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Can Small Investors Exploit the Momentum Effect?

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Can Small Investors Exploit the Momentum Effect?

Abstract This study uses U.K. data and investigates whether small investors can exploit the continuation effect in share prices. Individual traders are not in a financial position to buy and sell short hundreds of firms, as suggested by existing academic research, and thus this study uses extreme performance companies to implement the strategy. We find that strong momentum gains appear when extreme winners and losers are employed. These returns remain strong even after considering the transaction costs of implementing such strategies, including commissions, stamp duty, selling-short costs, and bid-ask spread. Overall, we show that a relatively large number of small investors can enjoy momentum gains, providing some evidence against stock market efficiency.

Keywords stock market efficiency; momentum effect; transaction cost.

JEL codes G14, G11.

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1. Introduction

Strategies of combining long and short positions in the market started in the 1980s, their aim being to benefit from both underpriced and overpriced securities. One of the most significant strategies that follows the hybrid long and short position is that used by Jegadeesh and Titman (1993). They find that an investment method that buys firms that performed the best over the previous three to twelve months and sells short firms that performed the worst over the past three to twelve months can generate an abnormal profitability of approximately 1% per month. This pattern in share prices is called the "momentum effect".

Empirical results based on international data support the existence of the momentum effect (Jochum 2000). For example, momentum profits are strong in 12 developed European markets (Rouwenhorst 1998), in 29 out of 37 international markets (Griffin *et al.* 2003), and in 17 out of 20 emerging stock exchanges (Rouwenhorst 1999). Momentum returns remain strong even after adjusting for various measures of risk. For example, Fama and French (1996) find that the three-factor model cannot explain momentum profitability. Interestingly, Verhofen and Ammann (2006) use regime-switching models and report that momentum returns are particularly strong when the prevailing regime is a low-variance regime.

There is, however, some debate on the extent to which momentum returns remain strong after adjusting for the transaction costs involved in implementing such strategies. Lesmond *et al.* (2004) report that the momentum returns found by U.S.

studies (Jegadeesh and Titman (1993, 2001); Hong *et al.* 2000) disappear after adjusting for transaction costs, since both winner and loser portfolios tend to include high transaction cost shares such as small capitalization and illiquid shares. Chen *et al.* (2002) use U.S. data and examine the price impact cost of following the momentum strategy. They report that the maximum fund size possible for exploiting the momentum strategy is only $44.2 million when value-weighted portfolios are created. However, U.K. studies argue that the momentum anomaly is exploitable within a different dataset. Agyei-Ampomah (2007), using U.K. data, reports that momentum strategies that use a longer than six-month periods for implementation can achieve statistically and economically significant returns after transaction costs. Li *et al.* (2009) find that the momentum strategy can generate post-cost abnormal returns as long as investors follow a strategy of using low transaction cost shares.

Within this context, a number of studies have attempted to minimize the transaction cost when implementing momentum strategies. Rey and Schmid (2007) use Swiss data and show that by using a limited number of large capitalization winner and loser companies, investors can generate significant momentum returns with low transaction cost. Li *et al.* (2009) rank companies based on their bid-ask spreads and follow the momentum strategies with low-cost stocks. Other studies restrict their sample to large capitalization companies (e.g., Chan *et al.* 1999) and high-priced (above $5) companies (e.g., Jegadeesh and Titman 2001).

This study uses U.K. data and contributes to the literature by investigating whether small investors can gain by following momentum strategies. To the best of our knowledge, this is the first time this issue has been examined in any dataset, even though it is an important issue, considering the criticism small investors receive in

the literature as to their investment decisions (e.g., DeBondt 1998). Since retail investors have a limited financial position, this paper studies the profitability of the momentum strategy when a much smaller number of firms is utilized to create the winner and loser portfolios. Rey and Schmid (2007) use Swiss data and show that using a limited number of winner and loser companies, investors can generate significant momentum returns with low transaction cost. Siganos (2007) uses U.K. data and reports that there is a tendency for a negative association between the number of winner and loser companies and momentum profitability. Thus, a small number of winner and loser firms are expected to generate relatively low transaction costs and high momentum profitability.

We first study the momentum strategy over a 12-month period, since there is no consensus in the literature as to which alternative continuation strategy offers the highest profitability and by using a long-period strategy, trading frequency is minimized, thus reducing transaction costs.[1] We find that continuation returns are economically and statistically significant when extreme winners and losers are employed. We also investigate whether those momentum gains remain strong after considering the cost of implementing such strategies, including the impact of commissions, stamp duty, selling-short costs, and bid-ask spread. We find that investors need to invest at least £15,000 among 20 winners and 20 losers to achieve economically and statistically significant momentum returns. We use the Sharpe ratio to identify the optimal level and find that this level is 20 winners and 20 losers.

[1] This statement holds as long as non-overlapping momentum strategies are employed and thus no monthly rebalancing is required.

We then investigate the robustness of our results by employing the strategy over three- to nine-month periods. We find that gross momentum returns remain strong for the alternative periods. When one adjusts for transaction cost, the profitability of the three-month strategy disappears due to the frequent transactions. Analyzing the net momentum returns for the six-month strategy, we find that investors need to invest among at least 20 winners and 20 losers to enjoy statistically and economically significant returns, and that the minimum investment necessary for such is £25,000. The momentum results for the nine-month strategy are the strongest found in this study and the transaction costs for that period are relatively low compared to those incurred in the three- and six-month strategies. We find that investors can achieve statistically and economically significant gains by investing in just two winner and two loser companies with a minimum investment of less than £5,000. Overall, our results show that a relatively large number of small investors can exploit the momentum effect, since studies (e.g., Goetzmann and Kumar 2008) show that retail investors hold, on average, shares worth around $35,000.

The remainder of this paper is organized as follows. The next section discusses the momentum strategy from the standpoint of small investors. The third section presents the data and explains how they are employed. The fourth section presents the empirical results, followed by our conclusions in the last section.

2. Small investors and the momentum strategy

Individual investors hold approximately 40 and 15 percent of all outstanding shares in the U.S. and the U.K. stock markets, respectively (National Statistics 2006), but they are often criticized severely for their investment decisions. DeBondt (1998) describes small investors as a "sorry picture". For instance, they tend to trade excessively (e.g., Barber and Odean 2000), maintain non-diversified portfolios (e.g., Statman 2004), and hesitate to sell loser shares (e.g., Odean 1998). Therefore, small traders could benefit significantly by adopting the momentum strategy, as such a strategy requires no profound knowledge of investing. All one needs to do is buy (sell short) firms that performed the best (worst) over the past period, information quite easily found, even in the popular press.[2]

It should be noted that small investors cannot take advantage of the momentum effect by investing via low-cost financial funds. A great many institutional managers tend to employ the momentum strategy by increasing their holdings of previous winner shares and slightly decreasing the number of prior loser shares (e.g., Burch and Swaminathan 2001) but, to the best of our knowledge, no fund strictly follows the momentum strategy in making investment decisions. Additionally, Carhart (1997) reports that the increase in fund managers' holdings of previous winners is accidental rather than an intentional effort to follow the

[2] It should be noted that a number of small investors may find it difficult to sell short shares, since it is necessary to find existing owners of the securities who are willing to lend their shares. Academics are not in agreement regarding the percentage of retail investors that take short positions in practice, since findings vary significantly within alternative samples. For example, Mizrach and Weerts (2009) report that around 42% of retail traders undertook at least one short-sale order, but Barber and Odean (2008) find that only 0.29% of individual traders took short positions. Another method to short-sell within the UK market is by using contracts for difference (CFDs). CFDs were introduced for professional investors in the early 1990s and were available for small investors by the end of that decade. These are financial futures contracts that are traded over-the-counter.

momentum strategy, since fund managers do not follow the same investment strategies over time.

Small investors thus need to invest in individual stocks when engaging in the momentum strategy. Previous studies in the field of momentum are not representative for individual traders. Most U.S. studies (e.g., Jegadeesh and Titman 1993) employ data from the CRSP database, which contains approximately 7,000 shares listed on the Amex, NYSE, and NASDAQ markets. Most U.K. studies (e.g., Liu *et al.* 1999) use data from LSPD or Datastream, which encompass almost 6,000 shares listed on the London Stock Exchange. These studies define winner and loser portfolios based on deciles, quintiles, or triciles, analyzing hundreds of companies in the process. Retail traders are definitely not in a financial position to hold such portfolios.[3] Goetzmann and Kumar (2008), for example, find that a typical U.S. investor holds shares worth $35,629 (median $13,869), with the majority of investors holding three or four stocks in their portfolios and only 5% of trader portfolios containing more than 10 firms. A strategy that buys a few shares for a large number of companies is unlikely to become profitable, since investors pay commissions either as a flat fee for each trade or as a percentage of the money invested beyond a minimum amount. Since retail traders are unlikely to be able to buy/sell-short hundreds of companies, this study explores the profitability of the momentum strategy when a much smaller number of companies is included in the winner and loser portfolios.

[3] One may argue that the limited financial position of small investors does not limit retail traders from engaging in the momentum strategy, since the momentum strategy is called a "zero-investment" strategy in which it is assumed that the short seller is allowed to use the proceeds from the short selling to buy the long portfolio. This is, however, a misconception, since in practice the proceeds from short selling are not available to the short seller, but are used as collateral with the lender to provide security for the borrowed shares (e.g., Alexander 2000).

3. Data and methodology

This study utilizes monthly return information for all listed and delisted U.K. companies reported by Datastream between January 1988 and December 2006. The inclusion of dead companies ensures that the sample is free of survivorship bias. The number of firms analyzed in any given period ranged from 758 to 1,137, with an average of 892. The range of firms analyzed over the sample period was limited. The sample period focuses on the post-1988 period, since we require information regarding the bid and ask prices of the companies, which are available only after 1987.

For each stock in the sample we collect the following information from Datastream:

- The RI data type determines monthly share returns [$r = \ln \frac{RI_t}{RI_{t-1}}$], which is adjusted for dividend payments.

- The MV data type shows the market capitalization of companies (in £ millions). The time selected is one month before the rank period.

- The UP data type shows the unadjusted closing prices of companies (in pence). This is the actual price as recorded on the day and it is not adjusted for bonus and rights issues. Liu *et al.* (1999) is one of the studies in the field that employs this data type to explore share price information. The time selected is one month before the rank period.

- The PA and PB data types show, respectively, the ask and bid prices of companies (in pence). The frequency of data is weekly and the time selected is 12 months before implementation of the strategy. Other studies (e.g.,

Agyei-Ampomah 2007) use monthly information to calculate the bid-ask spreads. This study uses weekly information, which provides a larger number of observations and a relatively stable estimation of the bid-ask spread of firms throughout the year.

The time selected for the above measures is done to avoid endogeneity issues by contaminating characteristics of companies with their performances. For example, if one considers the ranking period of market capitalization of companies, losers (winners) would appear to be low (high) market capitalization companies simply due to the portfolio construction. The time selected for the above measures is in line with that used in the literature (e.g., Lesmond *et al.* 2004).

Momentum profits are calculated by ranking companies on the basis of their stock market performance over the previous 12 months (the rank period).[4] Companies must have been traded in all 12 months to be included in the sample. Unlike previous studies, the winner portfolio, W (the loser portfolio, L), contains the best (the worst) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30, 40, and 50 performing shares. The more extreme the definition of winners and losers employed, the higher the magnitude of momentum profits expected (Siganos, 2007). The momentum effect is calculated on the compound returns of each of the equally weighted portfolios over the following 12-month period after the rank period (test period). If a company becomes delisted during the test period, the respective return is determined to be equal to zero.[5] This procedure is repeated for each non-overlapping 12-month

[4] We use alternative three- to nine-month periods to define winners and losers later in the study.

[5] This approach to determine the influence of delisted companies on the testing period is similar to that used by Agyei-Ampomah (2007). Another approach used in the literature (e.g., Liu *et al.* 1999) is to set -100% in the case a company is liquidated and 0% otherwise. Our approach probably downward biases the size of the momentum returns, since most of the liquidated companies tend to appear in the loser portfolio and thus our approach may underestimate the forthcoming finding as to whether small investors can exploit the momentum effect.

period. The use of non-overlapping periods, rather than overlapping periods, is realistic for small investors, since it provides a reasonable number of transactions and thus relatively low transaction costs. The difference between winner and loser portfolio returns ($W - L$) shows the profitability of the momentum strategy. When the $W - L$ portfolio return is positive, the momentum strategy has generated a gain. Alternatively, either the reverse occurs ($W - L < 0$) or market efficiency holds ($W - L = 0$).

4. Empirical findings

4.1 Momentum returns unadjusted for cost

Panel 1 of Table 1 shows the gross returns for the winner, loser, and momentum portfolios unadjusted for transaction costs. The continuation returns appear economically and statistically significant when extreme winners and losers are employed.[6] All momentum strategies provide positive abnormal returns, with most of the continuation returns statistically significant either at the 1 or 5% level. For example, an investment strategy that buys the best two winners and sells short the worst two losers realizes significant compound gains at the level of 5.77% per month ($p - value < 10\%$). Results are driven by the loser portfolio. The level of the momentum returns reported in this study tends to be higher than that found by other U.K. studies (e.g., Liu *et al.* 1999; Hon and Tonks 2003). Those studies employ

[6] Notice that we investigate the statistical inference using conventional t-statistics and the bootstrap method. This checks for violation of the assumptions of the parametric model. We resample the $W - L$ portfolios, with replacement, 10,000 times using the full original data. We then calculate the average mean of these 10,000 re-samples and subtract this from each individual average return. We then follow the percentile method (Efron 1982) to estimate the statistical inference, which simply ranks the 10,000 mean returns, and investigate the position of the original $W - L$ return within the distribution. RATS software is employed for the particular analysis. We find that parametric and nonparametric methods demonstrate similar levels of statistical significance, thus the conventional parametric inference is applicable. In unreported results, the bootstrapped distributions of $W - L$ returns provide a close approximation to the parametric distribution.

conventional decile/quintile/tricile portfolios to define winners and losers and, consistent with Siganos (2007), momentum profits tend to be lower among broad definitions of winners and losers.

Panel 2 of Table 1 sets out descriptive statistics for the momentum returns. It appears that the high level of momentum profits holds when one uses a simple average/median to calculate the $W - L$ returns. The large momentum returns remain strong even when one excludes the highest 1% $W - L$ profits; thus the results are not driven by a few extreme positive returns. Momentum returns are also positive for around 60% of the months during the sample period. A small number of share portfolios, however, tends to realize a high range of momentum profits. Consistent with Rey and Schmid (2007) and Siganos and Chelley-Steeley (2006), momentum returns are negatively correlated with market returns (FTSE-All Share), indicating that momentum returns are mainly driven by the loser portfolio during bear markets.

As a robustness test, we split the sample into two equal sub-periods and re-estimate the magnitude of momentum returns. Panel 3 of Table 1 shows the results. We find that momentum returns tend to be slightly lower during the second sub-period and that there is a significant difference in momentum profitability over time only when an investor buys one winner and sells short one loser. Overall, results reveal that momentum profits remain relatively robust over time.

4.2 Transaction costs estimation

Can small investors enjoy the seemingly strong momentum returns reported above? To test this, we need to control for the cost of implementing such a strategy. To follow the continuation strategy, investors should buy and, 12 months later, sell the winner portfolio; at the same time, they should sell short and, 12 months later, buy back the loser portfolio, implying that four transactions should be executed on an annual basis. There are many costs associated with these transactions.

We first consider the commission cost of following the momentum philosophy. We assume that commission is charged at a flat fee of £10 per trade. This is a reasonable level of commission charged to small investors by on-line brokers.[7] Previous studies use a specific percentage to measure the commission cost (e.g., Agyei-Ampomah 2007). This study investigates the amount of money required to achieve momentum gains and thus the commission cost, in percentage terms, is not constant. The commission cost decreases (increases) significantly in large (small) investments and in strategies that use a small (large) number of companies. The percentage of commission cost for each individual strategy also changes during the sample period according to the $W - L$ performance. The commission cost in incurred for buy and sell transactions.

In addition to commissions, investors face additional costs when investing in shares. The stamp duty is a considerable cost that is payable when buying U.K. shares, amounting to 0.5% per purchase trade.

Another significant cost comes from selling short firms. The magnitude of this cost varies significantly dependent on the supply and demand of the particular shares

available to lend. D'Avolio (2002) uses U.S. data and finds that loan fees can vary from a low of 0.17% per year up to, in some rare instances, over 50% per year. Within the U.K. context, there are no readily available data regarding selling-short costs.[8] Consistent with Li *et al.* (2009) and Ellis and Thomas (2004), we assume that the selling-short cost is 1.5% per year. This may be an inaccurate estimation of short-selling cost but it is an at least somewhat reliable estimate of the transaction cost that investors face, and better than ignoring such costs altogether.

Panel 1 of Table 2 sets out the results regarding the bid-ask spread cost. This cost is the highest for small illiquid firms. It is also especially difficult for small investors to trade within the bid-ask spread due to their limited negotiation power. We use the spread specification suggested by Lesmond (2007), adapted for weekly data.

$$BidAskSpread = \frac{1}{T}\sum_{i=1}^{T}\frac{Ask_{i,t} - Bid_{i,t}}{(Ask_{i,t} + Bid_{i,t})/2} \quad (1)$$

where $Ask_{i,t}$ ($Bid_{i,t}$) is the weekly ask (bid) price for share i at day t and T is the number of weeks for which bid and ask prices were recorded by Datastream.

The weekly information provides a large number of observations and a relatively stable estimation of firms' bid-ask spread throughout the year. The time selected is 12 months before the ranking period so as to avoid endogeneity issues. We also exclude firm-years of companies with bid-ask spreads greater than 100% so as to avoid the problem of outliers significantly influencing the results. This exclusion of

[7] http://www.moneysupermarket.com/shares/ (last access April 2009).
[8] As far as we know, Index Explorers and Crest are the only databases that provide short-selling costs for U.K. companies. Short-selling data are, however, available only for large capitalization companies in the post-2002 period.

firm-years is common in the literature (e.g., Soares and Stark 2009; Li *et al.* 2009).[9] Half the bid-ask spread cost is incurred at the beginning and half at the close of each winner and loser transaction.

In contrast to other work (e.g., Agyei-Ampomah 2007), we find that the winners' bid-ask spreads tend to be higher than the losers' bid-ask spreads. Panel 2 of Table 2 shows that winners are smaller capitalization companies with lower prices than are the losers. This is an advantage when implementing the strategy since it is difficult to sell short very small capitalization firms. The sum of the winners' and losers' bid-ask spreads for different definitions of winners and losers is around 15% per year. This level of cost is similar to that found by Agyei-Ampomah (2007) using U.K. data.

To sum up, the estimated total annual transaction costs incurred when following the momentum strategy using a 12-month holding period are as follows:

$$WinnerCost = 2 * Commissions + StampDuty + W_{BidAsk} \quad (2)$$

$$LoserCost = 2 * Commissions + StampDuty + ShortSellingCost + L_{BidAsk} \quad (3)$$

$$Total = 4 * Commissions + 2 * StampDuty + ShortSellingCost + W_{BidAsk} + L_{BidAsk} \quad (4)$$

[9] Notice that with the inclusion of outliers in the sample, there is only a slightly upward movement of

4.3 Momentum returns adjusted for transaction costs

In this section, we investigate whether small investors can enjoy momentum returns after adjusting for transaction costs. Table 3 shows the results for alternative investment amounts and number of companies used to define winners and losers. Notice that we deduct the costs associated with momentum strategies in the month they actually occur. We find that net momentum returns are significantly lower than those reported in Table 1. This is especially the case for strategies that use a large number of companies to define winners and losers and/or for strategies that invest a relatively small amount. Overall, we find that investors may need to invest at least among 20 winners and 20 losers to enjoy statistically and economically significant returns, and that the minimum investment required is £15,000. For example, an investor who invests £20,000 among 20 winners and 20 losers gains 1.78% per month after adjusting for transaction costs. These results show that a relatively large number of small investors can enjoy momentum gains.

In Table 3 it is assumed that investors rebalance their entire portfolio from one holding period to another. This is an inaccurate assumption, since a number of companies are expected to remain in the portfolio and thus there is no need to re-buy or re-short those firms. Table 4 shows the mean proportion of W and L firms that are retained in the same portfolio in the following period. Winners tend to remain more frequently in the same portfolio over the subsequent holding period than do losers. In general, the proportion of firms that are retained in the same portfolio is significantly smaller in this study compared to other studies in the literature (e.g., Lesmond *et al.* 2004). This study uses a much smaller number of

spreads.

firms to define winners and losers and thus a much smaller proportion of companies are expected to remain in the same portfolio.

Table 4 shows the monthly post-cost momentum returns when real turnover is considered. The post-cost momentum returns shown in this table are larger than those reported in Table 3 since it is cheaper to implement the momentum strategies. We find that the increase of the post-cost momentum returns is relatively small (due to the small number of firms retained in the same portfolio), indicating that investors still need to invest at least £15,000 among 20 winners and 20 losers to achieve economically and statistically significant momentum returns.

4.4 Risk considerations

We investigate whether net momentum returns remain strong after adjusting for risk. We use alternative risk measurements and estimate the following OLS regressions:

$$NMR_{i_t} = a + bR_{mt} + u_t \quad (5)$$

$$NMR_{it} = a + bR_{mt} + cHMLBM_t + u_t \quad (6)$$

where NMR_{it} is the net monthly momentum return of strategy i when real turnover is considered, R_{mt} is the market return (FTSE-All Share), and $HMLBM_t$ is the high minus low book-to-market value. We collect book-to-market data from Kenneth French's Data Library for the United Kingdom. The frequency of the data (monthly) and the sample period selected are similar to those used in this study. Market returns are collected from Datastream. Model 5 is a capital asset pricing model and Model 6 is a multifactor model that adjusts for the BM factor used in the three-factor model

(Fama and French 1993). The factor selection is based on data available in Kenneth French's Data Library.

Panels 1 and 2 of Table 5 show, respectively, the alphas after using Models (5) and (6). Alphas indicate the abnormal profits after adjusting for risk. If risk measurements can capture momentum profitability, alphas should be economically and statistically insignificant. We find that risk measurements not only fail to explain the momentum profitability, but that $W - L$ returns actually increase after adjusting for risk. The greater the number of risk factors employed, the larger the momentum profits become (the majority of slope coefficients are negative). The failure of risk measurements to capture $W - L$ profitability is also found in other studies (e.g., Liu *et al.* 1999; Agyei-Ampomah 2007; Chelley-Steeley and Siganos 2008; Fama and French 1996).

In unreported results, we also employ the Sharpe ratio (Sharpe 1994) and investigate the optimal level of companies that should be included in the winner and loser portfolios. The Sharpe ratio is calculated as follows:

$$Sharpe_i = \frac{NMR_i - R_f}{STDEV_i} \quad (7)$$

where NMR_i is the net monthly momentum return of strategy i when real turnover is considered, R_f is the one-month treasury bill rate, and $STDEV_i$ is the monthly standard deviation for strategy i. High (low) Sharpe ratios imply high (low) return per unit of risk. We focus on strategies that generate economically and statistically significant net momentum returns and find that the optimal level is 20 winners and 20 losers.

4.5 Sub-sample analysis

Our sample includes all U.K. companies listed on the London Stock Exchange and thus some of the firms in the sample have a very small capitalization. These firms may be difficult to sell short and are expensive to trade since they tend to have high bid-ask spreads and high lending charges. Within medium/large capitalization companies, momentum strategies are much easier to implement and transaction costs are relatively low. Additionally, according to Siganos (2007), we expect that medium and large capitalization companies generate large momentum returns when extreme definitions of winners and losers are employed. This section therefore replicates previous analysis in its exclusion of small capitalization companies. We use the market capitalization of companies one month before each rank period to measure size and exclude from the sample companies in the smallest quintile.

Table 6 shows the results when the restricted sub-sample is employed. Panel 1 of Table 6 shows that all momentum strategies, unadjusted for transaction costs, provide economically and statistically significant returns.[10] Momentum returns are very strong when one uses a relatively small number of firms to implement the strategy, but momentum gains become relatively low when one uses more than 30 winners and 30 losers. In unreported results, the high level of momentum profits holds when one uses simple average/median to calculate the $W - L$ returns and momentum profits tend to remain relatively robust over time. The large momentum returns continue to be strong even when one excludes the highest 1% $W - L$ profits. As expected, it is also found that the sum of the winners' and losers' bid-ask spreads is significantly lower (almost half) in the subsample, which is the result of excluding from the sample small capitalization companies with very high bid-ask spreads.

Panel 2 of Table 6 shows the post-cost momentum returns when real turnover is considered. We find that investors can achieve statistically and economically significant gains by investing in up to 20 winners and 20 losers; the minimum required investment is less than £5,000. These results show that a considerable number of small investors can exploit the momentum effect. We also find that the optimal level is seven winners and seven losers if the investment is up to £30,000 and nine winners and nine losers when the investment is more than £60,000. [11]

Overall, empirical results change significantly using the restricted sample that excludes small capitalization companies. Within this subsample, momentum strategies employing an extreme definition of winners and losers perform best, providing even more support for the idea that small investors can exploit the momentum effect.

4.6 Momentum profitability using alternative rank and test periods

To this point, we have followed the momentum strategy over a 12-month period. We now investigate the robustness of our results by testing the strategy over different rank and test periods. We employ three-, six-, and nine month-periods to define winners and losers. In the momentum literature there is no consensus as to what continuation strategy will generate the highest/lowest profitability and so although we expect there to be differences in returns for these different period lengths, we have no expectations as to their magnitude. Panel 1 of Table 7 shows that gross momentum returns when three-, six-, and nine-month periods are used tend to be stronger than those found using 12-month period (see Table 1). In unreported results, the high level of momentum profits holds when one uses simple

[10] Notice that parametric and nonparametric methods show similar levels of statistical significance, meaning that the conventional parametric inference is applicable.

average/median to calculate the $W - L$ returns and momentum profits tend to remain relatively robust over time. The momentum returns continue to be high even when one excludes the highest 1% $W - L$ profits. The level of the bid-ask spreads is relatively similar, regardless of length of time the strategy is employed.

Panel 2 of Table 7 shows the post-cost momentum returns when real turnover is considered. Interestingly, the strong gross momentum returns reported for the three-month strategy totally disappear. This occurs due to the high transaction costs of follow such strategies. As stated before, if one follows the strategy for a 12-month period, there are a total of four transactions involved annually. Investors should buy and, 12 months later, sell the winner portfolio; at the same time, they should sell short and, 12 months later, buy back the loser portfolio. However, if this strategy is followed for a three-month period, it will necessitate 16 transactions annually—four transactions four times per year.

To successfully engage in the six-month strategy, we find that investors need to invest among at least 20 winners and 20 losers and that the minimum investment required is £25,000. Thus, to be profitable, both the 12-month and the six-month momentum strategies require an identical minimum number of companies, but the 12-month $W - L$ strategy requires a lower investment (£15,000). The nine-month strategy generates strong momentum returns and has relatively low transaction costs compared to the three- and six-month strategies. The momentum results for the nine-month strategy are the strongest found in this study. We find that investors can achieve statistically and economically significant gains by investing in as few as

[11] We also use risk adjustment models (see Models (5) and (6)) to investigate risk-adjusted momentum returns. We find that risk measurements cannot explain the momentum profits that are generated within the subsample; these results are not reported due to space considerations.

two winners and two losers and that the minimum investment required is less than £5,000.

Although not reported in detail here, we also investigated the Sharpe ratios for the three- to nine-month strategies. We find that investors who follow the six-month strategy, investing between £25,000 and £120,000, the optimal level is 30 winners and 30 losers. For investors who follow the strategy over six months and invest more than £240,000, the optimal level is 40 winners and 40 losers. We find that investors who follow the nine-month strategy and invest between £5,000 and £10,000, the optimal level is five winners and five losers. For investors who follow the nine-month strategy and invest more than £15,000, the optimal level is eight winners and eight losers.[12]

Overall, we find that gross momentum returns for the three- to nine-month strategies remain strong (actually become stronger) compared to returns for the 12-month strategy. When one adjusts for transaction costs, momentum profits decrease significantly especially for short-term strategies. These results agree, to some extent, with those of Agyei-Ampomah (2007), who reports that net momentum returns are positive only if the momentum strategy is followed over long periods.

[12] Similar to the 12-month strategy, we also use risk-adjustment models (see Models (5) and (6)) to investigate risk-adjusted momentum returns. We find that risk measurements cannot explain the momentum profits generated by the three- to nine-month strategies; these results are not reported due to space considerations.

5. Conclusion

This study employs U.K. data in an investigation of whether small investors can take advantage of one of the best-known stock market anomalies. To the best of our knowledge, this is the first time this issue has been examined in any dataset and thus our study makes a valuable contribution to the field. We find that momentum returns are strong when extreme winners and losers are analyzed. We then investigate whether those momentum gains remain strong after considering the transaction costs involved, including commissions, stamp duty, selling-short costs and bid-ask spreads. Results regarding the optimum portfolio selection and the minimum investment required vary for different samples and for different rank and test periods. However, we find that one needs to buy and sell short only a limited number of companies to exploit the momentum effect and thus the required financial investment is relatively small. Overall, this study's findings argue against stock market efficiency by showing that a relatively large number of small investors, in addition to professional investors, can exploit the momentum effect.

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Table 1 Gross momentum returns (%)

	1	2	3	4	5	6	7	8	9	10	20	30	40	50
Panel 1: Compound monthly portfolio returns: full period														
L	-2.83	-4.91	-6.10	-4.21	-4.22	-3.09	-3.23	-3.40	-3.37	-3.36	-3.47	-2.95	-2.63	-2.46
W	0.04	0.85	-0.87	-0.76	-0.16	-0.39	-0.21	-0.33	-0.29	-0.40	-0.03	0.17	0.10	-0.05
W – L	2.87	5.77 $^{*}_{\#}$	5.23 $^{*}_{\#}$	3.45	4.05 $^{**}_{\#\#}$	2.70	3.02 $^{**}_{\#\#}$	3.07 $^{**}_{\#\#}$	3.08 $^{***}_{\#\#\#}$	2.96 $^{***}_{\#\#\#}$	3.44 $^{***}_{\#\#\#}$	3.12 $^{***}_{\#\#\#}$	2.73 $^{***}_{\#\#\#}$	2.41 $^{***}_{\#\#\#}$
Panel 2: Description of W – L returns: full period														
%>0	56	60	59	58	60	58	61	62	60	59	63	64	66	64
Minimum	-105	-122	-125	-78	-72	-59	-70	-58	-56	-56	-37	-26	-28	-30
Maximum	93	88	108	81	66	52	50	51	47	43	32	24	24	22
Mean	2.62	3.35	3.09	2.37	3.20	1.93	2.42	2.63	2.64	2.54	309	2.89	2.53	2.24
Mean (excl. 1% max)	1.56	2.56	2.19	1.76	2.62	1.47	1.99	2.18	2.23	2.16	2.85	2.70	2.34	2.06
Median	3.57	4.93	4.92	3.42	3.82	3.15	3.42	3.70	3.94	3.78	3.37	2.52	2.74	2.35
Stdev	30	27	27	22	20	17	16	15	15	14	10	9	8	7
Correlation (market)	-0.169	-0.127	-0.097	-0.111	-0.104	-0.106	-0.118	-0.100	-0.120	-0.124	-0.216	-0.219	-0.237	-0.196
Panel 3: Compound monthly portfolio returns: sub-periods														
W – L (Jan88/Jun97)	-0.17	5.88	6.47	3.67	5.15 $^{**}_{\#\#}$	3.33	3.76 $^{*}_{\#}$	4.07 $^{**}_{\#\#}$	4.37 $^{**}_{\#\#}$	3.79 $^{**}_{\#\#}$	3.97 $^{***}_{\#\#\#}$	3.76 $^{***}_{\#\#\#}$	3.35 $^{***}_{\#\#\#}$	3.00 $^{***}_{\#\#\#}$
W – L (Jul97/Dec06)	5.53 $^{*}_{\#}$	5.62	4.17	3.18	3.04	2.11	2.36	2.16	1.91	2.19	2.95 $^{***}_{\#\#\#}$	2.52 $^{***}_{\#\#\#}$	2.15 $^{***}_{\#\#\#}$	1.86 $^{**}_{\#\#}$

Note: Momentum profits are calculated by ranking each company on the basis of its stock market performance over the previous 12 months. Companies had to have been traded all 12 months to be included in the sample. Unlike most previous studies, the winner portfolio, W (the loser portfolio, L), contains the best (the worst) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30, 40, and 50 performing firms. The momentum effect is calculated on the returns of each of the equally weighted portfolios over the following 12-month period. If a company becomes delisted during the test period, the respective return is determined to be equal to 0. This procedure is repeated for each non-overlapping 12-month period. The difference between winner and loser portfolio returns (W – L) shows the profitability of the momentum strategy. %>0 is the percentage of monthly periods that momentum returns (W – L) are positive; Mean (excl. 1% max) is the mean return after excluding the highest 1% W – L values; Stdev is the standard deviation; and FTSE-All Share represents the market returns.
* Significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level (conventional parametric t-tests).
# Significant at the 10% level, ## significant at the 5% level, and ### significant at the 1% level (nonparametric bootstrapped values, 10,000 simulations).

Table 2 Estimation of bid-ask spreads

		1	2	3	4	5	6	7	8	9	10	20	30	40	50
Panel 1: Bid-ask spreads (%)															
W		14.41	11.62	10.93	10.66	10.11	10.47	10.00	9.66	9.30	8.98	7.83	7.08	6.58	6.25
		(9.91)	(10.26)	(9.91)	(9.48)	(8.77)	(8.85)	(8.49)	(8.04)	(7.56)	(7.05)	(5.42)	(4.99)	(4.59)	(4.29)
L		5.30	4.77	4.80	5.79	5.44	5.28	5.26	5.27	5.78	5.72	5.63	5.61	5.52	5.49
		(2.61)	(3.07)	(3.40)	(3.37)	(3.34)	(3.31)	(3.40)	(3.34)	(3.47)	(3.60)	(3.84)	(3.85)	(3.75)	(3.62)
W + L		19.71	16.39	15.73	16.45	15.55	15.75	15.26	14.93	15.09	14.70	13.46	12.68	12.10	11.73
Panel 2: Description of W and L															
W	MV	44	490	416	342	323	385	347	313	482	445	864	2499	2175	5158
		(19)	(21)	(21)	(19)	(22)	(19)	(22)	(23)	(23)	(23)	(28)	(31)	(34)	(37)
	P	239	392	455	395	344	307	290	267	281	263	240	475	428	405
		(47)	(48)	(53)	(48)	(56)	(63)	(69)	(71)	(72)	(72)	(85)	(90)	(97)	(104)
L	MV	1573	1407	1000	810	662	808	705	654	595	549	2081	2456	4267	3589
		(103)	(121)	(87)	(79)	(65)	(65)	(65)	(69)	(65)	(65)	(44)	(44)	(46)	(47)
	P	694	526	395	338	298	279	268	250	245	250	220	262	283	289
		(149)	(177)	(137)	(138)	(138)	(138)	(139)	(138)	(137)	(134)	(116)	(119)	(116)	(120)

Note: We use the spread specification suggested by Lesmond (2007) adapted for weekly data to calculate the bid-ask spreads. $BidAskSpread = \frac{1}{T}\sum_{i=1}^{T}\frac{Ask_{i,t} - Bid_{i,t}}{(Ask_{i,t} + Bid_{i,t})/2}$, where $Ask_{i,t}$ ($Bid_{i,t}$) is the weekly ask (bid) price for share *i* at day *t* and T is the number of weeks during which bid and ask prices were recorded by Datastream. L represents the loser portfolio, W the winner portfolio, MV shows the market capitalization (in £ millions), and P is the unadjusted price (in pence). Median values are in parentheses.

Table 3 Net monthly momentum returns (%)—Full turnover

	1	2	3	4	5	6	7	8	9	10	20	30	40	50
£5,000	1.15	4.12	3.49	1.54	2.16	0.75	1.06	1.08	1.01	0.83	0.78	-0.16	-1.16*	-2.11***
£10,000	1.18	4.19	3.59	1.68	2.33	0.95	1.29	1.35	1.32	1.16	1.45	0.85	0.18	-0.44
£15,000	1.19	4.21	3.63	1.73	2.39	0.99	1.37	1.44	1.42	1.27	1.67*	1.19	0.63	0.12
£20,000	1.20	4.22	3.64	1.75	2.42	1.05	1.41	1.48	1.47	1.33	1.78*	1.35*	0.85	0.40
£25,000	1.20	4.23	3.65	1.76	2.44	1.07	1.43	1.51	1.50	1.36	1.85*	1.45*	0.98	0.56
£30,000	1.20	4.23	3.66	1.77	2.45	1.09	1.45	1.53	1.52	1.39	1.90**	1.52*	1.07	0.67
£60,000	1.21	4.24	3.68	1.79	2.48	1.12	1.49	1.57	1.57	1.44	2.01**	1.69**	1.30*	0.95
£120,000	1.21	4.25	3.69	1.81	2.49	1.14	1.51	1.59	1.59	1.47	2.06**	1.77**	1.41**	1.09*
£240,000	1.21	4.25	3.69	1.81	2.50	1.14	1.52	1.60	1.61	1.48	2.09**	1.81**	1.46**	1.16*
£500,000	1.21	4.25	3.69	1.81	2.50	1.15	1.52	1.61	1.61	1.49	2.10**	1.83**	1.49**	1.20*
£1,000,000	1.21	4.25	3.69	1.82	2.50	1.15	1.53	1.61	1.61	1.49	2.11**	1.84**	1.50**	1.21*

Note: This table shows the monthly momentum returns after adjusting for transaction costs.
* Significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level (conventional parametric t-tests).

Table 4 Net monthly momentum returns (%)—Real turnover

	1	2	3	4	5	6	7	8	9	10	20	30	40	50
Retained (of W)	11.11	5.56	5.56	4.17	3.33	2.78	3.17	3.47	4.32	4.44	3.89	5.37	7.08	6.89
Retained (of L)	0.00	2.78	1.85	1.39	1.11	0.93	0.79	2.08	1.85	2.22	5.28	5.19	6.53	6.78
£5,000	1.29	4.20	3.57	1.60	2.21	0.77	1.10	1.14	1.08	0.90	0.90	0.02	-0.89	-1.80**
£10,000	1.32	4.26	3.66	1.73	2.38	0.97	1.33	1.40	1.37	1.22	1.54	0.97	0.35	-0.24
£15,000	1.33	4.28	3.69	1.78	2.43	1.16	1.41	1.48	1.47	1.33	1.75*	1.29	0.77	0.27
£20,000	1.33	4.29	3.71	1.80	2.46	1.07	1.45	1.53	1.52	1.39	1.86*	1.44*	0.98	0.53
£25,000	1.33	4.30	3.72	1.81	2.48	1.09	1.47	1.55	1.55	1.42	1.92**	1.54**	1.10	0.69
£30,000	1.34	4.30	3.73	1.82	2.49	1.10	1.48	1.57	1.57	1.44	1.96**	1.60**	1.18	0.79
£60,000	1.34	4.31	3.74	1.84	2.52	1.14	1.52	1.61	1.62	1.49	2.07**	1.76**	1.39**	1.05
£120,000	1.34	4.32	3.75	1.86	2.53	1.15	1.54	1.64	1.64	1.52	2.12**	1.84**	1.49**	1.18*
£240,000	1.34	4.32	3.76	1.86	2.54	1.16	1.55	1.65	1.65	1.53	2.15**	1.88**	1.55**	1.24*
£500,000	1.34	4.32	3.76	1.86	2.54	1.17	1.56	1.65	1.66	1.54	2.16**	1.90***	1.57**	1.28**
£1,000,000	1.34	4.32	3.76	1.87	2.54	1.17	1.56	1.65	1.66	1.55	2.17**	1.91***	1.59**	1.29**

Note: This table shows the monthly post-cost momentum returns when real turnover is considered. A number of firms remain in the same portfolio and thus there is no need to re-buy or re-short those companies.

* Significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level (conventional parametric t-tests).

Table 5 Risk adjustments (monthly)

	1	2	3	4	5	6	7	8	9	10	20	30	40	50
Panel 1: Alpha (%) – CAPM														
£5,000	1.62	2.29	1.89	0.94	1.71	0.32	0.81	0.95	0.92	0.77	0.90	0.12	-0.76	-1.67**
£10,000	1.65	2.36	1.98	1.07	1.88	0.52	1.03	1.20	1.21	1.08	1.53**	1.05	0.45	-0.16
£15,000	1.66	2.38	2.01	1.11	1.3	0.69	1.11	1.28	1.30	1.19	1.73**	1.36**	0.86	0.34
£20,000	1.67	2.39	2.03	1.13	1.96	0.61	1.15	1.33	1.35	1.24	1.84**	1.51**	1.06*	0.59
£25,000	1.67	2.39	2.04	1.15	1.97	0.6	1.17	1.35	1.38	1.27	1.89**	1.60**	1.18**	0.75
£30,000	1.67	2.39	2.04	1.15	1.98	0.64	1.18	1.37	1.40	1.29	1.94***	1.67***	1.26**	0.85
£60,000	1.67	2.41	2.06	1.18	2.01	0.68	1.22	1.41	1.44	1.34	2.04***	1.82***	1.47***	1.09**
£120,000	1.68	2.41	2.07	1.19	2.02	0.70	1.24	1.43	1.47	1.37	2.09***	1.90***	1.57***	1.22**
£240,000	1.68	2.42	2.07	1.20	2.03	0.71	1.25	1.44	1.48	1.38	2.12***	1.93***	1.62***	1.29**
£500,000	1.68	2.42	2.07	1.20	2.03	0.71	1.25	1.45	1.49	1.39	2.13***	1.95***	1.64***	1.32**
£1,000,000	1.68	2.42	2.07	1.20	2.03	0.71	1.25	1.45	1.49	1.39	2.14***	1.96***	1.66***	1.33**
Panel 2: Alpha (%) – two-factor model (market, book-to-market)														
£5,000	1.66	2.27	1.86	0.92	1.72	0.35	0.84	0.98	0.98	0.84	0.95	0.19	-0.70	-1.62**
£10,000	1.69	2.33	1.95	1.05	1.88	0.55	1.06	1.23	1.26	1.15	1.58**	1.11*	0.51	-0.10
£15,000	1.70	2.35	1.98	1.09	1.93	0.73	1.14	1.31	1.36	1.26	1.78**	1.42**	0.92	0.40
£20,000	1.71	2.36	2.00	1.11	1.96	0.64	1.17	1.36	1.40	1.31	1.89**	1.58**	1.12*	0.65
£25,000	1.71	2.36	2.01	1.13	1.97	0.66	1.20	1.38	1.43	1.34	1.95***	1.67***	1.25**	0.81
£30,000	1.71	2.37	2.01	1.13	1.98	0.67	1.21	1.40	1.45	1.36	1.99***	1.73***	1.33**	0.91
£60,000	1.72	2.38	2.03	1.15	2.01	0.71	1.25	1.44	1.50	1.42	2.10***	1.89***	1.53***	1.16**
£120,000	1.72	2.38	2.04	1.17	2.02	0.72	1.27	1.46	1.52	1.44	2.15***	1.97***	1.63***	1.29**
£240,000	1.72	2.39	2.04	1.17	2.03	0.73	1.28	1.47	1.53	1.46	2.17***	2.01***	1.68***	1.35**
£500,000	1.72	2.39	2.04	1.17	2.04	0.73	1.28	1.48	1.54	1.46	2.19***	2.03***	1.71***	1.38***
£1,000,000	1.72	2.39	2.04	1.17	2.04	0.74	1.28	1.48	1.54	1.47	2.19***	2.03***	1.72***	1.40***

Note: Panels 1 and 2 show the alphas of the following regressions: $NMR_{i\,t} = a + bR_{mt} + u_t$ and $NMR_{it} = a + bR_{mt} + cHMLBM_t + u_t$, where NMR_{it} is the net monthly momentum return of strategy i when real turnover is considered, R_{mt} is the market return (FTSE-All Share), and $HMLBM_t$ is the high minus low book-to-market value.

* Significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level (conventional parametric t-tests).

Table 6 Results using the restricted sample

	1	2	3	4	5	6	7	8	9	10	20	30	40	50
Panel 1: Gross monthly momentum returns (%)														
L	-7.83	-3.69	-4.96	-4.44	-4.22	-4.23	-3.89	-3.65	-3.58	-3.47	-2.72	-2.09	-1.74	-1.69
W	0.02	0.45	0.05	0.26	0.12	0.00	0.25	0.25	0.32	0.06	-0.12	-0.11	-0.19	-0.18
W – L	7.85 $^{**}_{\#\#}$	4.14 $^{**}_{\#\#}$	5.01 $^{**}_{\#\#}$	4.70 $^{***}_{\#\#\#}$	4.34 $^{***}_{\#\#\#}$	4.23 $^{***}_{\#\#\#}$	4.14 $^{***}_{\#\#\#}$	3.89 $^{***}_{\#\#\#}$	3.90 $^{***}_{\#\#\#}$	3.53 $^{***}_{\#\#\#}$	2.60 $^{***}_{\#\#\#}$	1.98 $^{***}_{\#\#\#}$	1.55 $^{***}_{\#\#\#}$	1.52 $^{***}_{\#\#\#}$
W + L BidAsk	10.88	9.43	8.55	8.06	7.71	8.19	8.06	8.11	8.18	8.03	7.45	7.21	7.07	6.89
Panel 2: Net monthly momentum returns—Real turnover (%)														
£5,000	6.54**	2.93**	3.89*	3.57**	3.16**	2.95**	2.81**	2.50**	2.44**	2.02*	0.52	-0.71	-1.71***	-2.35***
£10,000	6.58**	2.96**	3.99*	3.70**	3.32**	3.15**	3.04**	2.76**	2.73**	2.34**	1.15	0.24	-0.47	-0.79*
£15,000	6.59**	2.97**	4.02*	3.74**	3.38**	3.23**	3.12***	2.85**	2.83**	2.45**	1.37*	0.56	-0.05	-0.28
£20,000	6.60**	2.98**	4.04*	3.76**	3.40**	3.25**	3.15***	2.89**	2.88**	2.51**	1.47*	0.71	0.15	-0.02
£25,000	6.60**	2.98**	4.05*	3.77**	3.42**	3.27**	3.18***	2.92**	2.91**	2.54**	1.54*	0.81	0.28	0.14
£30,000	6.60**	2.98**	4.05*	3.78**	3.43**	3.28**	3.19***	2.93**	2.93**	2.56**	1.58*	0.87	0.36	0.24
£60,000	6.61**	2.99**	4.07*	3.80**	3.46**	3.31**	3.23***	2.98***	2.97***	2.61**	1.68*	1.03	0.57	0.50
£120,000	6.61**	2.99**	4.08*	3.82**	3.47**	3.33**	3.25***	3.00***	3.00***	2.64**	1.74*	1.11	0.67	0.63
£240,000	6.61**	2.99**	4.08*	3.82**	3.48**	3.34**	3.26***	3.01***	3.01***	2.65**	1.76*	1.15	0.72	0.69
£500,000	6.61**	2.99**	4.08*	3.82**	3.48**	3.34**	3.26***	3.02***	3.02***	2.66**	1.78**	1.17	0.75	0.72
£1,000,000	6.61**	2.99**	4.09*	3.82**	3.49**	3.34**	3.27***	3.02***	3.02***	2.66**	1.78**	1.18	0.76	0.74

Note: This table shows the results when small capitalization firms are excluded from the sample. We use the market capitalization of companies one month before each rank period to measure size and exclude from the sample companies that are at the smallest quintile. L represents the loser portfolio, W the winner portfolio and W – L the momentum portfolio.
* Significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level (conventional parametric t-tests).
# Significant at the 10% level, ## significant at the 5% level, and ### significant at the 1% level (nonparametric bootstrapped values, 10,000 simulations).

Table 7 Results using alternative rank and test periods (%)

	1	2	3	4	5	6	7	8	9	10	20	30	40	50
Panel 1: Gross monthly momentum returns (W – L)														
3x3	-2.37	0.92	2.83	2.72$^{*}_{\#}$	2.66$^{**}_{\#}$	2.33$^{**}_{\#\#}$	2.43$^{**}_{\#\#}$	3.59$^{***}_{\#\#\#}$	4.19$^{***}_{\#\#\#}$	6.42$^{***}_{\#\#\#}$	5.89$^{***}_{\#\#\#}$	5.15$^{***}_{\#\#\#}$	4.95$^{***}_{\#\#\#}$	4.77$^{***}_{\#\#\#}$
6x6	1.73	4.36	7.66$^{**}_{\#\#}$	5.92$^{**}_{\#\#}$	4.25$^{**}_{\#\#}$	4.91$^{***}_{\#\#\#}$	4.68$^{***}_{\#\#\#}$	4.94$^{***}_{\#\#\#}$	5.43$^{***}_{\#\#\#}$	5.08$^{***}_{\#\#\#}$	4.71$^{***}_{\#\#\#}$	5.32$^{***}_{\#\#\#}$	5.14$^{***}_{\#\#\#}$	4.96$^{***}_{\#\#\#}$
9x9	9.93$^{***}_{\#\#\#}$	5.35$^{***}_{\#\#\#}$	5.37$^{***}_{\#\#\#}$	8.07$^{***}_{\#\#\#}$	8.53$^{***}_{\#\#\#}$	8.02$^{***}_{\#\#\#}$	7.92$^{***}_{\#\#\#}$	7.88$^{***}_{\#\#\#}$	7.38$^{***}_{\#\#\#}$	6.97$^{***}_{\#\#\#}$	5.72$^{***}_{\#\#\#}$	5.37$^{***}_{\#\#\#}$	4.93$^{***}_{\#\#\#}$	4.54$^{***}_{\#\#\#}$
Panel 2: Net monthly momentum returns—Real turnover														
3x3														
£5,000	-10.13***	-6.06	-0.23	0.43*	-5.41**	-5.30***	-5.14***	-4.49***	-1.98***	-2.52***	-4.92***	-8.06***	-10.55***	-13.10***
£10,000	-10.06**	-5.93	0.29	1.09	-5.07*	-4.89**	-4.66**	-3.96**	-0.71**	-1.18**	-2.37***	-4.23***	-5.52***	-6.83***
£15,000	-10.04**	-5.88	0.48	1.31	-4.95*	-4.51**	-4.50**	-3.78**	-0.29*	-0.73*	-1.52**	-2.95***	-3.85***	-4.75***
£20,000	-10.02**	-5.86	0.57	1.43	-4.90	-4.69**	-4.42**	-3.69*	-0.07	-0.50	-1.10*	-2.32***	-3.01***	-3.70***
£25,000	-10.02**	-5.85	0.63	1.50	-4.86	-4.64**	-4.38**	-3.64*	0.06	-0.37	-0.84	-1.93***	-2.51***	-3.08***
£30,000	-10.01**	-5.84	0.66	1.55	-4.84	-4.62**	-4.34**	-3.60*	0.14	-0.28	-0.67	-1.68***	-2.18***	-2.66***
£60,000	-10.00**	-5.81	0.76	1.68	-4.78	-4.55**	-4.27**	-3.52*	0.36	-0.06	-0.25	-1.04*	-1.34**	-1.62***
£120,000	-9.99**	-5.80	0.81	1.74	-4.76	-4.52*	-4.23**	-3.47	0.47	0.06	-0.03	-0.72	-0.92*	-1.10**
£240,000	-9.99**	-5.80	0.84	1.77	-4.74	-4.50*	-4.21**	-3.45	0.52	0.11	0.07	-0.56	-0.71	-0.84*
£500,000	-9.99**	-5.79	0.85	1.79	-4.73	-4.49*	-4.20**	-3.44	0.55	0.14	0.13	-0.48	-0.60	-0.70
£1,000,000	-9.99**	-5.79	0.86	1.80	-4.73	-4.49*	-4.19**	-3.43	0.56	0.15	0.15	-0.44	-0.55	-0.64
6x6														
£5,000	-1.70	-0.64	4.12	2.24	0.55	1.05	0.65	0.71	1.09	0.64	-0.76	-1.30**	-2.61***	-3.99***
£10,000	-1.63	-0.51	4.32	2.52	0.89	1.45	1.12	1.24	1.69	1.30	0.54	0.61	-0.10	-0.85
£15,000	-1.61	-0.47	4.39	2.61	1.00	1.83	1.28	1.42	1.89	1.52	0.97	1.25	0.74	0.19
£20,000	-1.60	-0.45	4.42	2.65	1.06	1.66	1.36	1.51	1.99	1.63	1.18	1.57	1.16	0.72
£25,000	-1.60	-0.43	4.44	2.68	1.09	1.70	1.41	1.56	2.05	1.69	1.31	1.77*	1.41	1.03
£30,000	-1.59	-0.42	4.45	2.70	1.12	1.72	1.44	1.60	2.09	1.74	1.40	1.89**	1.57*	1.24
£60,000	-1.58	-0.40	4.49	2.74	1.17	1.79	1.52	1.69	2.19	1.85	1.61	2.21**	1.99***	1.76**

£120,000	-1.57	-0.39	4.50	2.77	1.20	1.82	1.56	1.73	2.23	1.90	1.72*	2.37***	2.20***	2.02***
£240,000	-1.57	-0.39	4.51	2.78	1.21	1.84	1.58	1.75	2.26	1.93	1.77*	2.45***	2.30***	2.15***
£500,000	-1.57	-0.38	4.52	2.78	1.22	1.85	1.59	1.76	2.27	1.94	1.80*	2.49***	2.36***	2.22***
£1,000,000	-1.57	-0.38	4.52	2.79	1.22	1.85	1.59	1.77	2.28	1.95	1.81*	2.51***	2.38***	2.25***
9x9														
£5,000	7.49	2.57*	3.00**	5.63***	6.02***	5.43***	5.24***	5.06***	4.51***	4.05***	2.16*	0.99	-0.22	-1.42*
£10,000	7.51	2.61*	3.07**	5.81***	6.25***	5.70***	5.55***	5.41***	4.91***	4.49***	3.02***	2.27**	1.47	0.69
£15,000	7.51	2.63*	3.09**	5.87***	6.33***	5.96***	5.66***	5.53***	5.04***	4.64***	3.31***	2.70***	2.03**	1.39*
£20,000	7.52	2.64*	3.10**	5.90***	6.36***	5.84***	5.71***	5.59***	5.11***	4.72***	3.45***	2.92***	2.31***	1.74**
£25,000	7.52	2.64*	3.11**	5.92***	6.39***	5.87***	5.74***	5.62***	5.15***	4.76***	3.53***	3.04***	2.48***	1.95***
£30,000	7.52	2.64**	3.11**	5.93***	6.40***	5.89***	5.76***	5.65***	5.18***	4.79***	3.59***	3.13***	2.59***	2.09***
£60,000	7.52	2.65**	3.12**	5.96***	6.44***	5.93***	5.82***	5.71***	5.24***	4.86***	3.73***	3.34***	2.87***	2.44***
£120,000	7.53	2.66**	3.13**	5.98***	6.46***	5.95***	5.84***	5.74***	5.28***	4.90***	3.80***	3.45***	3.01***	2.61***
£240,000	7.53	2.66**	3.13**	5.99***	6.47***	5.96***	5.85***	5.75***	5.29***	4.92***	3.84***	3.50***	3.08***	2.70***
£500,000	7.53	2.66**	3.13**	5.99***	6.47***	5.97***	5.86***	5.76***	5.30***	4.93***	3.86***	3.53***	3.12***	2.75***
£1,000,000	7.53	2.66**	3.14**	5.99***	6.47***	5.97***	5.86***	5.76***	5.31***	4.93***	3.87***	3.55***	3.14***	2.77***

Note: This table shows the results when alternative rank and test periods are employed (3x3, 6x6, and 9x9). W – L represents momentum returns.

* Significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level (conventional parametric t-tests).

Significant at the 10% level, ## significant at the 5% level, and ### significant at the 1% level (nonparametric bootstrapped values, 10,000 simulations).