	0.0129	0.0141	0.0118	0.0061	0.0099	0.0034
<i>T-statistic</i>	5.45	3.85	5.30	2.03	2.17	1.33
Excluding delisting returns						
<i>Winners</i>	0.0205	0.0194	0.0209	0.0169	0.0183	0.0161
<i>Losers</i>	0.0111	0.0142	0.0093	0.0167	0.0203	0.0132
<i>Winners–Losers</i>	0.0094	0.0052	0.0116	0.0003	–0.0020	0.0030
<i>T-statistic</i>	3.71	1.29	5.21	0.07	–0.38	1.09
Excluding delisted firms						
<i>Winners</i>	0.0210	0.0198	0.0212	0.0173	0.0189	0.0163
<i>Losers</i>	0.0122	0.0184	0.0094	0.0169	0.0277	0.0137
<i>Winners–Losers</i>	0.0088	0.0014	0.0118	0.0003	–0.0088	0.0026
<i>T-statistic</i>	3.30	0.20	5.17	0.09	–1.40	0.91

referred to as 'low Z-score', includes all firms with Z-scores below 1.81, and the second one, 'high Z-score', includes all firms with Z-scores above 1.81. I then perform the momentum strategy separately for the low- and high Z-score groups.

Table 8 presents the average profits of the standard, the low Z-score, and the high Z-score strategies, with and without the returns of the delisted firms, for horizons 6–6 and 12–12. The results show first that firms with high bankruptcy risk generate higher momentum profits than firms with low bankruptcy risk. For the 6–6 (12–12) horizon, the low Z-score portfolio generates an average monthly profit of 1.41 (0.99), compared to 1.18 (0.34) of the high Z-score portfolio. This finding is consistent with Avramov et al., although they find a larger difference in the profits of low- and high-graded firms. The difference might be explained by the different criterion used for bankruptcy risk (bond rating and Z-score), and also by the different sample periods (1985 to 2003 in Avramov et al. and 1975 to 2005 in this study).

Second, the differences between the profits of the low and high Z-score portfolios are coming mainly from the losers portfolio. This result is not surprising; firms with high bankruptcy risk are more likely to be delisted, and since the firms in the losers portfolio are held in short position, they gain the profits of the large negative delisting returns.

Third, and very interestingly, the results show that almost the entire profits of the low Z-score portfolios are coming from delisted firms, and primarily from their delisting returns (the profits of the high Z-score portfolios are, as expected, almost not affected by the returns of delisted firms). For the 6–6 horizon, the average profit of the low Z-score



Table 9

## Merger-candidates portfolios

Based on the Stevens's (1973) model for predicting mergers, firms each month are divided into two sub-groups: the 'low  $M$ -score' includes all firms with  $M$ -scores below its median (i.e., merger-candidates) and the 'high  $M$ -score' includes all firms with  $M$ -scores above the median (i.e., no merger-candidates). The momentum is performed separately for these two sub-groups of firms. The table presents the average monthly returns (and their  $t$ -statistics) of the standard, the low  $M$ -score, and the high  $M$ -score strategies for horizons 6–6 and 12–12, with and without the returns of the delisted firms, over the period 1975–2005.

	6–6			12–12		
	All firms	Low $M$ -score	High $M$ -score	All firms	Low $M$ -score	High $M$ -score
Including delisting returns						
<i>Winners</i>	0.0195	0.0111	0.0205	0.0162	0.0093	0.0163
<i>Losers</i>	0.0067	0.0029	0.0071	0.0102	0.0043	0.0099
<i>Winners–Losers</i>	0.0129	0.0082	0.0135	0.0061	0.0050	0.0064
<i>T-statistic</i>	5.45	1.89	6.10	2.03	1.06	1.72
Excluding delisting returns						
<i>Winners</i>	0.0205	0.0116	0.0220	0.0169	0.0123	0.0170
<i>Losers</i>	0.0111	0.0101	0.0131	0.0167	0.0142	0.0158
<i>Winners–Losers</i>	0.0094	0.0015	0.0090	0.0003	–0.0018	0.0012
<i>T-statistic</i>	3.71	0.31	4.01	0.07	–0.39	0.37
Excluding delisted firms						
<i>Winners</i>	0.0210	0.0119	0.0224	0.0173	0.0129	0.0173
<i>Losers</i>	0.0122	0.0131	0.0141	0.0169	0.0183	0.0182
<i>Winners–Losers</i>	0.0088	–0.0012	0.0083	0.0003	–0.0054	–0.0009
<i>T-statistic</i>	3.30	–0.27	3.02	0.09	–0.88	–0.25

portfolio is reduced from 1.41 to 0.52 percent without delisting returns, and to 0.14 percent without the entire returns of delisted firms. For the 12–12 horizon, the profit of the low  $Z$ -score portfolio is even negative without the returns of the delisted firms. That is, while in the standard momentum portfolio about 40 percent of the profit is generated by delisted firms, in the high bankruptcy risk portfolio, almost the entire profit disappears without the returns of the delisted firms.

### 5.2.2. Merger-candidates portfolio

While the profitability of bankruptcy-candidates has been previously addressed in the literature, to the best of my knowledge, that of merger-candidates has not. As in the bankruptcy-candidates case, I examine the momentum profitability of firms with high likelihood to be merged, and what portion of it is coming from delisted firms.

Several studies have attempted to develop a model for predicting merger targets. These include Simkowitz and Monroe (1971), Stevens (1973), Wansley (1984), Dietrich and Sorenson (1984), Palepu (1986), Pastena and Ruland (1986), and Barnes (1990). I use the Stevens models (the Wansley model produces similar results).<sup>10</sup> I calculate the Stevens-model

<sup>10</sup>Stevens model for predicting mergers is:  $M = 0.108(EBIT/Sales) - 0.033(\text{net working capital}/\text{total assets}) + 0.987(\text{sales}/\text{total assets}) + 0.111(\text{long-term liabilities}/\text{total assets})$ , where the lower the value, the higher the probability of merger. The inputs of the model are computed from COMPUSTAT in the same way as in the Altman model.

value (referred to as the *M*-score) for all firms each month; and since there is no specific value that indicates high merger probability, I simply use the median of the scores to construct two sub-portfolios: ‘low *M*-score’ and ‘high *M*-score’.

Table 9 presents the average profits of the standard strategy and the two merger-based strategies, with and without the returns of the delisted firms, for horizons 6–6 and 12–12. The results show that merger-candidates firms exhibit a weaker momentum than firms with low likelihood to be merged. That is, while firms with high likelihood to be delisted from the market due to bankruptcy exhibit relatively stronger momentum, firms that are likely to be delisted as a result of merger exhibit generally weaker momentum. In the 6–6 (12–12) horizon, the average profit of the high *M*-score strategy is 1.35 (0.64) percent, while the average profit of the low *M*-score strategy is 0.82 (0.50) percent.

As in the bankruptcy-candidates portfolios, delisted firms have a great impact on the profitability of the merger-candidates momentum, as the positive profits of the low *M*-score portfolios completely disappear when the delisting returns are excluded (and as expected, delisted firms has almost no effect on the high *M*-score portfolio profits). Thus, the momentum returns of both the bankruptcy- and merger-candidates portfolios are driven almost entirely by the returns of delisted firms.

## 6. Discussion

The evidence of the relatively high contribution of delisted firms to the momentum profit can enhance our understanding of the phenomenon.

First, given the significant positive profits of momentum strategies, the common perception in the literature is that stocks returns exhibit a monotone return pattern that generate these large profits. As in this study I show that a significant portion of the momentum profit is not driven by monotone returns during the life-cycle of the firm, but rather from final price drifts before delisting and relatively large delisting returns of the same sign, momentum pattern in stock returns might be less strong as it is perceived.

Second, the relatively large profits generated by negative delisting returns of bankrupt firms might have implications on the implementability of momentum strategies. As shown in Fig. 1, bankrupt firms typically exhibit a negative price drift before delisting, and thus are more likely to enter the bottom decile and held in short position in the momentum portfolio. As a result of the negative delisting returns, these firms generate large profits. Thus, since the delisting returns reflect transactions made after delisting, to enjoy the profit generated by the delisting return of bankrupt firms, the momentum investor should remain the short position after the delisting date. However, due to common restrictions on short position when approaching delisting (i.e., all short position should be close out before the delisting day), the investor may not be able to earn the profits generated by the delisting returns.

## 7. Conclusions

I find that delisted firms play an important role in the momentum anomaly. On average about 40 percent of the momentum profit is generated by the returns on firms that are delisted from the market during the holding period, mainly by their delisting returns. Most of the delisting effect is attributed to firms that went bankrupt during the holding period, while merged firms have a minor effect on the momentum profit. I explain this difference by the characteristics of the pre-delisting price movements of merged and bankrupt firms.

I further examine whether ex-ante, firms with high likelihood to be delisted have an effect on the momentum profitability. By employing both bankruptcy- and merger-prediction models, I find first that strategies based on firms with high bankruptcy risk exhibit relatively strong momentum, and strategies based on firms with high likelihood to be merged exhibit relatively weak momentum; and second, that almost the entire positive profits of these bankruptcy- and merger-candidates portfolios are generated by delisting returns.

The large effect of delisted firms on the momentum profitability has implications on the size and the implementability of momentum.

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