MOMENTUM PROFITS AND TRADING COSTS

Mouna Boujelbène Abbes, Younès Boujelbène, Abdelfettah Bouri

1. Introduction

A puzzling finding of return predictability is the intermediate momentum effect documented by Jegadeesh and Titman [14]. They show that stocks with low returns over the past 3-12 months tend to underperform over the next 3-12 months, while stocks with past high returns continue to outperform over the following 3-12 months. This finding, obtained using data from the U.S. market, also holds in international markets [22] and in different samples time periods [13]. Why does this return continuation arise? Much research has focused on whether momentum profits can be explained by risk. Jegadeesh and Titman [14] find that momentum cannot be explained by exposure to market risk alone. Fama and French [7] show that abnormal momentum returns remain after adjusting for risk under their three-factor model of market return, size, and book-to-market. Conrad and Kaul [4] conjecture that momentum returns could be entirely due to cross-sectional variations in mean returns rather than to any predictable time-series variations in stock returns. Grundy and Martin [11] test the Conrad and Kaul conjecture by using each stock as its own risk control. They find that the momentum strategy still yields excess returns of 9.24 % per annum in the period 1966-1995. Jegadeesh and Titman [12] also find that the variation in mean returns explains very little of momentum profits. Chordia and Shivakumar [3] provide empirical evidence that links momentum profits to business cycle risk and macroeconomic instrumental variables and show that momentum effect is due to business cycle risk. Griffin et al. [10] provide international evidence against this explanation: momentum profits appear to be large and statistically significant across good and bad economic states. They also show that the multifactor macroeconomic model of Chordia and Shivakumar [3] cannot explain momentum across markets. Moskowitz and Grinblatt [20] further show that such momentum effects are mainly driven by industry factor in the sense that the profitability of individual stock momentum strategies can be substantially explained by industry momentum. Contrary to the finding of Moskowitz and Grinblatt [20], Grundy and Martin [11] find that industry effect cannot fully explain the momentum effect. In particular, a random industry strategy still earns statistically significant returns in months other than January. In short, current risk-based explanations fail to account fully for the momentum effect. As Grundy and Martin [11] summarize succinctly, ‘‘A full understanding of the source of the risk-adjusted profitability of the momentum strategy remains an open question.‘‘

In the absence of a risk based explanation for momentum profits, an important question is whether there are significant limits to arbitrage that prevent investors from taking advantage of momentum strategies. In this paper, we test whether momentum strategies remain profitable after considering trading costs, including price impact. In particular, we estimate the maximal fund size possible before abnormal return become negative.

We incorporate several models of trading costs, including proportional and non-proportional costs. The proportional cost models are based on quoted and effective spreads. The non-proportional costs are based on price impact models: the Glosten and Harris [9] and the Breen, Hodrick, and Korajczyk models [2].

The remainder of this paper is organised as follows: Section 2 presents a literature review of momentum and transaction cost priors studies. Section 3 provides a description of our data and methodology and examines the profitability of momentum strategies. Section 4 introduces measures of proportional and non-proportional trading costs. Section 5 presents liquidity measures. The performance of momentum strategies after trading costs is evaluated in Section 6. Section 7 provides concluding remarks.

2. Related Literature

The literature provides a menu of trading cost estimation procedures for consideration. The first class of estimators measures the components of trading costs by examining transaction costs data directly. The components that can be measured with the least error are the explicit trading costs of commissions and bid/ask spreads. Schultz [23] and Stoll et al. [24] investigate the effect of commissions and spreads on size-based trading strategies. The second class of estimators indirectly infers trading costs based on price impact. The nature of the price impact of trades has been the subject of extensive theoretical and empirical study ([16], [5], [9] and [2]).

A number of studies on momentum strategies have considered the effect of transaction costs on momentum returns. Jegadeesh and Titman [14] find that the risk-adjusted return of the momentum trading rule after considering a transaction cost of 0.5 % is 9.29 % per year, which is reliably different from zero. Grundy and Martin [11] examine a momentum strategy with monthly rebalancing and one-month gap between formation and investment period. The stocks are selected on the basis of 6 months past returns and preserved for 6 months.

They find that only for round trip transaction cost less than 1.5 %, momentum strategy become significantly profitable. Lesmond et al. [19] analyze a 6/6 strategy over the period January 1980 to December 1998. They use four measures of transaction costs: spread estimates, mean direct effective spread and mean Roll effective spread, commission estimates, and total trading cost estimate based on limited dependent variable (LDV) estimate (Lesmond, et al. [18]). Authors find that the evidence for positive trading profit after transaction costs appears weak. The magnitude of trading costs, particularly for those firms, which play an important role in generating abnormal return, appears sufficiently large such that realizing net trading profits is likely to be illusive. Incorporating non-proportional price impacts of trades into trading strategies has only recently received significant attention. Korajczyk and Sadka [15] examine the profitability of long positions in winner based momentum strategies when trading costs including the price impact are taken in to account. They analyze several models of trading costs, including measures of proportional and non proportional (price impact) costs. Similar to Lesmond et al. [19], Korajczyk and Sadka [15] show that losers are much less liquid than winners. In addition, Korajczyk and Sadka investigate the performance of a liquidity-weighted portfolio rule that maximizes under simplifying assumptions post price impact expected return on the portfolio. After incorporating transaction costs, the results indicate that proportional spread costs do not eliminate statistical significance of momentum profits. For non proportional trading costs (price impact), they show that profits of the equal-weighted strategy disappear quickly, and abnormal returns for the value-weighted strategies are driven to zero with investment portfolios larger than $2 billion. However, for the liquidity-weighted strategy, abnormal returns are driven to zero only after approximately $5 billion is invested. They conclude that trading costs in the form of spread and price impact cannot fully explain the momentum anomaly.

3. Momentum Trading Strategies

To assess the profitability of momentum strategies, we borrow the methodology from Jegadeesh and Titman [14]. We define momentum-based strategies by the length of the period over which past returns are calculated, *J*, and the length of time the position is held, *K*. Specifically, a strategy that selects stocks on the basis of returns over the past *J* months and holds them for *K* months is constructed as follows: at the beginning of each month *t* the securities are ranked in ascending order on the basis of their returns in the past *J* months. Based on these rankings, five decile portfolios are formed that equally weight the stocks contained in the top decile, the second decile, and so on. The top decile portfolio is called „Loser" decile and the bottom decile is called the „Winner" decile. In each month *t*, the strategy buys winner portfolio and sells the loser portfolio, holding this position for *K* months.

We consider the strategies that select stocks based on their returns over the past 6 or 12 months (*J= 6, 12*). We also consider five holding periods (*K=1, 3, 6, 9, 12*). This gives a total of 10 strategies. Our sample consists of 120 French stocks traded in the Paris stocks exchanges from January 1995 to December 2004. Data relative to prices, trading volume, book value and market capitalisation are drawn from Data Stream International database. Stocks monthly returns are calculated taking into account the dividends. We use intraday data to estimate the price impact coefficient each month. French equity market is

Tab. 1: Winner, Loser, and zero-cost portfolio (W-L) profitability for different ranking and holding periods

Ranking period	Portfolio	Holding period K=1	K=3	K=6	K=9	K=12
J=6	Loser	0.0058	0.0392	0.0733	0.0651	0.2156
	Winner	0.0183	0.0577	0.1177	0.1085	0.1907
	W – L	0.0124	0.0185	0.0443	0.0433	-0.0249
	(t-statistic)	(2.029)	(0.527)	(30.179)	(4.497)	(-9.473)
J=12	Loser	0.0048	0.0325	0.0557	0.098	0.1647
	Winner	0.0177	0.0666	0.1170	0.1383	0.1383
	W – L	0.0129	0.034	0.0673	0.0404	-0.0264
	(t-statistic)	(2.1105)	(41.389)	(42.286)	(5.869)	(-0.959)

Source: own

characterised by electronic trading system created in order to organise a centralised, order-driven market. Buy and sell orders are centralised in an order book, where they are automatically matched.

Table 1 reports the average returns of the winner and loser portfolios as well as of the zero-cost winner minus loser portfolio (*W-L*) for the different strategies. For each portfolio, we report the mean monthly returns and its associated t-statistic in parentheses.

The results show that all momentum strategies produce significant positive profits for up to nine months after formation. The successful zero-cost strategy selects stocks based on their returns over the previous 12 months and then holds the portfolio for 6 months. This strategy produces return about 6.73 % (t-statistic of 42.286). The table also finds reversals at longer horizons, momentum profits turn negative in the 12th month after formation. They become equal to -0.0249 (t-statistic of -9.473) for the strategy based on prior 6 months returns and -0.0264 % (t-statistic of -0.959) for the strategy based on prior 12 months returns.

4. Trading Cost Estimation

Assessing the profitability of relative strength trading strategies requires an assessment of the trading costs facing the arbitrageur. We study the effects on the profitability of the momentum strategies implied by four alternative measures of trading costs. Two of the measures are proportional trading cost models, and therefore, are independent of the size of the portfolio traded. These are based on the quoted and effective spreads. The remaining two measures are non-proportional trading cost models and reflect the fact that the price impact of trading increases in the size of the position traded. The price impact measures are based on the models of Glosten and Harris [9] and Breen et al. [2].

4.1 Proportional Trading Costs

4.1.1 Quoted Spread Estimate

We use quoted spread estimates similar to those used by Stoll and Whaley [24]. From our daily data, we calculate the quoted spread given by the following expression:

$$S_{it}^{Q} = \frac{A_{it} - B_{it}}{(A_{it} + B_{it})/2} \tag{1}$$

where S_{it}^{Q}, is the quoted spread of asset *i* in time period *t*, A_{it} is ask price of stock *i* in time period *t* and B_{it} is the bid price of stock *i* in time period *t*.

4.1.2 Effective Spread Estimate

We compute the direct effective spread by comparing the quoted spread to the contemporaneous execution price.

$$S_{it}^{E} = \left| \frac{p_{it-} \ (A_{it} + B_{it})/2}{(A_{it} + B_{it})/2} \right| \tag{2}$$

where S_{it}^{E}, is the effective spread of asset *i* in time period *t*, is the transaction price of asset *i* in time period *t*. Monthly estimates of these two measures (Quoted spread and Effective spread) are obtained as their simple average throughout the month.

4.2 Non Proportional Trading Costs

4.2.1 Model of Breen, Hodrick, and Korajczyk (2002)

This model posits a proportional relation between percentage returns and net share turnover:

$$\frac{\Delta p_{it}}{p_{it-1}} = \lambda_i^{BHK} \times Turnover_{it} \qquad (3)$$

where, $\Delta p_{it}=p_{it}-p_{it-1}$ is the price impact associated with the transactions in period t, is asset i's price impact coefficient, and $Turnover_{it}$ is the net number of shares traded divided by the number of shares outstanding for firm i. We deduce the trade direction using the algorithm roughly based on the Lee and Ready [17] procedure. A trade is classified as a „buy“ if the trade price is greater than the midpoint of the quote. A trade is classified as a „sell“ if the trade price is less than the midpoint of the quote. If the trade price is equal to midpoint of the quote, then the trade is classified as a buy (sell) if the price immediately before the trade is positive (negative).

4.2.2 Model of Glosten and Harris (1988)

The Glosten and Harris [9] specification allows a decomposition of the price impact into fixed and variable components.

$$\Delta p_{it} = \alpha_i + \lambda_i^{GH} q_{it} + \psi_i \Delta d_{it} + \varepsilon_{it} \qquad (4)$$

where, Δp_{it} is the price change of stock i from trade $t-1$ to trade t as a consequence of a (signed) trade of q_{it} shares of the stock. Every trade is classified as a „buy“ or a „sell“ according to the classification scheme of Lee and Ready [17]. The sign of a trade is denoted d_{it} and is assigned a value of +1 for a „buy“ and -1 for a „sell“. The difference between the sign of a current trade and the previous trade is denoted Δd_{it}. The regression coefficient λ_i^{GH} represents the variable cost of trading, while ψ_i represents the fixed costs.

Table 2 reports the time-series means of cross--sectional diagnostics of different transaction costs estimates (proportional and non proportional). Panel A includes quoted spread and effective spread. Panel B summarises the cross-sectional distributions of Breen et al. [2] and Glosten and Harris [9] coefficients estimates. The results presented in this table show that quoted spread is relatively large, it is on average equal to 2.28 % and it vary from 0.03 % to 7 %. This result can be explained by the important difference between ask and bid prices. The effective spreads go from 0.02 % to 1.97 %, so the contemporaneous price of asset is close to the midpoint of the quote.

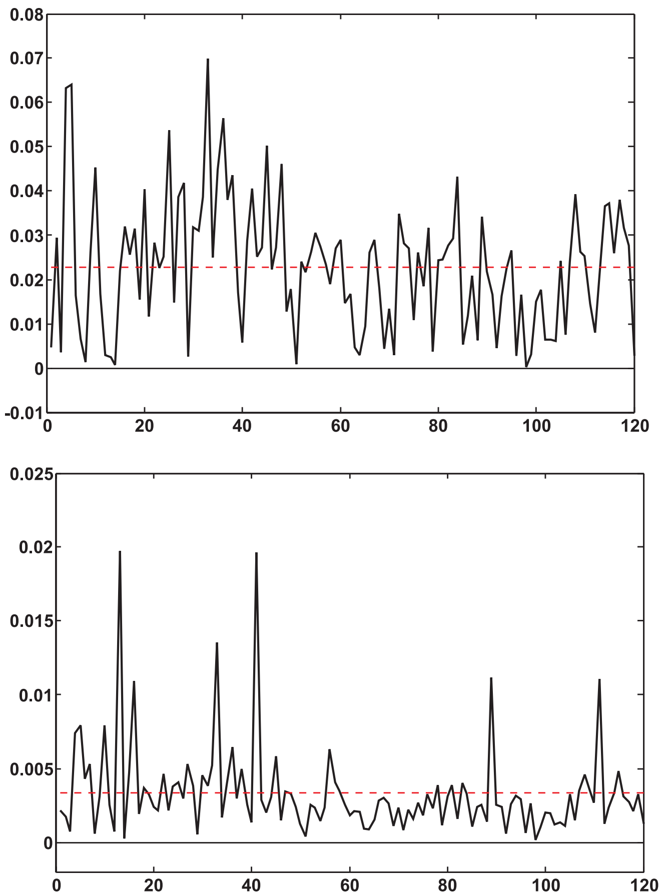
Fig. 1 plots the mean quoted spread and effective spread estimates for 120 stocks. This figure shows some strong disparities between the quoted spread supported on the different stocks. In Fig. 2, we present the price impact estimates of Breen- Hodrick- Korajczyk and Glosten- Harris models. This figure shows that transaction costs of Glosten and Harris model [9] are greater that of Breen et al. model [2]. This result can be ex-

Tab. 2: Descriptive statistics of transaction costs

Transaction cost	*Mean*	*St deviation*	*Minimum*	*Median*	*Maximum*
Panel A : Proportionate costs					
S_i^Q	0.0228	0.0147	0.0003	0.0238	0.0699
S_i^E	0.0033	0.00031	0.0002	0.0026	0.0197
Panel B : Non Proportionate costs					
λ_i^{BHK}	3.5×10^{-5}	0.0003	-0.0007	-3.46×10^{-7}	0.003
λ_i^{GH}	0.00027	0.0075	-0.0661	0.0001	0.0273
ψ_i	0.001	0.0046	-0.0072	1.72×10^{-5}	0.0423

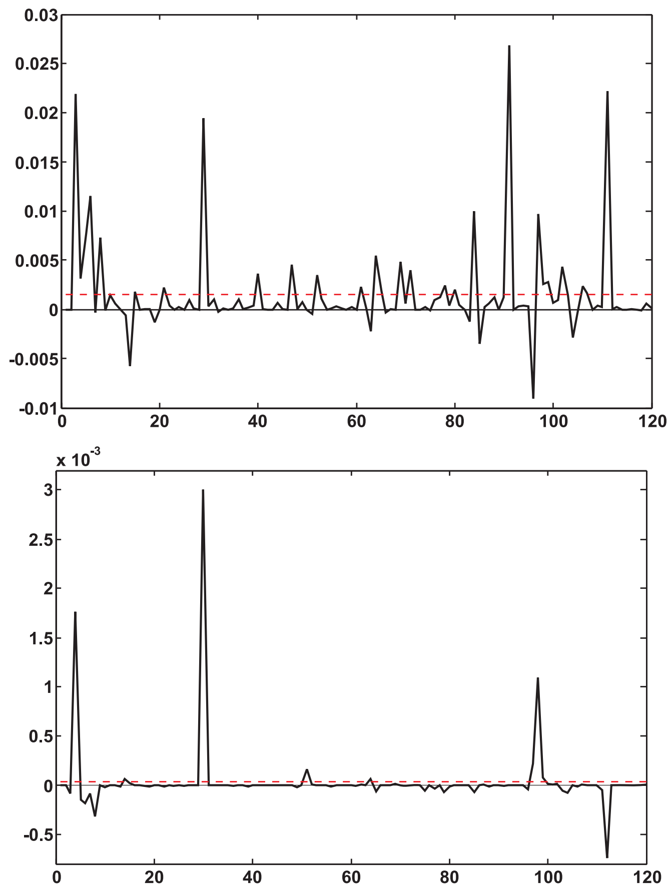
Source: own

Fig. 1: Proportional trading cost



Source: own

Fig. 2: Non proportional trading costs



Source: own

plained by the fact that the model of Glosten and Harris includes two types of trading costs; the variable cost and the fixed costs.

5. Measures of Liquidity

The financial literature includes several proxies for liquidity such as market capitalization; volume; turnover; and the more recent Amihud [1] measure, which is defined as the monthly average of absolute value of daily return divided by daily dollar volume. In our paper we use liquidity measures to determine momentum strategies returns after considering trading costs. For this we estimate the cross-sectional relation between the trading costs measures (λ_{it}^{BHK}, λ_{it}^{GH}, ψ_{it}, effective and quoted spreads), and a set of predetermined firm-specific variables considered as proxies for market-making costs and shareholder heterogeneity.

For the Breen, Hodrick, and Korajczyk [2] specification, (Eq. 3), the cross-sectional relation is characterized by the following expression:

$$\hat{\lambda}_t^{BHK} = X_{t-1}\Gamma_t + \upsilon_t \qquad (5)$$

where $\hat{\lambda}_t^{BHK}$ is the $n \times 1$ vector of price impact coefficients of n firms estimated for month t, $\hat{\Gamma}_t$ is the estimated vector of coefficients and $X_{i,t-1}$ is the $n \times k$ matrix of predetermined variables for the cross-section of firms with $X_{i,t-1} = (1, X_{1,i,t-1}, X_{2,i,t-1}, X_{3,i,t-1}, X_{4,i,t-1}, X_{5,i,t-1}, X_{6,i,t-1})$, $X_{1,i,t-1}$ = market capitalisation of firm i at the end of month t divided by the average market capitalisation of sample firms, $X_{2,i,t-1}$ = total volume for firm i from month t-2 to month t divided by the total volume, over the same period, for the average sample firms, $X_{3,i,t-1}$ = firm i's stock price at the end of month t divided by the price at the end of month t -6, $X_{4,i,t-1}$ = dummy variable equal to unity if the firm is included in the CAC40 index, $X_{5,i,t-1}$ = R^2 of firm i's returns regressed on returns of the sample equally weighted index over the preceding 36 months, $X_{6,i,t-1}$ = inverse of stock price of the previous month.

To estimate the price impact for firm i over month t, we calculate the product of $\hat{\Gamma}$ and $X_{1,i,t-1}$, for example, for the Breen et al. specification [2]:

$$\lambda_{i,t}^{BHK} = X_{i,t-1}\hat{\Gamma} \qquad (6)$$

We note that the same approach is used to estimate the coefficients from the Glosten and Harris model [9], λ_{it}^{GH} and ψ_{it} and effective and quoted spreads, S_{it}^{E} and S_{it}^{Q}. Table 3 reports the sample statistics for firm characteristics.

The ratio of the stock capitalization (X_1) range from 0 to 320.192 with an average equal to 1.034. We note that there is a big scattering between stocks. This difference can be induced by the composition of our sample which is formed of stocks with different sizes. In the same way, the volume of transaction ratio (X_2) is on average equal to 1.043 with minimum equal to 3.09×10^{-8} and a maximum of 142.035. So, several stocks of our sample are more liquid than others. Indeed, they have transaction volume superior to the mean transaction volume of the entire sample.

Table 4 reports the estimates of the average cross-sectional relation between transaction costs and firm specific predetermined variables (Eq. 5); t-statistics reported in the parentheses are adjusted for the heteroscedasticity using Newey and West correction [21]. This table indicates that transaction costs are negatively related to market capitalisation of firms. Concerning the ratio of the transaction volume, results are not homogeneous. The ratio is negatively related to Breen et al. measures of transaction costs and to the effective spread [2]. But, the coefficient of this ratio is positive for the fixed component of transaction costs of Glosten and Harris model [9].

Table 5 presents details of the distribution of the quoted spread, effective spread and price impact measures obtained from the cross-sectional regressions, similar to Eq. (6) for λ_i^{BHK}.

The results in this table continue to show that the quoted spread is extensively superior to the effective spread where the first is on average equal to 0.0235 while the second is the order of 0.0033. In addition, the variable components of price impact costs λ are smaller than proportionate trading costs. As in Korajczyk and Sadka [15], trading costs of price impact models increase in the size of the position traded.

6. Performance Evaluation of Momentum Strategies

In this section we wish to evaluate the performance of momentum-based trading strategy. Two approaches were followed to estimate the returns of the momentum strategy net of the trading costs.

Tab. 3: Firm characteristics

Variable	***Mean***	***St deviation***	***Minimum***	***Median***	***Maximum***
X_1	1.034	4.668	0.000	0.0350	320.192
X_2	1.0439	4.9507	3.09×10^{-8}	0.0242	142.0357
X_3	1.0232	0.8325	0.00	0.9893	29.213
X_4	0.1167	0.321	0.000	0.000	1.000
X_5	0.0259	0.1407	-0.1834	-0.0003	0.8506
X_6	0.1177	0.4698	2.77×10^{-11}	0.0215	10.8108

X1= market capitalisation at the end of month t divided by the average market capitalisation of sample firms
X2= total volume from month t-2 to month t divided by the total volume, over the same period, for the average sample firms
X3= stock price at the end of month t divided by the price at the end of month t -6
X4= dummy variable equal to unity if the firm is included in the CAC40 index
X5= R2 of returns regressed on returns of the sample equally weighted index over the preceding 36 months
X6= inverse of stock price of the previous month.

Source: own

Tab. 4: Transaction costs and firm characteristics

Variable	*Non-proportionate costs*			*Proportionate costs*	
	λ^{BHK}	λ^{GH}	ψ	S^Q	S^E
Intercept	0.0005 (3.382)	0.0017 (0.526)	0.0139 (1.219)	0.0057 (0.817)	0.0033 (2.264)
X_1	6.61×10^{-6} (0.429)	-0.0004 (-1.185)	-0.0052 (-4.189)	-6.4705 (-0.0954)	-2.1310^{-5} (-0.145)
X_2	-1.8410^{-5} (-1.236)	0.0061 (1.998)	0.0017 (1.4031)	0.0006 (0.945)	-3.2710^{-5} (-0.231)
X_3	-0.0005 (-3.5487)	0.0046 (1.317)	-0.0165 (-1.4623)	0.0143 (2.157)	-0.0001 (-0.077)
X_4	7.81×10^{-5} (0.579)	-0.0014 (-0.4518)	0.0265 (2.447)	0.0079 (1.338)	-0.0009 (-0.756)
X_5	-2.49×10^{-5} (-0.118)	0.00129 (0.2727)	0.0003 (0.206)	0.0072 (0.7705)	-0.0007 (-0.3406)
X_6	0.0004 (2.819)	-0.0008 (-2.366)	0.0015 (0.118)	0.0197 (2.882)	0.0022 (1.499)

Source: own

Tab. 5: Estimated measures of liquidity

Variables	*Mean*	*St deviation*	*Minimum*	*Median*	*Maximum*
λ^{BHK}	4.79×10^{-5}	0.0005	-0.0150	2.23×10^{-5}	0.0047
λ^{GH}	0.00029	0.00464	-0.12335	0.00030	0.04991
ψ	-0.0024	0.02751	-1.6292	-0.0019	0.2403
S^E	0.0033	0.00119	-0.0046	0.0032	0.0273
S^Q	0.0235	0.0159	0.0042	0.0212	0.4260

Source: own

Tab. 6: Estimate relative strength strategy trading profits

Portfolio (t-statistic)	*Raw return*	*Non-proportionate costs*		*Proportionate costs*	
		λ^{BHK}	λ^{GH}, ψ	S^{Q}	S^{E}
Loser	0.0047 (1.077)	0.0001 (4.878)	0.0031 (122.929)	0.026 (50.579)	0.0036 (90.778)
P2	0.004 (1.346)	6.92 10^{-5} (4.109)	0.0029 (144.92)	0.0232 (53.82)	0.0033 (112.616)
P3	0.0046 (1.85)	5.6510^{-5} (3.5048)	0.00297 (96.420)	0.0231 (1.483)	0.0031 (122.54)
P4	0.016 (2.368)	1.3410^{-5} (0.766)	0.0030 (125.557)	0.0226 (50.459)	0.0030 (138.93)
Winner	0.0177 (3.995)	1.0210^{-5} (0.5091)	0.0029 (112.69)	0.0225 (42.632)	0.0031 (118.18)
W-L raw return	0.0129 (2.1105)				
W-L net return		0.0128 (1.6713)	0.0069 (2.188)	-0.035 (-4.407)	0.0066 (0.833)

Source: own

The first consists in comparing the gross returns of the winner minus loser (*W-L*) portfolio to the transaction costs associated with executing these positions. The second consists in estimating the model of Fama and French [6] by using the returns nets of the transaction costs. The intercept of this model represents the abnormal return of the momentum strategy net of trading costs and adjusted to risk factors. The performance of the trading strategy is independent of the size of the portfolio for proportional trading costs and declines with the size of the portfolio for non proportional trading costs. Therefore, we are interested in determining the amount that a single portfolio manger could invest before the performance of momentum strategies become negative.

Our analysis is restricted to a strategy that selects stocks on the basis of returns over the past twelve months and holds the position of buying winners and selling losers for one month, since it exhibits significant performance before transaction costs and price impacts (Tab. 1) and it requires more transaction costs than other strategies. So, if the excess return after trading costs of this strategy remains positive, we can conclude that other strategies tend to be profitable after trading costs.

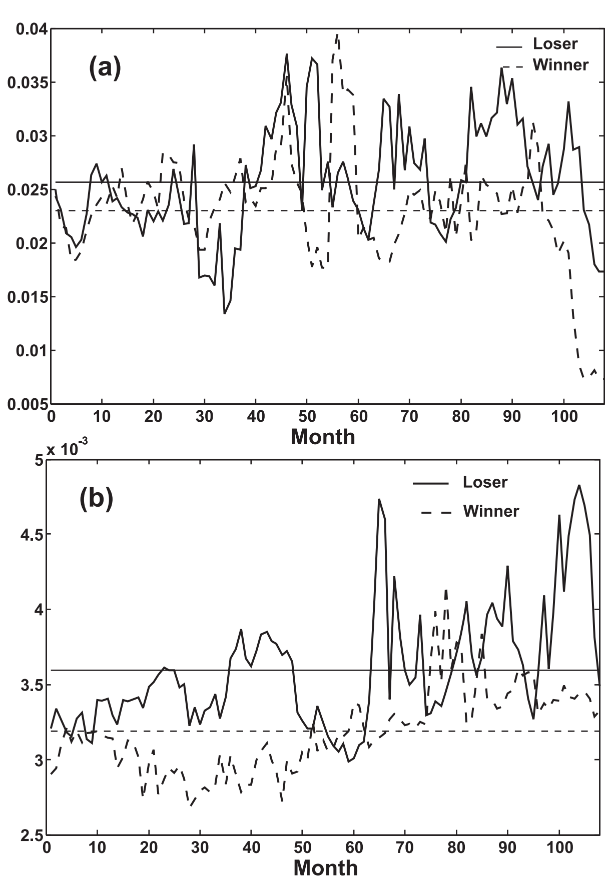
6.1 Portfolio Returns after Trading Cost Measures

According to the no-arbitrage rule, the *W-L* returns should not exceed the respective expected transaction costs. In Table 6, we compare the mean raw returns from the various relative strength portfolios to the trading cost estimates associated with executing these positions. In this table, we report the mean raw returns of momentum portfolios. We also report the mean trading cost estimates associated with the corresponding portfolios and the return of momentum strategy after transaction costs (*W-L* net return); t-statistics are reported in the parentheses.

Because returns from standard relative strength strategies are computed using an equal weighting, the trading costs are also equal-weighted. Our trading cost estimates represent the mean roundtrip cost for trading the stocks within the respective portfolios for which obtain estimates. The results suggest that trading costs of *Loser portfolio* are superior to transaction costs of others portfolios. The difference is especially marked for the *Winner portfolio*.

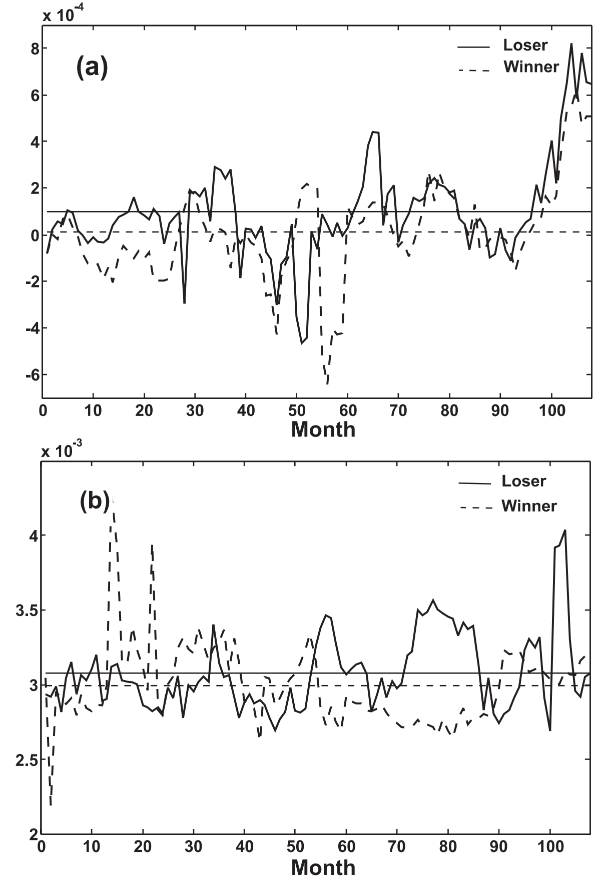
In Figures 3 and 4, we compare the monthly trading cost estimates for the stocks associated

Fig. 3: Monthly spreads of Loser and Winner portfolios (a): Quoted read, (b): Effective spread



Source: own

Fig. 4: Monthly price impact costs of Loser and Winner portfolios (a): Breen, Hodrick, and Korajczyk cost, (b): Glosten and Harris cost



Source: own

with the portfolios *Loser* and *Winner*. Each figure illustrates a time-series of the trading cost estimates. Figure 3(a) shows that the average quoted spread of Loser portfolio is the order of 0.026 whereas it is the order of 0.022 for *Winner* portfolio. In addition, quoted spread records a decrease at the end of the sample period. In the same way, the *Loser* portfolio records the most elevated effective spread (Fig.3(b)), it is equal to 0.0036 (*t-statistic* of 90.778).

For non proportional transaction costs, figure 4(a) presents an increase of the price impact coefficient at the end of the sample period. Moreover, monthly trading costs of loser stocks are greater to those of winner stocks.

For all measures of trading costs (proportional and non proportional), we can conclude that on average the loser's stocks are less liquid than the winners stocks.

We use the trading cost estimates (Tab. 6) to examine the after trading cost profitability of relative strength strategy. For the retained strategy, the long position (*W*) produces returns of 1.77 % (t-statistic of 3.995) while the short position (*L*) only costs 0.47 % (t-statistic of 1.077) generating a monthly before trading cost return of 1.29 % (*t-statistic* of 2.1105). To realize the *W-L* returns, the relative strength investor must short the Loser stocks and also buy the Winner stocks. The execution requires paying the trading costs on both the long and short positions incurring the proportionate costs and price impact costs. These costs can be considerable, particularly when the strategy is tilted toward relatively illiquid securities.

Since the quoted spread measure constitute the classic trading costs facing investors, we begin by comparing the *W-L* profits to the total quoted spread. Given that the relative strength investor opens and closes positions in both the *Loser* and *Winner* stocks, the *W-L* quoted spread estimate is simply the sum of the respective quoted spread estimates. From the table 6, selling the Loser portfolio is associated with quoted spread of 2.6 %, while buying the *Winner* portfolio is associated with quoted spread costs of 2.2 %. The combined trading cost facing the investor is the sum 4.8 %. Subtracting the estimated quoted spread of 4.8 % from the raw *W-L* return of 1.29 % produces an after-cost return estimate of -3.59 %. Based on this estimate, the costs of frequent trading exceed the strategy's profit. However, momentum strategy remains profitable after considering the other transaction costs measures. Indeed, the after effective spread estimate profit is 0.66 % (t-statistic of 0.833). For the non proportional trading costs, the net return is respectively 1.28 % (*t-statistic* of 1.6713) for Breen et al. specification [2] and 0.69 % (t-statistic of 2.188) for Glosten and Harris [9].

6.2 Abnormal Returns of Fama and French Model (1993)

Using the Fama French (1993) three-factor model we estimate the time-series regression:

$$r_{pt} = \alpha_p + b_p(r_{mt} - r_{ft}) + s_p SMB_t + h_p HML_t + e_{pt} \qquad (7)$$

where r_{mt}-r_{ft} is the monthly return of the momentum portfolio in excess of the one-month free risk return (r_{ft}); r_{mt} is the return on the equally weighted market portfolio, in excess of r_{ft}; SMB_t is the average return on the small capitalization portfolio minus the average return on the large capitalization portfolio; and HML_t is the average return on high book-to-market equity portfolio minus the average return on low book-to-market equity portfolio. To construct these three factors, the methodology of Fama and French [6] is considered. The conditional exposures of the momentum portfolios to the three factors are denoted by b_p, s_p, and h_p. This methodology allows to adjusted momentum return after trading costs to risk factors. For proportional trading costs, this model is estimated for the top (*Losers*) decile, bottom (*Winners*) decile and for the *W-L* portfolio. For non proportional trading costs we limit our analysis to winners alone. The reason steams from the potential asymmetry of trading costs between engaging in a long position and short selling. Loser portfolio comprises stocks that have extreme past underperformance, and are biased to small firms, which may be difficult to short sell. Therefore, short selling execution, especially large positions, involves additional costs not fully captured by our measures of price impact (Korajczyk and Sadka [15]). Geczy et al. find that the costs of short selling are not sufficient to eliminate momentum profits [8]. The persistence of winners is an important anomaly on its own, since the excess returns of winners exhibited in the data are statistically significant.

6.2.1 Abnormal Momentum Profits with Proportional Costs

Table 7 reports the results of estimating Fama French model for *Loser*, *Winner* and *W-L* portfolios with proportional trading costs. The estimated abnormal returns, α, of *W-L* portfolio are respectively 0.0193 (*t-statistic* of 1.975) and 0.0201 (*t-statistic* of 2.5778) per month respectively for the quoted spread and effective spread.

amount invested in each at the beginning of January 1995. Every month, the portfolios are rebalanced according to the rules dictated by the trading strategy. These rules define the stocks to be included in the portfolio according to the ranking and holding periods. The net returns are calculated using the trading model developed below, assuming that the price impact coefficients are known.

The momentum profit arises because the continuation in return over the 3 to 12 months.

Tab. 7: Performance under proportionate transaction costs

Portfolio	α	*Rm*	*SMB*	*HML*
W-L raw return	0.0268 (2.121)	0.0422 (0.215)	-0.020 (-0.276)	-0.3623 (-2.199)
Panel A : Quoted spread				
Loser	-0.0066 (-0.897)	0.619 (5.768)	-0.0088 (-0.723)	0.2096 (3.400)
Winner	0.0127 (1.974)	0.5744 (5.570)	0.0076 (0.647)	0.0225 (0.308)
W-L	0.0193 (1.975)	-0.0446 (-0.310)	0.0164 (1.003)	-0.1871 (-2.264)
Panel B : Effective spread				
Loser	0.016 (2.086)	0.6255 (5.784)	-0.0081 (-0.661)	0.2118 (3.408)
Winner	0.0328 (4.595)	0.5793 (5.580)	0.0072 (0.6115)	0.0185 (0.3104)
W-L	0.0201 (2.5778)	0.1179 (1.038)	0.0125 (0.9718)	-0.1488 (-2.2814)

Source: own

This result indicates that the proportional costs used here do not drive away the statistical significance of momentum profits. This observation is different from the results reported in Tab. 6 as we find that after consideration of quoted spread, strategy momentum generates a negative return of -3.05 %. This opposition can be owed to the adjustment of returns to the Fama and French three risk factors. Indeed, Jegadeesh and Titman find that adjustment the returns to risk factors tend to strengthen rather than to explain momentum strategies profits [12].

6.2.2 Abnormal Momentum Profits with Price Impact Costs

We study the profitability of long position in winner based momentum strategy as we vary the initial

To profit from this return behaviour, one would want to buy a *Winner* portfolio (*P5*), and at the same time short a *Loser* portfolio (*P1*) with both sides of the same euro amount invested. In particular, suppose that we start with an initial fund size π_0 and implement a self-financing long-short arbitrage over the next T periods. In each period, we short an equally weighted portfolio of all the stocks in the top decile and hold an equally weighted portfolio of all the stocks in the bottom decile. At the beginning of period 1, we invest π_0 euros in *P5* and short π_0 in *P1*. After price impact costs, we effectively hold $b_1=\pi_1-PIL_1-PIS_1$ euros of *P5* in our long portfolio, and are short b_1 euros of *P1*, where PIL_1 and PIS_1 represent the price impact costs necessary to create respectively our long position and short position. At the beginning of period 2, we rebalance our portfolio in a self-financing manner such that euros are invested in *P5* and π_1 euros are shorted of *P1*. The value of each position is $b_2=\pi_1-PIL_2-PIS_2$, after price impact costs. We compute PIL_2 and PIS_2 based only on the rebalancing amount for each stock and not on π_1. Both the long and the short portfolios are held until the end of period 2, and thus the value of our total portfolio changes to $\pi_2=(1+r_{L,2}-r_{s,2})b_2$. The amount π_2 will be the initial value of our portfolio in the beginning of the third period when we rebalance again in order to be long in *P5*, and short in *P1*, and so on. Thus, the portfolio dynamics are governed by:

$$b_t=\pi_{t-1}-PIL_t-PIS_t \quad (8)$$

$$\pi_t=(1+r_{L,t}-r_{st})b_t \quad (9)$$

for $t\in\{1,2...T\}$, the excess returns are calculated for each period by

$$r_t=\frac{\pi_t}{\pi_{t-1}}-1 \quad (10)$$

After subtracting the price impact cost, the long position is worth $\pi_{t-1}-PIL_t$ euros, while the short position's value is $\pi_{t-1}-PIS_t$.

Table 8 presents the estimated portfolio abnormal returns, α, and the three factors estimates coefficients for several initial investment levels (*I1, I2....I5*); *t*-statistics are reported in the parentheses.

For price impacts implied by the Breen et al. specification [2], price impact drives away the profitability of equal-weighted strategies with investment portfolios larger than 5 million euros. For top break even sizes abnormal returns are superiors to zero.

Tab. 8: Performance under non proportionate transaction costs for several initial investment levels

Size		*Rm*	*SMB*	*HML*
Panel A: Breen, Hodrick, and Korajczyk (2002) model				
I1	0.3600 (2.5136)	-0.0997 (-0.491)	-0.0597 (-0.2594)	-1.0076 (-0.8647)
I2	0.2509 (2.0779)	-0.0256 (-0.0146)	-0.0269 (-0.135)	-0.1718 (-0.1708)
I3	0.1769 (1.538)	-2.1822 (-1.3082)	0.0043 (0.0229)	-0.1239 (-0.1293)
I4	-0.0110 (-0.076)	-4.143 (-1.980)	0.090 (0.3819)	1.432 (1.191)
I5	-0.0777 (-0.640)	-2.2108 (-1.2566)	-0.0179 (-0.0899)	0.4709 (0.4659)
Panel B: Glosten and Harris (1988) model				
I1	0.2472 (2.2185)	0.3833 (0.2372)	-0.1030 (-0.5615)	-0.9514 (-1.0248)
I2	0.2283 (1.2879)	-3.2487 (-1.2639)	-0.0482 (-0.1652)	0.9296 (0.6296)
I3	0.2785 (1.944)	-2.2852 (-1.1001)	-0.0379 (-0.1607)	-0.6031 (-0.5054)
I4	0.0816 (0.7762)	-2.7822 (-1.8241)	-0.0036 (-0.021)	0.7005 (0.7995)
I5	0.0700 (0.9584)	1.3285 (1.2528)	-0.0537 (-0.4461)	0.0992 (0.1629)

I1= 0.5 million euros, I2=1 million euros, I3= 2 million euros, I4 = 5 million euros and I5(5 million euros

Source: own

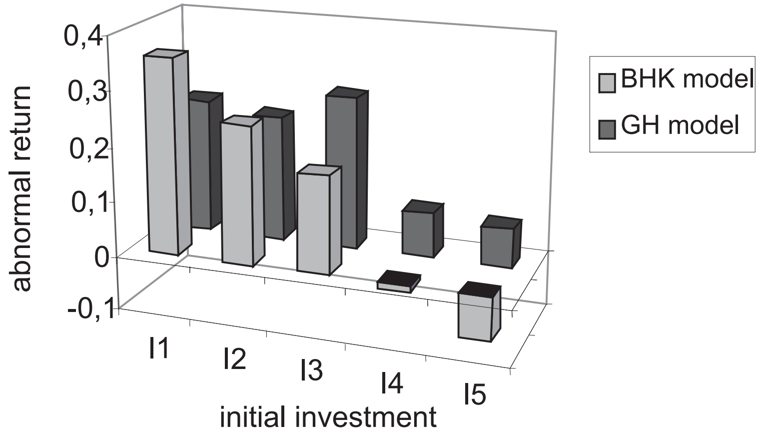
While for the Glosten and Harris specification [9], the price impact can not drives away the profitability of equal-weighted s$\hat{t}$rategy. Abnormal returns α are positives for all the level of initial investment.

In figure 5 we plot the estimated portfolio abnormal returns, $\hat{\alpha}$, for Breen et al. and Glosten-Harris models as a function of the level of initial investment. We conclude that non proportional trading costs do not eliminate the observed profitability of winner based momentum strategies.

costs are based on quoted and effective spreads. These measures are independent in the size of the portfolio. We study two alternative price impact models, one based on Glosten and Harris [6] and the other from Breen et al. [2]. These measures are non-proportional trading cost models and reflect the fact that the price impact of trading increases in the size of the position traded.

The estimate measures of trading costs are then adjusted to a set of predetermined firm's

Fig. 5: Abnormal momentum profits with price impact costs



Source: own

7. Conclusion

The finance literature has continued to struggle to understand the profitability of momentum-based trading strategies, first documented by Jegadeesh and Titman [14]. The main contribution of this paper is to test whether momentum based strategies that previously have been shown to earn high abnormal returns remain profitable after considering transaction costs and price impact induced by trading. Momentum strategies are applied for various formation and holding periods. Using French firms quoted over the period 1995-2004, we document that theses strategies that buy past winners and sell past losers realise significant abnormal returns. Results confirm that profits generated by these strategies decrease with holdings periods.

To test whether momentum profits are robust to trading costs, we applied to proportional and non-proportional costs. Two proportional trading specifics variables meant to be a proxy of a liquidity level.

Subtracting proportional transaction costs (quoted and effective spread) from raw returns, the net returns are -3.5 % (*t-statistic* of -4.407) and 0.66 % (*t-statistic* of 0.833) respectively for quoted spread and effective spread. When returns net transaction costs are adjusted to Fama and French three risk factors [6], we conclude that abnormal returns (α) are superior to after transaction cost returns. This result confirms that adjustment for factors such as the Fama and French three factors tend to strengthen, rather than to explain, momentum.

For the two alternatives measures of price impact from Glosten and Harris (1988) and the other from Breen et al. [2], the returns after trading costs are also positives, they are respectively 1.28 % (*t*-statistic of 1.6713) and 0.69 % (*t*-statistic of 2.188). Since the price impact models imply that abnormal returns to portfolio strategies decline with portfolio size, we have estimate abnormal returns (α) relative to the three factor model of Fama and French for different initial investment levels (*I1, I2...I5*). For the major break even fund sizes, momentum strategies perform better post price impact. Our results suggest that transaction cost do not appear to fully explain the momentum return. Therefore this anomaly remains an important puzzle.

References:

[1] AMIHUD, Y. Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets*, 2002, Vol. 5, pp. 31 - 56. ISSN 1386-4181.

[2] BREEN, W. J., HODRICK, L. S., KORAJCZYK, R. A. Predicting equity liquidity. *Management Science*, 2002, Vol. 48, pp. 470 - 483. ISSN 1526-5501.

[3] CHORDIA, T., SHIVAKUMAR, L. Momentum business cycle and time-varying expected returns. *Journal of Finance*, 2002, Vol. 57, pp. 985 -1019. ISSN 0022-1082.

[4] CONRAD, J., KAUL, G. An anatomy of trading strategies. *Review of Financial Studies*, 1998, Vol. 11 No. 3, pp. 489 - 519. ISSN 0893-9454.

[5] EASLEY, D., OHARA, M. Price trade size and information in securities markets. *Journal of Financial Economics*, 1987, Vol. 19, pp. 69 - 90. ISSN 0304-405X.

[6] FAMA, E., FRENCH, K. Common risk factors in the returns and bonds. *Journal of Financial Economics*, 1993, Vol. 33, pp. 3 - 56. ISSN 0304-405X

[7] FAMA, E., FRENCH, K. Multifactor explanations of asset pricing anomalies. *Journal of Finance*, 1996, Vol. 51 No. 1, pp. 55-84. ISSN 0022-1082.

[8] GECZY, C., MUSTO, D. K., REED, A. V. Stocks are special too: An analysis of the equity lending market. *Journal of Financial Economics*, 2002, Vol. 66, pp. 241-269. ISSN 0304-405X.

[9] GLOSTEN, L. R., HARRIS, L. E. Estimating the components of the bid/ask spread. *Journal of Financial Economics*, 1988, Vol. 21, pp. 123 - 142. ISSN 0304-405X.

[10] GRIFFIN, J. JI, S., MARTIN, S. J. Momentum investing and business cycle risk: evidence from pole to pole. *Journal of Finance*, 2003, Vol. 58 No. 6, pp. 2515 - 2547. ISSN 0022-1082.

[11] GRUNDY, B. D., MARTIN, J. S. Understanding the nature of the risks and the source of the rewards to momentum investing. *Review of Financial Studies*, 2001, Vol. 14, pp. 29 - 78. ISSN 0893-9454.

[12] JEGADEESH, N., TITMAN, S. Cross sectional and time-series determinants of momentum returns. *Review of Financial studies*, 2002, Vol. 15 No. 1, pp.143 - 158. ISSN 0893-9454.

[13] JEGADEESH, N., TITMAN, S. Profitability of momentum strategies: An evaluation of alternative explanations. *Journal of Finance*, 2001, Vol. 56 No. 2, 2001, pp. 699 - 720. ISSN 0022-1082.

[14] JEGADEESH, N., TITMAN, S. Returns to buying winners and selling losers: Implication for stock market efficiency. *Journal of Finance*, 1993, Vol. 48 No. 1, pp. 65 - 91. ISSN 0022-1082.

[15] KORAJCZYK, R., SADKA, R. Are momentum profits robust to trading costs? *Journal of Finance*, 2004, Vol. 55, pp. 1039 - 1082. ISSN 0022-1082.

[16] KYLE, A. S. Continuous auctions and insider trading. *Econometrica*, 1985, Vol. 53, pp. 1315-1335. ISSN 0012-9682.

[17] LEE, C. M. C., READY, M. J. Inferring trade direction from intraday data. *Journal of Finance*, 1991, Vol. 46, pp. 733 - 754. ISSN 0022-1082.

[18] LESMOND, D. A. OGDEN, J. P., TRZCINKA, C. A. A new estimate of transaction costs. *The Review of Financial Studies*, 1999, Vol. 12, pp. 1113 - 1141. ISSN 0893-9454.

[19] LESMOND, D. A. SCHILL, J. S., ZHOU, J. The illusory nature of momentum profits. *Journal of Financial Economics*, 2004, Vol. 71, pp. 349 - 380. ISSN 0304-405X.

[20] MOSKOWITZ, T., GRINBLATT, M. Do industries explain momentum? *Journal of Finance*, 1999, Vol. 54, pp. 1249 - 1290. ISSN 0022-1082.

[21] NEWEY, W., WEST, K. A Simple Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica*, 1987, Vol. 55, pp. 703 - 708. ISSN 0012-9682.
[22] ROUWENHORST, K. G. International momentum strategies. *Journal of Finance*, 1998, Vol. 53, pp. 267-284. ISSN 0022-1082.
[23] SHULTZ, P. Regulatory and legal pressures and the costs of NASDAQ trading. *Review of Financial Studies*, 1983, Vol. 13, pp. 917 - 957. ISSN 0893-9454.
[24] STOLL, H. R., WHALEY R. E. Transactions costs and the small firm effect. *Journal of Financial Economics*, 1983, Vol. 12, pp. 57 - 80. ISSN 0304-405X.

Mouna Boujelbène Abbes
Faculté des Sciences Economiques
et de Gestion de Sfax
Unité de Recherches en Economie Appliquée-
URECA
ms_abbes@yahoo.fr

Younès Boujelbène
Faculté des Sciences Economiques
et de Gestion de Sfax
Unité de Recherches en Economie Appliquée-
URECA

Abdelfettah Bouri
Faculté des Sciences Economiques et de
Gestion de Sfax
Corporate Finance Financial Theory- COFFIT

Doručeno redakci: 4. 12. 2007
Recenzováno: 25. 1. 2008
Schváleno k publikování: 7. 4. 2008

ABSTRACT

MOMENTUM PROFITS AND TRADING COSTS

Mouna Boujelbene Abbes, Younes Boujelbene, Abdelfettah Bouri

This paper investigates whether momentum strategies remain profitable, when the trading costs, including price impact are considered. Using French enterprises quoted over the period 1995-2004, momentum strategy is applied for various formation (6 and 12 months) and holding (1, 3, 6, 9, 12 months) periods. Performance of momentum strategy is evaluated after taking into account alternative measures of transaction costs. In order to estimate measures of liquidity, trading cost estimates are adjusted to a set of predetermined firm-specific variables. Two approaches were followed to estimate the returns of the momentum strategy, net of the trading costs. First we compared the returns of the winner minus loser portfolio to the respective transaction cost estimates. Second, we estimate the abnormal returns of Fama and French three factors model [6]. We find that the returns associated with relative strength investing strategies exceed three measures of trading costs: effective spread, price impact measures of Breen et al. [2] and Glosten et al. [9] cost models. For proportional trading costs (quoted spread and effective spread), the estimated abnormal return imply that proportional spreads do not eliminate the statistically significance of momentum profits. For non proportional trading costs (price impact models), the performance of the trading strategy declines with portfolio size. We estimate the abnormal returns for different levels of initial investment. For Breen et al. specification, we find that for the major break even fund sizes momentum strategies perform better post price impact. For Glosten et al. specification, we find that abnormal return remains positive for all levels of initial investment.

Key Words: *Momentum strategies, Transaction costs, Price impact, Market efficiency.*

JEL Classification: *G1, G14, C01*