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Momentum Profits and Return Persistence on the Swedish Stock Market

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Abstract

Within the field of momentum effects, this paper investigates whether a zero-investment strategy, where a short position in a portfolio of previously bad performing stocks finance a long position in a portfolio of past well performing stocks, generate positive returns in the period 1987 to 2008. The primary focus is to examine whether it is possible to earn abnormal returns from such a strategy and if these returns can be explained by various types of risk measures. Moreover, we also investigate if we can observe any kind of persistence pattern among the included portfolio companies. We find that several strategies yield significant momentum returns, especially those strategies having an evaluation period of six to twelve months and a holding period of one to six months. When adjusting for various conventional measures of risk, we find that many of the strategies with previously significant returns continue to generate significant returns even after the risk-adjustment. Traditional models, such as CAPM and the Fama-French model, proved to explain momentum returns to some extent whilst adding a coskewness factor to the latter model only slightly improved the results. Finally, we find evidence for that the probability of being included in either of the two portfolios under investigation in two consecutive periods is significantly larger than expected.

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1. Introduction

A debated area within finance is whether there are trading strategies that create abnormal returns only based on historic and publicly available information. This would violate the efficient market hypothesis put forward by Fama (1970) which says that stock prices always embody the currently available information. Economists have subsequently tested if this hypothesis holds under various conditions and have found evidence that some strategies actually tend to generate significant abnormal profits. One of these strategies is to take advantage of so-called *momentum effects*.

The momentum effects phenomenon is well known within the field of finance, but also one that is internationally debated. One of the reasons for why it has drawn so much attention is that various studies have reached rather contradictive results, depending on in which country the tests have been performed and which method that has been used. Jegadeesh and Titman (1993) constructed a zero-investment strategy where past winner stocks are bought while historic underperforming stocks are sold short and examined if this strategy was profitable for US listed companies. The strategy turned out to be successful in the medium term and Rouwenhorst (1998) concluded that this also was true in a European setting, whereas DeBondt and Thaler (1985) observed a long term reversal effect, i.e. the previous return trend is reversed. In a Swedish environment the tests results are far from unanimous, where the paper by Rouwenhorst (1998) and Griffin et al (2003) strongly indicates that it does not exist a momentum effect in the Swedish stock market while Söderström (2000) finds clear evidence of such a phenomenon if the effects of the devaluation of the krona in 1992 are excluded.

The explanations for why economists have observed momentum effects in various countries have primarily been attributed to different behavioural theories (e.g. Shleifer (2000)), which say that there are situations where investors not always react rationally. Furthermore, another theory presented is that the abnormal return from a strategy exploiting momentum effects is due to the higher risk exposure such a strategy incorporates. The empirical results from several studies suggests that common risk factors cannot explain the existence of the momentum returns, but e.g. Avramov et al (2007) find that the momentum returns to a large extent can be attributable to a company's credit rating. An alternative explanation is that there might not be anything such as a momentum effect but that the abnormal returns observed are rather due to imperfect tests procedures.

1.1 Purpose and Contribution

With this paper we are examining if an investor by using a momentum strategy, exploiting medium term momentum, can earn profits in excess of what is expected on the Swedish stock market. In comparison to similar studies done in the past, we will in this paper put more emphasis on if we can find a persistence pattern among the included portfolio companies rather than just trying to characterize them as previous studies have done. This approach is unique in that sense and we have tested for the presence of persistence based on four different measures in order to get a picture as complete as possible. Furthermore, another aspect of our thesis that very few studies in the past have covered is the usage of non-overlapping portfolios, i.e. the procedure of not liquidating the entire portfolio simultaneously, which give us more reliable results from a statistical point of view. Lastly, we also explore how well the model proposed by Harvey and Siddique (2000), which is an extension of the Fama-French model, can explain momentum returns. What differentiates this model from others is that it takes into account negative skewness which, to the best of our knowledge, is a risk that previously only has been scarcely investigated, and nothing based on Swedish data.

1.2 Outline

We have organized our thesis as follows. In Section 2 we will present the theoretical frameworks that can help to explain the existence of the observed momentum effects. Section 3 summarizes the result previous studies have reached; both in an international and a Swedish context. After that, Section 4 describes our hypotheses and the reason for why we have chosen them. In section 5, a brief description of the sample data is made and we also discuss the undertaken adjustments of the data in relation to previous studies. Section 6 will present our methodology for the portfolio construction and Section 7 describes the statistical tests we will perform, the empirical results and our interpretation of them. Finally, section 8 will present our conclusions together with suggestions of areas for further research.

2. Theoretical Background

2.1 The Efficient Market Hypothesis

A natural starting point, when studying a phenomenon such as momentum effects, is to put the findings by prominent authors such as Jegadeesh and Titman (1993) and Rouwenhorst (1998) into perspective by using the efficient market hypothesis (EMH). The EMH proposed by Fama (1970) says that security prices should always reflect all currently available information. Hence, since markets are efficient it should be impossible to use a strategy that consistently outperforms a passive market portfolio. Therefore, active management will not lead to superior risk-adjusted returns.

The EMH rests on three fundamental arguments according to Shleifer (2000). Firstly, investors are assumed to behave rationally and be able to value a stock based on its fundamental value. When new information is released, investors adjust their view of the stock accordingly and thus the price will move so it once again incorporates all available information and the price is equal to the net present value of expected future cash flows discounted considering its risk characteristics. Secondly, the EMH states that the assumption of rational investors is not a necessary constraint as long as the behaviour of the investors has other characteristics. For instance, if the trades made by irrational investors are random and the trading volume is significant, the trades are likely to not influence the stock price since they will cancel each other out if we assume that they are not correlated. Thirdly, if irrational investors' trades are indeed correlated, rational arbitrageurs will step in and eliminate the deviating stock price movement, bringing the stock price back to the equilibrium level. Thus, the emerged mispricing is exploited by arbitrageurs who short-sells (purchases) the overvalued (undervalued) stock and purchases (selling) a stock with similar characteristics as a risk hedge. Since arbitrageurs are competing with other arbitrageurs to exploit this kind of opportunities, this will lead to that such mispricings will disappear quickly.

When new information about a company is released, the price of the stock should adjust according to the relevance of the news, and when the price is adjusted, the news can be seen as stale. According to Fama (1970), the EMH can also be divided into three forms depending on the type of stale information, namely the weak, semi-strong and the strong form. The weak form says that it is not possible to earn superior risk-adjusted returns purely based on stale information of past prices and returns, thus no trading strategy using past prices can generate excess risk-adjusted returns. In terms of the semi-strong form, it is neither possible to earn superior risk-adjusted returns, but this time the stale information also includes any other publicly available information. Finally, there is also the strong form which, in some sense, is rather extreme since it says that an investor cannot earn superior risk-adjusted returns even based on non-public information since insider information is expected to leak out and quickly be incorporated in the stock price.

Many studies have been conducted within this field; some have shown support of the EMH whereas others conclude, based on their obtained results, that the EMH does not hold. During the 1960s and 1970s, several studies were published that was in favour of the EMH. Just to mention a few, Fama (1965) found that stock prices followed a random walk, but he found no evidence of any technical trading strategy that was systematically profitable. Evaluating the EMH was also done through event studies, which measure the effect a certain event, e.g. an IPO or earnings announcement, has on the stock price. Scholes (1972) investigated the effect on the share price when large blocks of stocks were sold in a company. Since such a trade does not reveal any new information (if we assume that there is close substitutes available), this should not significantly affect the stock price, especially if the trade is made by an uninformed investor. Scholes (1972) finds that the price changes in general are relatively small and thus the EMH appears to hold.

There has also been a number of studies that question the EMH and many attributes this deviation to the assumption of rational investors, which are believed to be far from rational (behavioural theories will be described in detail in a later section). The results that Banz (1981) obtained clearly challenge the EMH since he found that small firms had higher beta-adjusted returns than large firms. Keim (1983) found that this size effect primarily was attributed to the returns in January, something that is hard to explain based on risk measures. Furthermore, DeBondt and Thaler (1985) and Jegadeesh and Titman (1993) observed that it was possible to create a trading strategy that, purely based on past prices, yielded superior risk-adjusted returns. Jegadeesh and Titman (1993) found that creating zero-investment portfolios where stocks that have performed best during a given time horizon were bought and the stocks that have performed the worst under the same period were short-sold yielded a monthly return of approximately 1%. This momentum strategy turned out to be successful in the medium term (3-12 months), whereas DeBondt and Thaler (1985) in their study observed a long term reversal effect (3-5 year time horizon).

Whether or not the momentum effect phenomenon exists can be argued, but the extensive studies performed in the past within the field have reached several conclusions that separately or jointly can begin to describe why one might observe a momentum effect. The momentum effect itself can be divided into two separate effects, namely *underreaction* and *overreaction*.

The underreaction phenomenon originates from observations that stock prices only gradually adjust to new information presented. Hence, in terms of positive news announcements, the stock tends to continue to perform well even after the initial price reaction has been incorporated into the stock price and thus stale information can help to predict future returns (Shleifer, 2000).

Overreaction, on the other hand, occurs when an investor reads in too much in information that consistently has pointed in the same direction (Shleifer, 2000). Thus, the effect is that stocks with strong track records in terms of performance become overvalued compared to its fundamental value and subsequently will generate lower returns. This phenomenon, where prices return to some sort of mean, is often referred to as the reversal effect.

From the point of view that the EMH actually holds, it should not exist a momentum effect, but Fama (1998) proposes in his paper, that this only is a modified version of the truth. He claims that market efficiency is not threatened by either under- or overreaction as long as these anomalies are randomly split among themselves. His view is not supported by, for example, Daniel et al (1998), since they say that these phenomena are not random but rather follow a distinct pattern.

Since the primary focus of this report is to study the occurrence of the underreaction phenomenon in a Swedish context, we will below present a number of factors that can help to explain this anomaly in more detail. The first factor, and the one that we will put most emphasis on, is behavioural theories, which will describe various investor behavioural characteristics that lead to actions departing from what one might expect based on conventional theories. Secondly, we will see if this anomaly can be explained by excessive risk taking and, finally, briefly check if the occurrence of the observed momentum effects can be due to the fact that the tests are flawed or inconclusive.

2.2 Behavioural Theories

One of the cornerstones behind the EMH is that investors are fully rational. In numerous studies focusing on human behaviour in a financial context, this has shown to not be true and in the paper by Statman (1996), a number of these irrational characteristics of investors are presented. A behaviour that is widely known is that investors are reluctant to realize losses and, in general, tend to hold on to stocks longer than appropriate and vice versa. Hence, the pain of losing a given dollar amount is larger than the satisfaction of earning the same amount. This loss aversion, where people assign different weights on gains and losses, is referred to as the prospect theory and was introduced by Kahneman and Tversky (1979).

Another type of biased behaviour is reflected in the theories of conservatism and representativeness heuristic presented by Edwards (1968) and Barberis et al (1998). The theory of conservatism states that investors will change their perception only slowly when facing new facts and put a too low weight on the new information, which leads to that the stock price will not adjust according to the value of the information revealed and thus we experience an underreaction. For example, Bernard (1992) observed on US data that stocks with positive earnings announcements also continued to earn higher return in the 60 days after the announcement. The results can, according to Bernard (1992), be explained by underreaction and more specifically that investors assumes that the earnings announcement, which deviates from the expected long-run behaviour, is due to a temporary change. Therefore, they will only make small adjustments to their beliefs. Another factor is brought forward by Festinger (1957) who says in his book that people generally try to ignore evidence that their beliefs are inaccurate. Together with the main conclusion in Wahlund (1989), that people tend to look for information or beliefs that support their view rather than doing an objective search, these two characteristics are likely to be other contributing factors to why the revision of investor beliefs does not fully reflect the change one would assume based on a Bayesian approach[2].

If conservatism helps to explain underreaction, representativeness heuristic, on the other hand, could be a reason to why e.g. DeBondt and Thaler (1985) observe a long term reversal. The investor sentiment model presented by Shleifer (2000) says that for companies who consistently, for a long time period, have had positive earnings announcements and this accompanied by other positive news, any previous conservatism by investors will be replaced with the view that the past pattern indicates the correct performance of the company. Thus, investors interpolates the trend into the long term (leading to overvaluation), disregarding that the strong earnings could have occurred due to a random process or that the likeliness of a similar high growth in the subsequent periods are low. In other words, investors sometimes see patterns in purely random sequences or overestimate the probability that an observed pattern will persist in the future. The results that Zarowin (1989) obtained in his study support this kind of behaviour since he observed that companies which have a series of negative returns tend to outperform companies with the opposite characteristics. This implies that the former (latter) group of companies are likely to be undervalued (overvalued).

Daniel et al (1998) propose that two common physiological biases can help to explain some of the irregularities in terms of investor behaviour. The first bias is investor overconfidence which is present within many professions and it has been found that experts in general are more overconfident than their inexperienced counterparts. Overconfidence is also more common when the

[2] The Bayesian approach states how a rational person should change his or her existing beliefs in the light of new evidence.

tasks are of a more diffuse nature or when the received feedback is delayed. Overconfident investors often overestimate their private information in terms of reliability, precision or uniqueness. This makes such investors to believe that their understanding is above the market average. The second bias is referred to as biased self-attribution. That is, people that usually tend to credit themselves for past success whereas they dismiss failures as a result of external factors. The result on the stock market when incorporating both these two physiological biases is that prices will overreact to private information (due to the overconfidence factor) and underreact to public information (due to the asymmetric interpretation of the public information) and therefore prices will only adjust partially. The second bias will lead to a continuation of trends since investors will tend to overestimate their private information even more after their view is confirmed in the first case. This effect is finally reversed when the stream of released public information to the market increases and investors need to revise their view, something that drives the price towards its fundamental value. Thus, the proposed theory by Daniel et al (1998) seems to match the results by Jegadeesh and Titman (1993) and DeBondt and Thaler (1985) rather well with a medium term momentum that is reversed in the long term.

The model presented by Hong and Stein (1997) adds an interesting perspective to the discussion since they contradict the norm within financial theory and say that investors are not a homogeneous group of people but rather that the market participants are heterogeneous. They also categorize them into two distinct types of agents; *newswatchers* and *momentum traders*. These two groups trade and value companies based on two separate types of information. Newswatchers only take private information about the future fundamentals of the company into account, such as earnings forecasts, and disregard any sort of public information. Momentum traders instead acts solely on companies' past price performance and ignore any released information. The conclusion Hong and Stein (1997) draw from their observations is that when only newswatchers are active, stock prices only gradually adjust when new information is presented due to the diffusion within the newswatcher community, i.e. a clear sign of underreaction. But when momentum traders also are active, the previous gradual change is accelerated since they notice the positive autocorrelation (underreaction) between periods and exploit that opportunity. Consequently, these stocks become overvalued due to overreaction when new information is released, and this later lead to a reversal effect. Hong and Stein (1997) concluded that the early momentum traders imposed a negative externality for the other momentum traders since they amplify the effect created by the newswatchers.

Cutler et al (1990) conclude in their paper that underreaction cannot be explained by changes in various risk factors, but that this phenomenon is due to heterogeneous investors, in line with the beliefs of Hong and Stein (1997). The approach undertaken by Cutler et al (1990) is somewhat different since they divide them into the following three groups: investors that invest based on rational expectations of future returns, fundamental investors that base expected returns on prices relative to perceived fundamentals and feedback traders who focus on past returns. One of the conclusions they reach is that the presence of feedback traders with long memories will generate negative long term autocorrelation but also short term positive autocorrelation. Thus, prices can overreact to fundamental news, but in the long run news should only adjust prices based on how they change the fundamental value of the company.

But if we would assume that investors constitute a homogeneous group, what other explanations might describe the underreaction phenomenon? Based on the results of many of the studies performed in the area of momentum effects, the stocks that generally are included in the winner portfolio are small capitalization stocks. Hong et al (1999) argue that one potential reason for why small capitalization stocks consistently dominate the winner portfolio can be due to that firm specific news for these companies is more slowly spread to investors. As many investors tend to base their views on how equity research analysts interpret a company's current and future performance, the number of analysts that cover a given company will have a significant and indirect effect on how news for that company are spread to the investor community. Since analysts know that a large portion of the investors are interested in taking significant positions in the companies they invest in they tend to primarily focus on larger companies where the liquidity is sufficient. The effect is that larger companies will be more closely monitored, which means that investors will react quicker to new information regarding these companies than in the case of small capitalization stocks. Hence, from a momentum strategy point of view, the fewer analysts that cover a company, the longer it takes for the investor community to incorporate the information and, thus, one can expect that these stocks are more likely to be part of a momentum portfolio where the underreaction phenomenon is exploited. Moreover, Hong et al (1999) argue that managers in small firms, due to lower coverage, in general are faster to release positive news, since that will benefit them through various incentive programs, whereas information that is less beneficial is withhold, and consequently positive information will reach the market quicker. Jiang et al (2005) and Zhang (2006) also found evidence of that momentum payoffs are significantly higher among firms with high information uncertainty, also after adjusting for the three factors proposed in the paper by Fama and French (1993). In their paper, information uncertainty was proxied by firm size, firm age, return volatility, cash flow volatility, and analyst forecast dispersion.

Lastly, it also important to note that the irrational behaviour is not only limited to uninformed investors but it has been proven that for example professional money managers also show behaviour that deviates from the expected. Lakonishok et al (1992), for example, discover that money managers tend to form their portfolios excessively close to the benchmark they are compared against. Moreover, Scharfstein and Stein (1990) also found that they to a large extent select the same stocks as other money managers in order to not risk performing worse in comparison.

2.3 Excessive Risk and Liquidity Constraints

The behavioural theories presented in the above section is one potential way to understand the occurrence of momentum effects, but what if the assumptions behind the efficient market hypothesis actually do hold and the observed abnormal returns can be explained by the fact that momentum portfolios earn excess returns due to higher risk taking or for not considering liquidity constraints? Hong et al (1999) conclude that investors tend to require higher returns when investing in stocks with low liquidity and since studies have shown that the composition of momentum portfolios mainly are based on small cap stocks, the higher returns can be generated due to the increased risk this strategy imply. Conrad and Kaul (1998) also argue in their paper that the higher return for momentum strategies is just a compensation for its higher risk exposure and that this also should be true in the subsequent time periods. In other words, high returns are due to higher risk and since the risk characteristic of a company is unlikely to change in the following time period, such stocks should continue to yield higher returns and thus create a momentum effect. Furthermore, Fama (1998) argues that another contributing factor, in terms of low liquidity, could be that small capitalization stocks generally have short-sale constraints. Hence, they are difficult to borrow and therefore the views of more negative investors will not be fully incorporated in the stock price. Thus, they are more likely to become overvalued. Avramov et al (2006) also find evidence that support this view since they find that weekly reversals are strongest for stocks in which liquidity is low.

A risk factor that has been successful in predicting stock returns, and which also is applicable for momentum strategies, have been found by Harvey and Siddique (2000). They extended the classical Fama-French model put forward by Fama and French (1993) with a fourth variable; a coskewness factor. They found that by adding an additional variable to the regression, the model also captures non-systematic risk associated with stock returns and becomes significantly better in predicting stock returns than conventional asset pricing models. Moreover, based on US data from 1963 to 1993, they observed that the R^2 for portfolios constructed based on various characteristics such as size, momentum and industry was clearly higher for this modified version of the Fama-French model than for the conventional one, both for constant and rolling betas. For momentum strategies in particular, they find a significant negative skewness (p-value equal to 0.001).

Moskowitz and Grinblatt (1999) demonstrate in their study that momentum strategies also have another less attractive characteristic, namely that they are rather undiversified. The reason for this is that there is a high correlation between stock prices for companies in the same industry. Hence, since the number of companies included in the portfolios at each point in time is limited it is common that momentum portfolios are overly exposed to a few industries.

One of the major obstacles with implementing zero-investment strategies is the problem with liquidity for the short leg of the portfolios. Shortselling is today mostly done in the most liquid stocks and together with the fact that transaction costs can be significant; this clearly limits the potential upside of a zero-investment strategy. Moreover, shortselling was not declared legal in Sweden until the end of 1991 (Nilsson (2005)), which means that studies performed on Swedish data before that time or on US data before 2001 would have been difficult to carry out in practise due to this constraint.[3]

2.4 Misspecified Tests

A third explanation to why momentum effects have been observed, which have been brought forward by defenders of the EMH, is that they are actually due to misspecified tests and data mining.

In a perfect world researchers should formulate hypotheses and test them against the available data. The reached results should then be able to withstand a change of examined time period and out of sample data. The problem, in this case, is that a number of the studies performed have been proven difficult to replicate even if the same time period is used. Many economists are due to this fact unsure whether this phenomenon actually exists or if it is just due to data mining or curve-fitting. McQueen and Thorley (1999) and Sullivan et al (1999) for example tested a number of the strategies suggested in previous papers regarding momentum effects and their results, based on out of sample data, proved that the strategies was not successful when the underlying conditions were changed. Moreover, many of the reached results have in fact been statistically significant but have lacked robustness in terms of theoretical foundation (Ayadi and Rydberg (2001)).

Fama (1998) states in his paper that many anomalies, such as under- and overreaction, are highly sensible to methodology changes so if the technique used is altered the anomaly is likely to vanish. Hence, before putting to much emphasis on a finding, checking the test procedures and the sample period is recommended. Summers (1986) provide another explanation to why one can question the results from previous studies. He states that many of the tests used to examine market efficiency have low power in discriminating against potential forms of market inefficiency and that e.g. some found patterns of momentum effects might not be due to that the market is inefficient.

Lo and MacKinley (1990) find in their study that momentum profits are likely to be due to model misspecification. They argue that news that affect all stocks are faster incorporated in larger companies since they in general tend to be more frequently traded than their smaller counterparts. So according to them, the reason why e.g. contrarian strategies (exploitation of mispricings originated from crowd behaviour among investors) can be profitable is primarily not due to overreaction but rather a systematic lead-lag relationship in terms of the returns (i.e. that the stock price movement of large capitalization companies can help to predict the stock price movement in smaller companies).

[3] However, that is not the same as impossible. Using e.g. synthetic stocks could have been an implementable strategy. Since the number of companies included during the first years in the sample is biased towards the largest companies of the Stockholm Stock Exchange (see section 5), we find it reasonable to assume that listed options were traded for most of these companies during this timeframe.

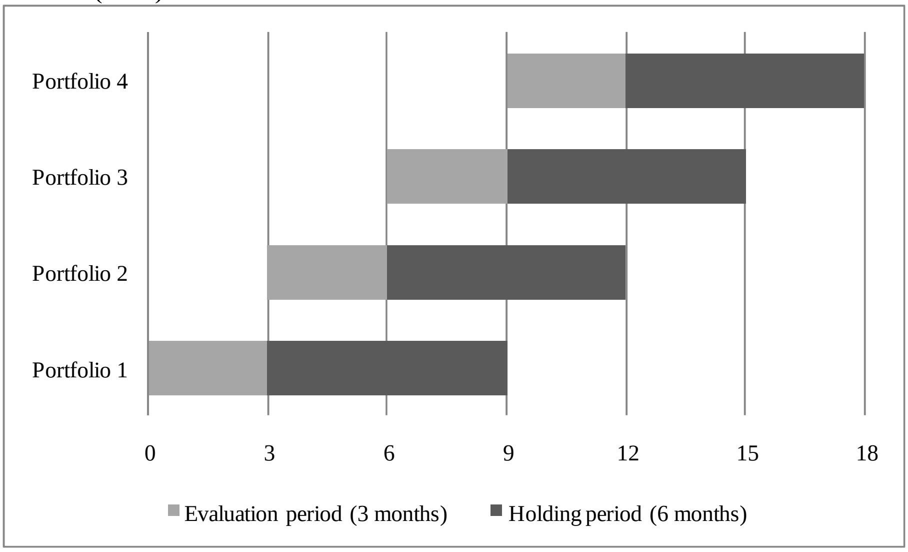
3. Former Research

In order to give a picture of what conclusions previous studies have reached in terms of momentum strategies, and in particular on the exploitation of the underreaction phenomenon, we will below describe them, both in an international (with a focus on studies on US and European data) as well as a Swedish context. We also describe what factors that previous studies have concluded help to explain the appearance of profits for momentum strategies.

3.1 International

Many of the earlier studies that have been performed on the subject of momentum strategies have been done on US data. Jegadeesh and Titman (1993) studied if it was possible to earn excess returns with a zero-investment strategy in the US. The strategy was carried out by creating winner and loser portfolios. The winner portfolio contained the stocks that had performed best in the previous period (top 10 percent) and the loser portfolio, on the other hand, consisted of the worst performing stocks in the same time period (bottom 10 percent). The stocks in the winner portfolio were bought whereas the stocks in the loser portfolio were short-sold, creating a zero-investment portfolio, whose proceeds come from the net returns of the winner and loser portfolio. The data Jegadeesh and Titman (1993) used was returns for the stocks listed on the New York Stock Exchange (NYSE) and American Stock Exchange (AMEX) for the period 1965 to 1989. The evaluation periods for the portfolios that were used was 3, 6, 9 and 12 months, respectively. Similarly, the holding periods for the same portfolios were either 3, 6, 9 or 12 months, hence there were in total 16 portfolios when combining the various evaluation and holding periods (see below a schematic picture of a 3-6 momentum strategy).

Figure 1. Schematic picture of the portfolio construction by Jegadeesh and Titman (1993)



A schematic picture of how Jegadeesh and Titman (1993) construct a zero-investment strategy involving a three month evaluation period and a six month holding period.

The returns of this strategy, without considering any transaction costs, on a monthly basis, are summarized in Table 1, with the corresponding *t*-statistics in parentheses.

Table 1. Momentum returns obtained by Jegadeesh and Titman (1993)

Evaluation period (*J*)	**Holding period (*K*)**			
	3	**6**	**9**	**12**
3	0.32% (1.10)	0.58% (2.29)	0.61% (2.69)	0.69% (3.53)
6	0.84% (2.44)	0.95% (3.07)	1.02% (3.76)	0.86% (3.36)
9	1.09% (3.03)	1.21% (3.78)	1.05% (3.47)	0.82% (2.89)
12	1.31% (3.74)	1.14% (3.40)	0.93% (2.95)	0.68% (2.25)

Monthly returns for the various zero-investment portfolios in the study by Jegadeesh and Titman (1993). The *t*-statistics are shown in parenthesis.

As one can see, the returns are positive for all portfolios and all the results are also statistically significant at the five percent significance level, besides the portfolio with an evaluation and holding period of three months. Jegadeesh and Titman (1993) also conclude that these excess profits cannot be explained by either increased risk or lead-lag effects from delayed stock price reaction to general information, as Lo and MacKinley (1990) suggest in their paper. They also find that in the following 24 months after the initial twelve months the strategies generate negative abnormal returns, i.e. they observe a reversal effect. Moreover, there is also a clear seasonal pattern, namely that the zero-investment strategy has consistently a very negative performance in January each year in which they, on average, lose about seven percent whereas it produces positive returns for the rest of the months. The study by Jegadeesh and Titman (1993) is especially interesting since it has many similarities to the study we will perform in this thesis, besides the fact that they use overlapping holding periods, whereas we do not.

Rouwenhorst (1998) uses the same methodology as applied by Jegadeesh and Titman (1993) but in a European setting, where 12 countries are studied in the period 1978-1995 (covered 60-90 percent of the total market capitalization in each country). He found an overall difference between the winner and loser portfolios by approximately one percent per month on average (the returns ranged between 0.63 and 1.35 percent), in favour of the winner portfolios. The best performing zero-investment strategy had an evaluation period of twelve months and a holding period of three months. Rouwenhorst (1998) also chose to study the characteristics of the momentum portfolio with a six month evaluation and holding period. He observed that the standard deviation of a 6-6 strategy is about four percent per month, which is similar to the volatility of a long position in the middle decile portfolios (stocks that neither has performed well or poor). A test to see if there are individual differences between the countries for the above mentioned portfolio is also made and he discover that the excess returns, adjusted for country specific factors, decreases from 1.16 to 0.93 percent (standard deviation of the excess return falls from 3.97 percent to 2.39 percent per month). Hence, a large part of the standard deviation for these portfolios is country-specific and thus can be reduced if you use an international sample. Furthermore, since Rouwenhorst (1998) notices that companies in the winner and loser portfolios on average are smaller than in the sample as a whole, he performed tests which indicated that there is a momentum effect in all size groups, but that the effect is larger for smaller companies. Rouwenhorst (1998) also studied the risk-adjusted returns of the above strategy and he concluded that, after controlling for size, the strategy yielded a return of 1.46 percent per month (i.e. an increase by 0.32 percentage points); no beta risk was either detected. Rouwenhorst (1998) also finds evidence relatively similar to the ones obtained by Jegadeesh and Titman (1993), namely when using longer holding periods than 11 months the returns of a zero-investment strategy turn negative. Gutierrez JR and Kelley (2008) find that this also seems to be true for very short holding periods. They observe that momentum strategies with holding periods up to two weeks have clearly negative returns (the same conclusion can be drawn from the obtained CAPM and Fama-French alphas), whereas in week three such strategies generate profits that is only slightly above zero. Thereafter, the momentum returns are positive and continues to be so for the period up to week 52.

The study by Griffin et al (2003) also investigates internationally if there are profits to be made by exploiting momentum effects. They use data from 40 countries, spread over many continents, which have at least 50 stocks. The equally-weighted momentum portfolios are constructed through an evaluation period of six months and a holding period of the same length, where the top and bottom 20 percent are included in the respective portfolios. The momentum return for the total sample was 0.49 percent and 0.77 percent in Europe and the corresponding *t*-statistics were 2.95 and 8.15. The momentum returns in Asia and for the emerging markets, in general, was notably lower than in other parts of the world and Europe was the only region where the loser portfolio did perform worse than the market as a whole. Griffin et al (2003) also concludes that the correlation between and across regions is relatively low and thus momentum profits cannot be explained by a global risk factor which other studies have proposed. Furthermore, the authors find that neither the results from the tested unconditional nor the conditional model provide evidence that macroeconomic risk factors can explain the observed momentum profits. They also check whether the return from this momentum strategy differs between up and down markets and they find that the profits are indistinguishable in developed countries but apparent in emerging markets (0.77 and 0.56 percent respectively for down markets and 0.64 and -0.01 percent respectively for up markets). Thus, momentum profits are not dependent on a certain state of the market and can neither be explained by standard macroeconomic state variables in developed countries. But in regions where the momentum profits significantly differ between the two states they are slightly higher when the market development is negative.

Chordia and Shivakumar (2002) find in their paper that momentum payoffs both for individual companies and industries as a whole can be explained by common macroeconomic variables, namely the dividend yield, the default spread, the yield on three-months T-bills and the term structure spread. The authors also investigate whether the returns of momentum strategies differ in various economic states. The obtained results showed that the returns are large during expansions and negative or nonexistent during recessions.

Avramov et al (2007) investigate if credit rating could be a crucial factor when explaining momentum profits, since credit rating varies over the business cycle just as momentum profits have been proven to do (Chordia and Shivakumar (2002)). The authors find that during the period 1985 and 2003, using US data, momentum profits are restricted to high credit risk companies and that it is non-existent for companies with high credit quality. They find that trading strategies based on previous 6-month return and credit rating yield momentum returns that increase with the credit risk, from 0.27 percent for the companies with the highest quality to 2.35 percent per month for the ones with highest credit risk. Moreover, they also find that the significant returns from the momentum strategies comes from companies that in total consist of less than four percent of the entire sample in terms of market capitalization. They conclude that information uncertainty variables do not capture the momentum profits across credit rating groups whereas, on the other hand, credit rating does capture the momentum profits across uncertainty groups. The authors also check if the results they obtained are robust to variables that have been proposed by previous papers on the topic and they find that the link between momentum and credit risk still is strong and significant after controlling for size, volatility, trading volume, analyst coverage and forecast dispersion among analysts. Hence, momentum profits appears to exist among companies with small market capitalization which have a low credit rating, but are not present in highly rated companies with small market capitalization.

Söderström (2008) uses the same methodology as Jegadeesh and Titman (1993) and the selection of countries is chosen in accordance with Griffin et al (2003). The overall results in terms of momentum profits are in general very similar to many earlier studies performed on the subject (Jegadeesh and Titman (1993), Rouwenhorst (1998) and Griffin et al (2003)). But what Söderström (2008) especially focus on is to investigate the empirical momentum return distribution in the sample countries. He finds that the momentum returns are far from normal, which proven by the test statistics obtained from the Jarque-Bera test, and that the distribution has a negative skew and excess kurtosis. This implies a leptokurtic distribution with fat tails (higher probability of extreme values than expected by the normal distribution). Even more interesting, Söderström (2008) finds that the likelihood of getting extreme values that are negative is significantly higher than for positive ones. This is caused by a sharp increase in returns for previous loser stocks which is not matched by the previous winner stocks. He also concludes that when excluding the least liquid stocks from the sample, the average momentum profits increase since the series that have these extremely negative returns are no longer incorporated. Söderström (2008) argue that these loser stock rallies is linked to macroeconomic shocks, such as the currency floatation by Sweden in 1992, the surprising interest rate reduction by Federal Reserve in 2001 and the East Asian crisis in 1997.

The study performed by Conrad and Kaul (1998), regarding the effectiveness of a momentum strategy in the US obtains results similar to Jegadeesh and Titman (1993), namely that momentum strategies are profitable at a three to twelve month time horizon. Cleary and Inglism (1998) tested if they could observe a momentum effect on the Canadian stock market in the period 1978 to 1990. They concluded that a momentum strategy was highly successful and that the excess return was only partially explained by increased risk. But if one also take into consideration the average transaction cost for an investor, it would be difficult to exploit the abnormal profits. Chan et al (1996) found in their study on US stock data between 1977 and 1993 that there is an apparent momentum effect for strategies with holding periods of six to twelve months but that the momentum returns to a large extent is explained by earnings momentum. The authors, for example, find that 41% of the superior performance in the first six months occurs around the earnings announcement dates.

3.2 Sweden

When examining the results of similar studies done on Swedish data, the results are less unanimous. Blank and Hehenberger (1999) created portfolios which consisted of the analyst covered stocks (254 stocks) that had performed best and worst in the past months and then evaluated their performance over various time horizons. In the sample period 1987-1996, they concluded that the stocks that had done well previously (top 20 percent) underperformed significantly when studying holding periods of six and twelve months, whereas the previous loser stocks (bottom 20 percent) showed positive returns over the same time horizons. They also tested if the results differed if they divided the sample period in two halves, and they found that the momentum profits were greater and had higher significance before November 1992 than after, which they concluded to be an effect of higher liquidity and a more efficient market.

The results that Rouwenhorst (1998) obtained for the individual countries in his sample showed that the results for all the other eleven countries besides Sweden were significant while for Sweden the return was only 0.16 percent (standard deviation of 6.32 percent) and the *t*-statistic was not more than 0.36. The Swedish sample consisted of 134 companies and the sample was in general biased towards larger companies.

Söderström (2000) replicates the method used by Rouwenhorst (1998) for Swedish companies in the period 1980-1999, but he also investigates the effect of the devaluation of the krona in 1992. If the devaluation is disregarded, only two out of 16 portfolios have statistically significant positive returns on a five percent level, whereas the rest is only weakly positive besides the strategy with an evaluation and holding period of three months, which is negative (see Table 2).

Table 2. Momentum returns obtained by Söderström (2000)

Evaluation period (*J*)	**Holding period (*K*)**			
	3	**6**	**9**	**12**
3	-0.37% (-0.83)	0.22% (0.61)	0.25% (0.92)	0.16% (0.53)
6	0.37% (0.70)	0.66% (1.99)	0.47% (1.49)	0.19% (0.59)
9	0.64% (1.25)	0.79% (2.13)	0.52% (1.52)	0.12% (0.34)
12	0.37% (0.68)	0.45% (1.03)	0.30% (0.76)	0.02% (0.05)

Monthly returns for the various zero-investment portfolios in the study by Söderström (2000). The *t*-statistics are shown in parenthesis.

But when he removes the devaluation effects, 15 out of 16 portfolios show positive and significant monthly returns at the five percent level. He also finds that the returns from momentum strategies are higher in the period after the devaluation and that this is driven by a good performance by the long leg whereas the opposite appear to be true in the period before the devaluation. Söderström (2000) also concludes that these returns are not explained by the beta, the standard deviation or a large firm sample bias. Moreover, a pooled regression is also performed but when excluding the stocks with market capitalization that belongs to the lower 70 percent, half of the significance of the size variable is lost and thus momentum profits appears to be more robust among smaller companies. Söderström (2000) also points out that despite the fact that the momentum profits pass several tests, one should also consider the risks associated with it. Momentum strategies perform well in stable periods but sudden shocks can lead to extremely negative returns and the found momentum premium could be a compensation for bearing this risk.

Regarding the results from the study that looks at the momentum effects in Sweden, Söderström (2008) finds that a zero-investment strategy, for the period 1984 to 2005 (with an evaluation and holding period of six months), yields a monthly return of 0.4 percent. The corresponding *t*-statistic was 0.9. Examining the empirical distribution, he found that the outcome of the Jarque-Bera test indicated that the error terms were clearly not normally distributed for Sweden.

From the part of the study by Griffin et al (2003) that focused on Sweden, one could see that there was no evidence of momentum profits since the monthly momentum profit was -0.01 with a corresponding *t*-statistic of -0.02. The return of the winner and loser portfolios (with evaluation and holding periods equal to six months) both generated negative monthly returns of about -0.05 and none of them were statistically significant.

4. Hypotheses

In this section we construct our hypotheses based on the findings and conclusions from previous empirical studies in the area of momentum effects, combined with some of the ideas presented in the behavioural theories section.

4.1 Momentum Profits on the Swedish Stock Market

In an international context, momentum profits have been proven to exist in almost all regions. For example, Jegadeesh and Titman (1993) observed that momentum profits could be made when using holding periods of three to twelve months based on US listed stocks. Rouwenhorst (1998) get similar results when studying momentum effects on European data, where he found that in eleven out of twelve countries, momentum profits were positive and significant. The studies on Swedish data, on the other hand, give a different picture. Both Griffin et al (2003) and Söderström (2008) find no or only weak signs of momentum effects with a holding and evaluation period of six months. Rouwenhorst (1998) concludes in his paper that Sweden was the only country in the sample where the momentum payoffs were not statistically significant. In the study by Söderström (2000), only two out of 16 momentum strategies yielded positive and significant returns (evaluation and holding periods ranged from three to twelve months), but after excluding the devaluation in 1992, the results changed considerably and now almost all strategies showed significant profits. Since the findings on Swedish data have been far from unanimous, we will primarily focus on strategies with evaluation periods of six months or more (besides the holding period expectations) since these tend to be most successful internationally. From the perspective of the behavioural theories presented, they support the view that momentum effects should occur in the medium term.

Hypothesis 1: We expect to observe statistically significant momentum returns for holding periods between three to twelve months and evaluation periods of six months or longer in Sweden for a zero-investment strategy.

4.2 Momentum Profits Adjusting for Various Measures of Risk

Next, we examine whether the potential momentum returns observed through hypothesis 1 are robust to various measures of risk. This is done by analyzing the size and the significance of Jensen's alpha (as will be described in section 7.2.1). Moreover, we also compare the size of the beta values for both legs and see if they differ considerably and examine what the beta value is for the zero-investment portfolio. Previous studies have shown that conventional measures of risk such as beta and Jensen's alpha cannot capture the momentum profits. The study by Söderström (2000) finds that momentum profits are robust to such risk measures if considering the devaluation. The latter conclusion, regarding the beta, is discussed by Jegadeesh and Titman (1993) who finds that the zero-investment portfolio (for a 6-6 strategy) has a small negative beta value but that the beta values for the respective legs was larger than the sample mean. The same conclusion is made by Rouwenhorst (1998) who finds a similar pattern when examining the betas in his sample.

Hypothesis 2a: If we find significant positive momentum returns, we expect them to continue to be significant after controlling for these two conventional measures of risk.

Another way of looking at the risk attributable to a momentum strategy, which also takes into account more risk factors than CAPM, is the Fama-French model. Gutierrez JR. and Kelley (2008) found in their paper that a zero-investment strategy with a holding period of twelve months yielded significant raw returns. Moreover, they also observed that the obtained alphas from the CAPM and Fama-French models were significant, and that this also was true when they excluded the first three weeks, in which a short term reversal effect often is observed. Söderström (2008) finds that the momentum returns for a 6-6 strategy is still significant after controlling for the risk factors in the Fama-French model, on US data, and that the observed return even increase. Moreover, as expected, a negative relation between momentum returns and the *SMB* and *HML* risk factors was found. On Swedish data, no study of Fama-French adjusted momentum returns has been undertaken, to our knowledge. Thus, based on previous studies, we expect that for the strategies where we previously had significant raw returns, the alphas we get from the Fama-French model will be significant.

Hypothesis 2b: If we find significant positive momentum returns, we expect them to be significant after controlling for the risk factors included in the Fama-French model.

Finally, Harvey and Siddique (2000) argue that a considerable part of the risk a momentum strategy investor is exposed to is skewness risk. The distribution for momentum strategies is in general negatively skewed and therefore an investor should be compensated for bearing this risk. Since a normal distribution often is assumed, this risk will not be captured by the above used models and therefore the significant momentum returns many authors have observed could be attributable to negative skewness risk. Thus, to test for this we add a coskewness term to the conventional Fama-French model, as done by Harvey and Siddique (2000), to see if the momentum returns still are significant after this adjustment. The formula we base our regression on is as follows (where the *SKS* variable is the additional coskewness factor):

$$r_{p,t} - r_{f,t} = \alpha_t + \beta(r_{M,t} - r_{p,f}) + \lambda_1 SMB_t + \lambda_2 HML_t + \lambda_3 SKS_t + \varepsilon_t \qquad (1)$$

Harvey and Siddique (2000) found that there is a systematic skewness in returns for momentum strategies and by including a conditional skewness factor, the stock returns prediction becomes much better than for both the CAPM and Fama-French model. Thus, we believe that including a skewness term will capture the potential returns of momentum strategies to a large extent and hence we do not expect to observe significant momentum returns after adding this factor.

Hypothesis 2c: If we find significant positive momentum returns, we expect them to not be significant after adding a coskewness variable to the Fama-French model.

4.3 Persistence among Included Portfolio Companies

An area that has not been touched upon by previous studies and therefore will be unique in that sense is whether there is a persistence pattern among the included portfolio companies, i.e. whether the likelihood that a specific company is in either the winner or loser portfolio in two or several consecutive periods are larger than what can be expected from a random draw. There have been studies that have tried to characterize what sorts of companies that are commonly included in the two portfolios and it has been found that they in general tend to be smaller than the sample mean, which e.g. Söderström (2000) and Rouwenhorst (1998) concluded. Avramov et al (2007) find that the factor that best capture momentum profits from included portfolio companies are actually their credit risk, but they also concluded that e.g. size and forecast dispersion among analysts had explanatory power. Thus, besides studying company characteristics in general which could imply some sort of persistence among certain sample companies, nothing has previously been tested explicitly. Therefore, based on the finding that portfolio companies have specific characteristics, we expect to find a significant persistence pattern.

Hypothesis 3: We expect that there should be a clear persistence pattern that is statistically different from what can be expected from a random draw.

We have decided to test four types of measures of persistence, namely the occurrence of a given company is included in the winner portfolio or the loser portfolio in two consecutive periods (W-W and L-L), and that a company which in the previous period was included in one of the two portfolios now is included in the opposite one (W-L and L-W). We expect to find that companies with shorter evaluation and holding periods should be included in the same portfolio in two consecutive periods to a greater extent, since it has been found that there is a reversal effect after approximately twelve months (Jegadeesh and Titman (1993)).

Hypothesis 3a: We expect that the likelihood of portfolios with evaluation and holding periods up to six months are included in the same portfolio in two consecutive periods is larger than the expected ten percent.

This also implies that for longer holding periods, we expect that companies should switch portfolios more frequently than the expected ten percent.

Hypothesis 3b: We expect that the likelihood of portfolios with evaluation and holding periods longer than six months are included in two different portfolios over two consecutive periods is larger than in the sample as a whole.

5. Data Description

The dataset used in this paper consists of return indices for the stocks listed on the Stockholm Stock Exchange (SSE) between January 1987 and March 2008. Specifically, the data represents the monthly level of the index for each stock, which is based on the closing values on the last trading day of each month. The main reason for using a return index to represent the performance of the companies rather than the monthly closing prices for the stocks is that the index chosen takes dividends, stock repurchases and splits into consideration. We therefore believe this index to be a good measure of the relative performance of a company. In the index, the discrete quantity of dividend paid is added to the price on the ex-dividend date [4]:

[4] Datastream provide the following description of the construction of the index: it shows "/…/ a theoretical growth in value of a share holding over a specified period, assuming that dividends are re-invested to purchase additional units of an equity or unit trust at the closing price applicable on the ex-dividend date".

$$RI_t = RI_{t-1} \times \frac{P_t + D_t}{P_{t-1}} \tag{2}$$

where *RI* represents the return on the index in month *t*, *P* the stock price and *D* the dividend paid, respectively.[5]

We have also collected monthly data for the market capitalization (share price multiplied by the number of ordinary shares) for the above specified time period as well as for turnover by volume, which in our case is the aggregated number of shares traded during a specific month. This data was collected for all the companies in our dataset, which included all firms that have been listed anytime during our chosen time period. That incorporates companies that have been delisted or suspended sometime during this period but also subsidiaries that has been separated from the parent company and listed on the exchange. To get hold of this data we used *Thomson Datastream* (Datastream), which we also used to download information of the risk-free interest rate (Sweden ten year government bond yield) and the return of the OMXS all share index. Since the data was not restricted to common shares, we manually went through the dataset and excluded data series such as preference shares, convertibles, warrants and redemption rights. Moreover, in accordance with Rouwenhorst (1998), we excluded all companies that have had a return history of less than twelve months. Only stocks that fulfilled all these requirements and that also was the major security were included in our sample (thus only one class of shares per company was allowed). In total, the sample consisted of monthly returns for 612 stocks and the average number of stocks listed at any point in time was 227. This gave us a dataset of 57 935 observations to work with.

The reason for choosing the specific time period as described above is because we wanted data that covered many business cycles, in order to avoid any bias in that sense. Hence, we wanted to include observations prior to and after the devaluation of the krona in 1992, the IT-boom at the turn of the century and the sub-prime crisis in 2007. The total number of months included in our sample is 255.

In order to mitigate problems with liquidity and short-sale constraints we decided, as many earlier studies in the field, to put certain restrictions on the data. In contrast to e.g. Jegadeesh and Titman (2001) and Avramov et al (2007), we do not put any limit in terms of the size of the stock price since we think there are better ways to adjust for illiquid stocks. Imposing a similar constraint, e.g. a hurdle of five US dollars in accordance with Jegadeesh and Titman (2001), would have excluded highly liquid stocks such as Ericsson for certain periods during the sample. Instead we choose to put a lower bound on the trading volume since we believe that if there is a high turnover in the stock, we are running a relatively small risk of affecting the share price by the trading itself. Also, since we are measuring the stock turnover over a one month period, temporary drops in turnover will not have such

[5] Datastream, Data Category Information Manual.

a large impact as if we were measuring the liquidity on a daily basis. We therefore decided to exclude the stocks that belong to the smallest decile in terms of trading volume but at the same time also exclude any observation that have a trading volume that is lower than 30 000 in a given month. Thus, we use both an absolute and a relative boundary, in order to adjust for the fact that the sample size increases over time. Furthermore, in accordance with Jegadeesh and Titman (2001) and Avramov et al (2007), we choose to restrict the sample so companies with a market capitalization equal to or less than the fifth percentile is not included, i.e. the bottom five percent. This deviates from what the above authors did (they excluded the entire lowest decile) and the reason for this is that their study is performed on US data which is much more extensive than the dataset we have collected and thus in order to be able to increase the chance of getting statistically robust results, we put a different lower bound. We are aware that this choice may affect the results from our tests since more highly volatile stocks are included. However, by imposing such a constraint we are still lowering the risk of including the most volatile stocks in the dataset. After making the above adjustments, our dataset now contains 49 800 observations and the average number of listed firms that fulfil our requirements in a given month is now 196.

Studying our original data sample over time, we notice that the number of listed firms at the second part of the sample period seems accurate but we question whether the data we received from Datastream at the end of the 1980s contains all companies listed during that time period. In 1987, our dataset indicates that in that year the number of listed companies varied between 34 and 37. This is considerably fewer than indicated by a list from OMX which suggests that 169 companies were listed that year.

6. Methodology – Portfolio Construction

The first step taken in order to evaluate the momentum phenomenon on the Swedish stock market was to calculate the returns of the shares included in our dataset from the obtained return indices. In order to measure the performance of the stocks over the various time periods, arithmetic averages were used. All the major papers done on the subject have used that approach and to be able to compare our results with the results from previous studies we decided to do the same, despite that fact that there are factors in favour of using geometric averages (e.g. that the geometric average better captures historical returns). To determine the portfolio composition, certain criteria had to be set up for how many stocks to include in each portfolio at any point in time for the various strategies, but also which stocks to include had to be decided.

In accordance with the studies performed by Jegadeesh and Titman (1993) and Rouwenhorst (1998), an amount of shares equal to one tenth of all shares listed on the Stockholm Stock Exchange (rounded to the nearest integer) at the date of the portfolio formation were selected for each of the two portfolios. The stocks included in a portfolio were evaluated based upon their historical returns. The period during which the stocks were evaluated, referred to as the evaluation period, varied between one and twelve months in the following intervals: one, three, six, nine and twelve months (henceforth *J* months). Stocks performing within the tenth decile in terms of average return were selected for the winner portfolio. Accordingly, stocks performing within the first decile were selected for the loser portfolio. Specifically, long and equally-weighted positions were taken in the top performing shares whilst short and equally-weighted positions were taken in the worst performing shares (together constituting 20 percent of the total number of listed companies). The shares were then held for one to twelve months (henceforth *K* months), in a similar manner to that of the evaluation period, which we will refer to as the holding period. At the end of the holding period, the portfolios are rebalanced based upon the outcome of the evaluation period. The evaluation period is of equal length as the previous one and ends at the time of the rebalancing. This rebalancing pattern is then repeated as many times as possible between January 1, 1987 and March 1, 2008 with a frequency equal to *K* months. When combining all possible lengths of the evaluation period with that of the holding period, 25 different winner and loser portfolios emerged.

However, the strategy of interest for this paper is the zero-investment strategy. This strategy takes a long position in the above described winner portfolio and a short position of equal size in the loser portfolio. Hence, assuming no transaction costs, no initial investment is needed. The loser portfolio always has the same length of *J* and *K* as the winner portfolio. This results in 25 possible combinations of zero-investment strategies.

An intuitive question related to the practical implementation of the above strategy is the treatment of delistings or, more specifically, delistings of companies currently included in any of the zero-investment portfolios. We find four possible alternatives to treat the value of the position held in a delisted company; reinvest the money in a representative market index, reinvest the money in the zero-investment portfolio, reinvest the money at the risk-free interest rate or not reinvest the money at all. Since the three former alternatives were expected to influence the performance of the portfolios too dramatically[6], we choose to not reinvest the money at all until the end of the current holding period. Noteworthy, of the total number of portfolios inclusions (in either the winner or loser portfolio) only 4.08 percent have been delisted in our sample. Moreover, an apparent pattern is that the frequency of delistings increases with the length of the holding period (see Table A2), which is understandable since the longer time period investigated, the possibility of a delisting taking place should increase. The impact delistings should have on the performance of the winner and loser portfolios is that the absolute return of both these portfolios decreases.

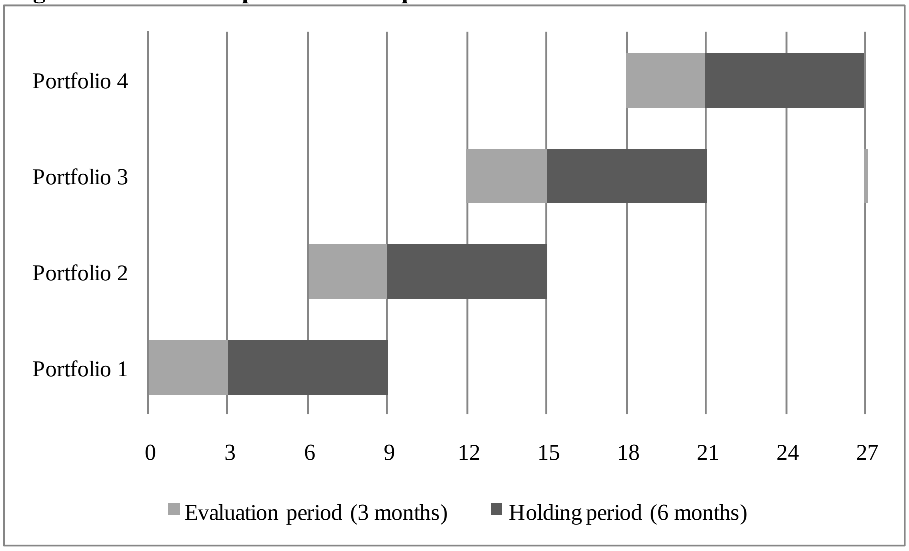
In terms of choosing whether to use equally- or value-weighted returns, Jegadeesh and Titman (1993) notice in their paper, that both methods yield very similar returns. Therefore, we choose to use only the former strategy for two reasons. First, equally-weighted returns give a more intuitive

[6] For example, in March 1990, the yield of a ten year government bond was 14.54 percent.

approach in terms of implementable strategies. Second, focusing on one of the two strategies allows for a more comprehensive analysis.

Finally, as opposed to the majority of the papers written on the topic (e.g. Jegadeesh and Titman (1993)) we have chosen to not investigate strategies with overlapping holding periods, i.e. two or several portfolios held simultaneously. Instead, as described above, at any time the portfolio is rebalanced, the strategy closes out of all positions taken in month t - K. Using overlapping portfolios will inevitably introduce severe autocorrelation in the returns of the portfolios, hence impeding the usage of the ordinary least squares (OLS) procedure to estimate risk-adjusted measures of the portfolio returns without making large adjustments. One problem with not using overlapping portfolios is that the number of observations to work with is reduced considerably which will affect the significance of the results, since the statistical uncertainty increases with fewer observations. A schematic picture of a strategy involving an evaluation period of 3 months and a holding period of 6 months is presented below.

Figure 2. Schematic picture of the portfolio construction



A schematic picture of a strategy involving a three month evaluation period and a six month holding period.

7. Methodology and Empirical Results

In the following section we will present the methodology and the outcome of the various tests and regressions performed for the 25 momentum strategies. We start by examining whether we observe positive momentum profits for the various zero-investment strategies and if they are statistically significant. Thereafter, we see if the potential momentum profits are robust to conventional measures of risk, in this case by Jensen's alpha, the size of the beta and a Fama-French regression. Subsequently, we also will undertake a modified version of the Fama-French model, with an additional coskewness factor, to investigate whether negative skewness is a factor of importance in terms of momentum returns. Finally, we will assess if there is a general persistence pattern among the included portfolio companies and if we can find that the potential persistence varies depending on the investigated type.

7.1 Hypothesis 1 - Momentum Profits on the Swedish Stock Market

7.1.1 Methodology

The methodology that is attributable to the creation of the portfolios, of which the 25 strategies is based upon, has already been described in detail. Below, we will instead focus on how the *t*-tests, that will determine the significance of the raw momentum returns, have been constructed. The single-sided *t*-tests were performed, as specified below:

$$t_{obs} = \frac{\overline{X} - \mu}{\left(S \big/ \sqrt{n} \right)} \sim t_{n-1,\,\alpha} \tag{3}$$

Firstly, we do not have an issue with the normality assumption underlying the above equation since the requirements of the central limit theorem are met in our case. Moreover, the expected return from a zero-investment strategy is zero, since you do not invest any money, the μ variable will be set to zero. For unadjusted returns it is reasonable that μ is equal to zero, but as Söderström (2008) states, momentum strategies are not risk-free and hence an investor should, based on that argument, earn some return in order to compensate for that risk exposure.

Important to note is that previous studies primarily have been done on portfolios with overlapping holding periods. The problem that arises is that the tests are not made on independent drawings and the normal *t*-tests give biased results. Therefore, it is common to use the Bonferroni inequality[7] in order to get a conservative upper bound, which for example Jegadeesh and Titman (1993) propose in their paper. This is not necessary in our case since we do not have overlapping holding periods and hence the regular *t*-statistics that we obtain are accurate in that sense.

7.1.2 Results

Studying the performance of the zero-investment strategies we see that only two out of 25 strategies show negative monthly returns. As can be seen in Table 3, these two strategies are 1-1 and 3-1, which is not very surprising. That is because many previous studies, e.g. Gutierrez JR. and Kelley (2008), show that there is a reversal effect in the first weeks after the formation. This also seems to be true in our case since the 1-1 strategy yields a monthly return of -1.91 percent, which is clearly significant at

[7] A procedure that provides a bound for the probability of observing a *t*-statistic of a certain magnitude with *N* tests that are not necessarily independent.

the five percent level. Among the positive returns we notice that the strategies that give the highest raw returns are the ones in the lower left corner, namely strategies with evaluation periods of six to twelve months and holding periods of one month to six months. These strategies have average returns of 1.29 to 2.63 percent, all significant at the five percent level. Overall, in terms of the significance, we observe that 9 out of 23 strategies with positive monthly returns are significantly different from zero. This is considerably more than what Söderström (2000) finds in his study before considering the effect of the devaluation in 1992. The result for the 6-6 strategy, which in our case yield a return of 1.29 percent (t-statistic equal to 2.05), is also significantly higher than what Rouwenhorst (1998) and Griffin et al (2003) found in their respective samples – neither of them found significant momentum returns in Sweden. In an international perspective, the returns we observe are generally higher for many strategies than what for example Jegadeesh and Titman (1993) obtained in the US and Rouwenhorst (1998) found on European data.

It is also interesting to study which leg that contributes most to the success of the top performing zero-investment strategies. From Table 3 it is evident that the performance of the winner portfolios are relatively similar across the examined strategies but that this over performance instead is attributable to the poor performance of the loser portfolios which on average give a monthly return of less than 1%. The weak result of the 1-1 strategy is both related to the strong performance of the loser portfolio (the portfolio that performs best among all included portfolios) and the low monthly return of 0.82 percent for the winner portfolio. A general conclusion is that the difference in returns between the various strategies is to a large extent due to the change in performance of the loser portfolios whereas the return from the winner portfolios tends to be more stable.

Table 3. Momentum returns for the various zero-investment strategies

Evaluation period (*J*)	Strategy	Holding period (*K*)				
		1	**3**	**6**	**9**	**12**
1	**W**	0.82%	2.68%	2.65%	2.23%	2.26%
	L	2.73%	1.80%	2.02%	1.77%	2.10%
	W - L	-1.91%**	0.91%*	0.70%	0.53%	0.19%
	(*t*-stat)	(-2.10)	(1.29)	(0.93)	(1.22)	(0.40)
3	**W**	1.93%	2.49%	2.45%	2.16%	1.81%
	L	2.01%	1.56%	1.57%	1.92%	1.73%
	W - L	-0.08%	0.96%	0.96%*	0.28%	0.10%
	(*t*-stat)	(-0.08)	(1.23)	(1.49)	(0.50)	(0.20)
6	**W**	2.49%	2.71%	2.05%	2.29%	1.95%
	L	0.72%	1.20%	0.82%	1.97%	0.80%
	W - L	1.78%**	1.54%**	1.29%**	0.38%	1.26%*
	(*t*-stat)	(1.89)	(2.06)	(2.05)	(0.33)	(1.54)
9	**W**	2.45%	2.43%	2.44%	2.04%	2.36%
	L	0.36%	0.97%	1.02%	1.09%	1.66%
	W - L	2.09%**	1.49%**	1.49%**	1.03%*	0.82%
	(*t*-stat)	(2.11)	(1.94)	(2.08)	(1.57)	(1.09)
12	**W**	2.65%	2.51%	2.39%	2.20%	2.53%
	L	0.02%	0.82%	1.01%	1.46%	1.58%
	W - L	2.63%***	1.72%***	1.46%**	0.82%	1.12%*
	(*t*-stat)	(2.80)	(2.46)	(1.90)	(1.24)	(1.50)

Monthly returns for the winner and loser portfolios as well as for the 25 zero-investment strategies. The *t*-statistics (used for increased comparability to previous findings) are shown in parenthesis. *Significant at the 10% significance level, ** significant at the 5% level and ***significant at the 1% level.

Our hypothesis was that we would find significant momentum returns for zero-investment strategies with evaluation periods of at least six months and with holding periods of three to twelve months. We find that this is partly true since six out of twelve strategies yielded significant positive monthly returns (at the five percent level) of 1.29 percent or more. We can also conclude that there is a clear pattern that long evaluation periods seems to be more important in general than long holding periods since the strategies that performs best have evaluation periods of six months or higher, as expected. But we also find that combining a holding period of one month with a long evaluation period seems to be a very attractive investment strategy. Thus, although our hypothesis is only partly supported, we find that an investor can maximize the return by choosing an evaluation period of six to twelve months and a holding period of one to six months in Sweden, at least from a historical perspective.

7.2 Hypothesis 2 - Momentum Profits Adjusting for Various Measures of Risk

7.2.1 Methodology

In order to determine the risk-adjusted performance for various momentum strategies, the OLS procedure is used, which is in line with the method used in previous studies. For comparative as well as illustrative purposes, we intend to follow this procedure by investigating the relationship between the excess[8] one month return of all 25 zero-investment strategies and the excess return of the market index, approximated by the OMXS price index. Specifically, the following regression will be estimated:

$$r_{p,t} - r_{f,t} = \alpha_t + \beta(r_{M,t} - r_{f,t}) + \varepsilon_t \tag{4}$$

In equation 4, $r_{p,t}$ equals the K month return of a zero-investment portfolio, $r_{M,,t}$ equals the K month return of the OMXS index estimated over the same time period, and $r_{f,t}$ equals the K month risk-free interest rate, as described above. Since the results from equation 4 are highly dependent on the fulfilment of the fundamental assumptions underlying the OLS procedure, we intend to test each of the assumptions that are not obviously fulfilled[9] in order to be able to make any necessary corrections. Specifically, we will test for the presence of a unit root, heteroscedasticity and serial correlation for all 25 zero-investment strategies. A formal test to see if the error term is normally distributed will also be conducted.

The next area of investigation is if the potential momentum returns are captured by the Fama-French model. Important to note is that we for these regressions have a more limited dataset, due to the fact that the book-to-market data is less extensive for Swedish listed firms. The method used is identical to the one used by Fama and French (1993) and the equation is constructed as follows:

$$r_{p,t} - r_{f,t} = \alpha_t + \beta(r_{M,t} - r_{f,t}) + \lambda_1 SMB_t + \lambda_2 HML_t + \varepsilon_t \tag{5}$$

In order to calculate the *SMB* and *HML* factors we first have to divide the sample into certain groups. Firstly, the companies are placed in one of two groups based on their market capitalization, depending on if they have a market capitalization above (big companies) or below (small companies) the median in each period. Secondly, the companies are divided into three groups based on their book-to-market ratio. The 30 percent of the companies that have the highest ratios are placed in one group (*high* book-to-market companies) and the bottom 30 percent in another one (*low*

[8] Relative to the current ten year government bond yield
[9] Obviously fulfilled assumptions: linear regression model, the number of observations exceed the number of estimated parameters and variability in the covariate.

book-to-market companies) and consequently the 40 percent that remains are grouped together in a separate portfolio. After doing that for each period, the intersection of these groups helps us to determine the above factors. The Small-Minus-Big factor and the High-Minus-Low factor are calculated as follows:

$$SMB = \frac{(r_{S/L} + r_{S/M} + r_{S/H}) - (r_{B/L} + r_{B/M} + r_{B/H})}{3} \tag{6a}$$

$$SMB = \frac{(r_{S/H} + r_{B/H}) - (r_{S/L} + r_{B/L})}{2} \tag{6b}$$

The final sub-hypothesis is based on an extended version of the Fama-French model, which was put forward by Harvey and Siddique (2000). They found that adding a coskewness term to the equation improves the prediction of stock returns significantly, since the factor captures the negative skewness, a risk factor that is usually not taken into consideration. The equation looks as follows:

$$r_{p,t} - r_{f,t} = \alpha_t + \beta(r_{M,t} - r_{f,t}) + \lambda_1 SMB_t + \lambda_2 HML_t + \lambda_3 SKS_t + \varepsilon_t \tag{7}$$

All factors, besides the coskewness factor is calculated in the same manner as above. In the paper by Harvey and Siddique (2000) several alternatives of how to calculate the coskewness factor are presented. We choose the one that is most intuitive in our view and that factor is based on the spread in returns between the S^- and S^+ portfolios. The S^- portfolio consists of the companies with the most negative skewness (bottom 30 percent) for the past 36 months and the S^+ portfolio of the companies with the most positive skewness (top 30 percent). Thus, the difference in returns for these portfolios represents the *SKS* factor. Among the other alternatives, the second approach that we also considered was to measure coskewness as the excess return for the S^- portfolio in relation to the asset beta. As mentioned above, we find the chosen approach to be more intuitive (both methods generate relatively similar results) but also more in line with the construction of the other Fama-French factors. Noteworthy, the time period that we focus on in this case is the period between January 1990 and March 2008, since we need 36 months of data in order to construct the skewness portfolios.

7.2.2 Results

The outcome of the tests where we examine whether the fundamental assumptions underlying the OLS regressions are fulfilled can be found in Appendix B. To summarize the findings, we observed that we had no problems with unit roots but some issues with serial correlation and heteroscedasticity and therefore we decided to use standard errors that are robust to both heteroscedasticity and serial correlation. In terms of a normally distributed error term, strategies with short evaluation or holding periods violated that assumption, but since the estimators in equation 4 will still be unbiased and have a minimum variance, we made no correction for it.

The main purpose of estimating equation 4 is to study the risk-adjusted alphas for all possible combinations of *J* and *K*, the results are summarized in Table 4.

Table 4. Jensen's alpha for the various zero-investment strategies

Evaluation period (*J*)	**Holding period (*K*)**				
	1	**3**	**6**	**9**	**12**
1	-3.02%	0.22%	0.00%	0.07%	0.53%
	(0.001)	(0.720)	(0.993)	(0.888)	(0.270)
3	-1.31%	0.44%	0.66%	-0.06%	-0.37%
	(0.171)	(0.592)	(0.302)	(0.923)	(0.491)
6	0.54%	1.25%	1.20%	0.71%	1.27%
	(0.566)	(0.082)	(0.034)	(0.394)	(0.058)
9	0.82%	1.23%	1.57%	0.84%	0.66%
	(0.409)	(0.084)	(0.011)	(0.174)	(0.286)
12	1.42%	1.57%	1.52%	0.76%	0.95%
	(0.129)	(0.015)	(0.042)	(0.243)	(0.153)

The alpha values and the corresponding *p*-values for the 25 zero-investment strategies.

As can be seen in Table 4, the significant alphas are clustered around relatively long evaluation periods and holding periods of short or medium length. Specifically, the alphas are highest when the evaluation period ranges between six and twelve months while the holding period simultaneously lasts either three or six months. In total, four out of 25 strategies had positive and significant returns at the five percent significance level (seven at the ten percent level).

Another pattern of interest is that strategies with relatively short evaluation periods have very small or even negative intercepts. The 1-1 strategy is once again significant and clearly negative and the return has become even more negative after the risk-adjustment. As previously mentioned, this is most likely due to the short term reversal effect as proposed by Gutierrez JR and Kelley (2008).

Regarding the rest of the strategies, we first notice that several of the strategies which turned out to be significant when calculating the raw returns are no longer significant when adjusting for the risk exposure to the market. Specifically, strategies with long evaluation periods and a holding period of one month generated the highest raw returns, but their observed Jensen's alpha values, on the other hand, are not statistically significant. Thus, the high returns these strategies generated were attributable to their increased riskiness. Moreover, a general observation is that several alpha values are either very low or even negative. Hence, momentum profits are far from insensitive to market risk in several cases. On the other hand, there are still relatively many strategies with significant alphas so the explanatory power of market risk tends to vary between various strategies.

Table 5. Beta values for the various zero-investment strategies

Evaluation period (*J*)	Strategy	Holding period (*K*)				
		1	3	6	9	12
1	W	0.16	1.75***	2.06***	1.47***	1.88***
	L	-0.22	1.50***	1.66***	1.52***	1.68***
	W-L	0.38***	0.25	0.40	-0.05	0.21
3	W	0.91***	0.17	1.47***	1.10***	1.29***
	L	1.23***	-0.10	1.64***	1.34***	1.59***
	W-L	-0.31*	0.27	-0.17	-0.22	-0.27
6	W	1.03***	1.01***	1.07***	1.05***	0.38
	L	1.34***	1.41***	1.63***	2.24***	1.18***
	W-L	-0.30*	-0.40**	-0.55**	-1.17*	-0.78**
9	W	0.97***	1.01***	1.04***	1.07***	1.05***
	L	1.36***	1.54***	1.79***	1.60***	1.54**
	W-L	-0.39**	-0.52***	-0.74***	-0.52*	-0.42
12	W	0.87***	0.92***	0.96***	1.15***	1.22***
	L	1.24***	1.49***	1.58***	1.69***	1.89**
	W-L	-0.36**	-0.56***	-0.62**	-0.52	-0.65

The beta values for the winner and loser portfolios as well as for the 25 zero-investment strategies. *Significant at the 10% significance level, ** significant at the 5% level and ***significant at the 1% level.

When studying the beta values for the zero-investment strategies to see whether an increased risk-taking can help to explain the positive return they yield, we see that the beta values range from -1.17 to 0.40. The intuition behind examining the beta values is that companies with high beta values should give higher return according to the CAPM formula, so if the zero-investment strategies would have high beta values the positive return could be a compensation for the increased risk such a strategy implies. But as we can see, most of the momentum strategies have negative betas, in some cases quite sizable ones and thus the positive returns cannot be explained by high beta values. This conclusion is also reached by Jegadeesh and Titman (1993) who find a beta of -0.08 for a 6-6 momentum strategy. On Swedish data, Söderström (2000) investigates the size of the beta for a 6-6 strategy over various time periods. He finds that the beta value is clearly negative in all the three examined periods, namely in the period before the devaluation in 1992, the period after the devaluation and consequently also in the entire sample. Interesting to note, both the winner and the loser portfolios in general have beta values above 1, i.e. they fluctuate more than the market. The loser portfolios also tend to have higher betas than the winner portfolios and thus the zero investment strategies have a negative risk exposure and therefore the observed momentum returns are clearly in the lower range in that sense. Moreover, a few of the winner and loser portfolios have very low betas and these are due to a couple of outliers who affect the results, and therefore they should be interpreted with caution (it is problematic to adjust for that since we must rely on ex ante information when performing the filtering).

For hypothesis 2a, we conclude that of the nine strategies that had significant positive raw returns only four of these have significant alphas at the five percent level after controlling for market risk. On the ten percent level, on the other hand, six strategies have significant alphas. After studying the beta values for the 25 zero-investment strategies we see that most of them in fact are negative and significant and thus, from that perspective, the returns could actually be higher for many strategies. Combining these results, we can partly support hypothesis 2a since these two conventional measures of risk, in many cases, cannot capture the observed momentum profits for strategies with significant raw returns.

Table 6. Fama-French alphas for the various zero-investment strategies

Evaluation period (*J*)	**Holding period (*K*)**				
	1	**3**	**6**	**9**	**12**
1	-2.99%	-0.27%	0.32%	0.04%	-0.27%
	(0.001)	(0.656)	(0.593)	(0.944)	(0.588)
3	-1.48%	0.32%	0.60%	-0.57%	-0.48%
	(0.129)	(0.690)	(0.396)	(0.458)	(0.480)
6	0.30%	1.60%	1.48%	0.17%	1.62%
	(0.762)	(0.027)	(0.014)	(0.878)	(0.043)
9	0.98%	1.78%	1.23%	0.49%	1.38%
	(0.327)	(0.017)	(0.085)	(0.557)	(0.224)
12	1.38%	1.69%	2.01%	-0.19%	1.17%
	(0.151)	(0.024)	(0.096)	(0.773)	(0.016)

The alpha values and the corresponding *p*-values from the regressed Fama-French model for the various zero-investment strategies.

Studying the results we get from our Fama-French regression we see that the alpha values (see Table 6) are relatively similar to the ones obtained through CAPM but, more importantly, considerably smaller than the raw returns. The trend that already started in the CAPM regression, but has become even more evident this time, is that quite a few of the alpha values are negative (seven to be more precise, only one is significant). Among the positive alphas, six are significant at the five percent level (eight at the ten percent level). The ones that are significant are also more scattered than previously, when the alphas were highest when the evaluation period ranged between six and nine months and the holding period simultaneously lasted three to six months. In this case, these strategies still performs well but the 6-12 and 12-12 strategy are now also highly significant. The strategies with the negative alphas have almost exclusively short evaluation periods (one to three months) whereas the length of the holding period seems to be of less importance. Comparing our results to what Söderström

(2008) concluded, he found that a 6-6 momentum strategy on US data (1940-2004) yielded a significant monthly return of 0.8%, whereas the same strategy generate a return of 1.48% in our sample. To note, the strategies with long holding periods but with only a one month evaluation period that had high raw returns do have positive alpha values, but as was the case for CAPM, they are once again not significant when performing the Fama-French regressions.

As illustrated in Table C1, eleven of the 25 *SMB* coefficients are significant at the five percent significance level whilst only six of the coefficients were positive. The positive coefficients all belong to strategies with holding periods of either six or twelve months. However, none of these observations are significant at any reasonable significance level which implies that, if there is an overall relationship between momentum profits and the *SMB* factor, the relationship is most likely to be negative. Statistically significant coefficients were found for all the five lengths of evaluation periods, but the number was highest for evaluation periods equal to twelve months.

These results confirm the findings presented by Söderström (2008) when he constructs zero-investment portfolios, based upon the cumulative return for the previous six months, containing stocks belonging to the first and fifth quintile. The estimated *SMB* coefficient was found to be -0.38 when using a six month holding period (significant at the one percent level). As can be seen in Table C1, when replicating this test, we obtain a coefficient equal to -0.52 with a corresponding *p*-value equal to 0.185. Harvey and Siddique (2000) obtain a *SMB* coefficient of 0.013 (*p*-value equal to 0.012) in their paper for a 12-6 strategy. That is quite the opposite of what we find since our *SMB* coefficient for that specific strategy is -0.62. It should be noted though that our coefficient is highly insignificant.

When estimating the coefficients of the *HML* factor, all results are positive and the coefficients for 15 out of the 25 strategies are significant at the five percent level. The statistically significant coefficients can be observed for several combinations of *J* and *K* but seem to be clustered around relatively short holding periods.

When comparing the *HML* coefficient for the 6-6 strategy with the results obtained by Söderström (2008), the results are fairly similar. His coefficient is estimated to -0.06 while we obtain a positive value of 0.14 with a corresponding *p*-value of 0.365. It should be noted that neither of the coefficients are significant at the ten percent level. Harvey and Siddique (2000) also observe a negative coefficient (-0.06) for their 12-6 strategy compared to 1.09, which we obtain. But in contrast to Söderström (2008), their coefficient is highly significant. Thus, it seems like the clear positive signs that our strategies have contradicts what previous studies have found but intuitively, their results are more appealing. That is because when Fama and French (1993) studied the returns for companies with high book-to-market ratios with those that had the smallest, the latter group had far more volatile returns. Thus, since only companies with rather extreme returns are included in either the winner or loser portfolio, one would expect a negative correlation between book-to-market and momentum returns, i.e. a negative *HML* coefficient.

In order to check whether the factor loadings for the Fama-French model that we use are accurate we decided to compare our loadings for the *HML* factor to the one published on Kenneth French's homepage for Sweden (no information is available for the *SMB* factor for Sweden). We are able to obtain data for the period 1987 to the end of 2007, so our time periods are identical besides the additional three months that our dataset contains. Taking an arithmetic average of the monthly factor loadings from the provided data for the above specified time period we receive a loading of 0.54, i.e. the monthly return for the *HML* portfolio is 0.54 percent. Comparing this loading to the ones we obtain for the 25 strategies we notice that our figures range between -0.12 and 2.45, but the majority of the loadings lie in the interval zero to one, where e.g. the 6-6 strategy has a loading of 0.31. We consider our factor loadings to be reasonable in most cases and for the instances where the loading is considerable larger than one, a look at the data show that these are due to outliers.

For hypothesis 2b, we conclude that of the nine strategies that had positive and significant momentum returns, after controlling for the risk factors included in the Fama-French model, four strategies still yield positive and significant momentum returns at the five percent level (and an additional two on the ten percent level), which is similar to what we observed for the CAPM regression. This might seem surprising since the Fama-French model incorporates more risk factors and thus should capture the risks associated with momentum returns considerably better. However, the strategies that have returns which are significant have not changed. All in all, we conclude that, as in the case of hypothesis 2a, our hypothesis is only partly supported.

Table 7. Alphas from the Fama-French model with the additional coskewness factor for the various zero-investment strategies

Evaluation period (*J*)	Holding period (*K*)				
	1	**3**	**6**	**9**	**12**
1	-3.12%	-0.19%	0.37%	0.18%	-0.31%
	(0.001)	(0.770)	(0.584)	(0.786)	(0.482)
3	-1.17%	0.55%	0.48%	-0.67%	-0.77%
	(0.251)	(0.577)	(0.541)	(0.342)	(0.289)
6	0.48%	1.81%	1.49%	-0.26%	0.60%
	(0.635)	(0.030)	(0.030)	(0.827)	(0.467)
9	0.48%	1.81%	1.23%	0.06%	1.49%
	(0.634)	(0.039)	(0.090)	(0.942)	(0.244)
12	1.43%	1.81%	1.92%	-0.22%	1.44%
	(0.156)	(0.034)	(0.080)	(0.763)	(0.003)

The alpha values and the corresponding *p*-values from the regressed Fama-French model with the additional coskewness factor for the various zero-investment strategies.

The final measure of risk that we will study is the skewness risk that has been proposed to be of considerable interest for momentum strategies. Focusing on the obtained alpha values, a general observation is that many of the previous patterns seem to persist. Furthermore, the strategies with positive and significant returns are to a large extent the same as for the conventional Fama-French regression, where most of them have a holding period of three to six months and an evaluation period of six to twelve months, with the 12-12 strategy as the only exception. The major difference is that even though most of these strategies are still significant, their *p*-values have now increased and the 6-12 strategy is now far from significant. In comparison to the conclusions drawn by Harvey and Siddique (2000), who expects that the negative skewness which zero-investment strategies are exposed to would capture the momentum returns, does not hold in our sample. For momentum portfolios with six month holding periods, the authors found that the R^2 improved after including the coskewness factor and the skewness was significantly negative for almost all presented momentum strategies. They did not, however, calculate any alphas based on their extended Fama-French model.

The *SMB* coefficients for the extended Fama-French model (see Table C2) show the same pattern as in Table C1 in the Appendix, i.e. statistical insignificance and positive values belonging to strategies with holding periods of six or twelve months. Twelve values are significant at the five percent level (three at the one percent level). The approximated coefficients for the *HML* factor are almost identical to the results from the conventional Fama-French model, both in terms of significance and sign.

As discussed in section 7.2.1, the main paper investigating the relation between momentum returns and coskewness is the one by Harvey and Siddique (2000). When using an evaluation period of eleven months and a six month holding period, the coefficient for the coskewness factor is positive and significant at the five percent level when using US data between 1963 and 1993. Interesting to note, in contrast to the other coefficients, the coskewness factor actually turns negative in some of the sub-samples which indicates that this coefficient is more sensitive to turbulence in the market than the other factor coefficients.

In our sample, we find ten of the coefficients to be negative and the remaining 15 to be positive. The negative values are most apparent for longer holding periods and are non-existing for holding periods up to three months. Of the four coefficients that are significant at the five percent level, only one is positive. In accordance with Harvey and Siddique (2000), we are therefore not able to draw any specific conclusions regarding the sign of the coskewness factor. Generally, however, we conclude that the negative and statistically significant coefficients are only to be found when using a holding period of either nine or twelve months.

Based on our results, including the coskewness variable in the regression does somewhat affect the results and hence it captures some of the momentum returns associated with zero-investment strategies. On the other hand, several of the strategies continue to have significant positive returns and the coefficients for the coskewness factor are rarely significant, neither of these things was expected. Moreover, the results from the extended Fama-French model are very similar to what we found for the conventional version in terms of the obtained alphas and hence it looks like the coskewness factor might not be the solution to the momentum return puzzle.

For hypothesis 2c, we conclude that the addition of the coskewness factor does not seem to influence the outcome to the extent that we had expected. We find that four strategies have significant alphas, at the five percent level, of the nine that had significant positive raw returns (six was significant at the ten percent level). The results are in line with what we found for the previous two risk models. Since the results obtained by Harvey and Siddique (2000) was promising we are rather surprised that, firstly, relatively many of the strategies show significant momentum returns and, secondly, that the difference between this method and both CAPM and the Fama-French model is not more evident. Based on our results, we conclude that hypothesis 2c is only partly supported.

7.3 Hypothesis 3 - Persistence among Included Portfolio Companies

7.3.1 Methodology

To examine whether we find a persistence pattern among the included portfolio companies, we decided to use a binomial test. We considered a binomial test to be the best choice since we know the statistical probability that a given company is included in each of the portfolios. The formula for the binomial test is as follows:

$$Z_{obs} = \frac{\frac{X}{n} - p}{\sqrt{\frac{pq}{n}}} \tag{8}$$

In this test we investigate whether the observed probability is equal to the assumed probability of ten percent (p is consequently set to 0.1). The reasoning behind choosing ten percent as the appropriate level is that the probability that a random company is included should be ten percent since that is the percentage of the sample that is included in each of the portfolios. Since the observed probability can both be larger and smaller than the assumed probability, we have chosen to use a double-sided test. As stated in our hypothesis section, we will study four types of measures for persistence. Firstly, we will look at the probability that a company which is included in the winner portfolio is included in the winner portfolio also the following holding period (W-W). Secondly, we will study the opposite phenomenon, namely that a company is included in the loser portfolio after having been included in the loser portfolio also during the previous holding period (L-L). Thereafter, we examine if a company that have been included in either of the two portfolios, in the subsequent period is included in the opposite one in the next period (W-L and L-W). We also considered testing the probability of a company being included over three consecutive periods but due to the very small probability of that happening and the insignificance, from a statistical point of view, such results would lead to, we decided to not extend our persistence testing further.

7.3.2 Results

The results for the first type of persistence can be found in Table 8 for the 25 zero-investment strategies. To note, momentum strategies with long evaluation periods and short holding periods, as can be seen in the table, tend to have the highest observed probabilities. In a few instances the probability is even above 50 percent. This can to a great extent be explained by the fact that these strategies have evaluation periods that overlap, even if we do not have overlapping holding periods. As described earlier, the start of the evaluation period is matched so that the subsequent holding period starts at the end of the previous one. Hence, when the length of the evaluation period is longer than the holding period, there will be overlapping evaluation periods and therefore the observed probabilities will be biased and thus will not be relevant when studying the persistence pattern. Therefore, we will exclude them from the analysis for all four persistence types (these figures are in italics and reported only for illustrative purposes).

A general conclusion one can draw is that for all strategies except one (the 6-12 strategy), the observed probability is higher than the expected ten percent and for 9 out of the 15 strategies included in the analysis the probabilities are significant at the five percent level. In this group, the probability ranged between 8.4 to 18.3 percent and a clear observed pattern is that the strategies with the highest values almost exclusively lie on the diagonal, i.e. momentum strategies that have evaluation and holding periods of equal length. Intuitively, this is not very surprising since there is not a time gap between the evaluation periods in these cases and since momentum as a phenomenon suggests that there is a trend in returns, a gap increases the probability that the trend in question has ended.

Table 8. Observed probabilities when testing persistence (W-W) for the various zero-investment strategies

Evaluation period (*J*)	Holding period (*K*)				
	1	3	6	9	12
1	**0.1213**	**0.1375**	**0.1458**	**0.1017**	**0.1335**
	(0.000)	**(0.000)**	**(0.000)**	**(0.878)**	**(0.041)**
3	*0.4689*	**0.1538**	**0.1152**	**0.1274**	**0.1094**
	(0.000)	**(0.000)**	**(0.174)**	**(0.053)**	**(0.576)**
6	*0.6247*	*0.3881*	**0.1546**	**0.1398**	**0.0836**
	(0.000)	*(0.000)*	**(0.000)**	**(0.007)**	**(0.355)**
9	*0.6782*	*0.4936*	*0.2989*	**0.1444**	**0.1145**
	(0.000)	*(0.000)*	*(0.000)*	**(0.002)**	**(0.384)**
12	*0.7272*	*0.5587*	*0.3642*	*0.2417*	**0.1826**
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	**(0.000)**

Observed probabilities from the binomial tests on persistence (W-W) for the various zero-investment strategies. The *p*-values are shown in parenthesis.

The results for the second type of persistence pattern can be found in Table 9 for the 25 momentum strategies. Focusing on the strategies of interest, we see that in this case none of the strategies have an observed probability that is lower than the assumed ten percent. Among the strategies with non-overlapping evaluation periods, 14 out of 15 are significant at the five percent level. The interval of observed probabilities ranges from 10.2 to 21.1 percent and the figures in general are slightly higher than what we observed for the previous persistence type. The pattern that the strategies with the highest observed probabilities lies on the diagonal is less evident in this case, even though they are all highly significant with values ranging from 16.4 to 21.1 percent. Noteworthy is that the only strategy that does not have an observed probability, which is not significantly different from ten percent, is the 1-12 strategy. That is interesting since that strategy is the one where the evaluation periods are the furthest away and thus the expected momentum trend is likely to have vanished.

Table 9. Observed probabilities when testing persistence (L-L) for the various zero-investment strategies

Evaluation period (*J*)	Holding period (*K*)				
	1	3	6	9	12
1	**0.1641**	**0.1613**	**0.1242**	**0.1356**	**0.1023**
	(0.000)	**(0.000)**	**(0.032)**	**(0.014)**	**(0.859)**
3	*0.4689*	**0.1887**	**0.1646**	**0.1318**	**0.1344**
	(0.000)	**(0.000)**	**(0.000)**	**(0.030)**	**(0.050)**
6	*0.6187*	*0.3894*	**0.1849**	**0.1871**	**0.1858**
	(0.000)	*(0.000)*	**(0.000)**	**(0.000)**	**(0.000)**
9	*0.6696*	*0.4750*	*0.3141*	**0.1904**	**0.1852**
	(0.000)	*(0.000)*	*(0.000)*	**(0.000)**	**(0.000)**
12	*0.7183*	*0.5427*	*0.3838*	*0.2536*	**0.2107**
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	**(0.000)**

Observed probabilities from the binomial tests on persistence (L-L) for the various zero-investment strategies. The *p*-values are shown in parenthesis.

The results for the third type of persistence can be found in Table 10 for the various zero-investment strategies. It should be mentioned that the strategies with overlapping evaluation periods for this and the coming persistence type are likely to have observed probabilities that is below ten percent, since here we focus on the behaviour of changing portfolios and overlapping evaluation periods limits the likeliness to do so.

Among the 15 examined strategies, the evident pattern found in the previous two persistence types does not seem to hold in this case. The observed probabilities for strategies with evaluation and holding periods of equal length are all higher than ten percent but only two of them are significant at the five percent level. Moreover, the pattern with many insignificant results is also apparent for the rest of the examined strategies (twelve out of 15 strategies) and a majority of the observed probabilities are clustered around values of ten to twelve percent. Hence, one can conclude that our results do not indicate that companies included in the winner portfolio in the previous month are more likely to be included in the loser portfolio the following period than what is expected from a random draw.

Table 10. Observed probabilities when testing persistence (W-L) for the various zero-investment strategies

Evaluation period (*J*)	Holding period (*K*) 1	3	6	9	12
1	**0.1602**	**0.1144**	**0.1107**	**0.1186**	**0.1080**
	(0.000)	**(0.068)**	**(0.327)**	**(0.191)**	**(0.594)**
3	*0.0188*	**0.1264**	**0.0974**	**0.1274**	**0.1250**
	(0.000)	**(0.001)**	**(0.174)**	**(0.053)**	**(0.136)**
6	*0.0045*	*0.0377*	**0.1110**	**0.1290**	**0.1084**
	(0.000)	*(0.000)*	**(0.303)**	**(0.044)**	**(0.579)**
9	*0.0015*	*0.0147*	*0.0565*	**0.1172**	**0.1179**
	(0.000)	*(0.000)*	*(0.000)*	**(0.222)**	**(0.288)**
12	*0.0005*	*0.0051*	*0.0238*	*0.0616*	**0.1180**
	(0.000)	*(0.000)*	*(0.000)*	*(0.007)*	**(0.251)**

Observed probabilities from the binomial tests on persistence (W-L) for the various zero-investment strategies. The *p*-values are shown in parenthesis.

The results for the fourth type of persistence can be found in Table 11 for the 25 zero-investment strategies. As for the third type, the number of high and significant observed probabilities among the examined strategies are low. In this instance, five strategies are significant at the five percent level and the highest observed probability is 14.6 percent. Similarly, strategies with evaluation and holding periods of equal length, which stood out for the first two types of persistence, are once again not different from the rest of the strategies since only two out of five strategies show significant observed probabilities. Moreover, despite the fact of many insignificant probabilities, there are still only two cases in which the observed figure is less than the assumed one.

Table 11. Observed probabilities when testing persistence (L-W) for the various zero-investment strategies

Evaluation period (*J*)	Holding period (*K*) 1	3	6	9	12
1	**0.1464**	**0.1273**	**0.1147**	**0.1208**	**0.1108**
	(0.000)	**(0.001)**	**(0.178)**	**(0.144)**	**(0.477)**
3	*0.0162*	**0.1164**	**0.0974**	**0.1296**	**0.0938**
	(0.000)	**(0.030)**	**(0.853)**	**(0.036)**	**(0.780)**
6	*0.0032*	*0.0243*	**0.1017**	**0.1290**	**0.1177**
	(0.000)	*(0.000)*	**(0.856)**	**(0.044)**	**(0.307)**
9	*0.0011*	*0.0160*	*0.0620*	**0.1109**	**0.1010**
	(0.000)	*(0.000)*	*(0.000)*	**(0.402)**	**(0.923)**
12	*0.0007*	*0.0083*	*0.0294*	*0.0687*	**0.1124**
	(0.000)	*(0.000)*	*(0.000)*	*(0.034)*	**(0.426)**

Observed probabilities from the binomial tests on persistence (L-W) for the various zero-investment strategies. The *p*-values are shown in parenthesis.

For hypothesis three we had one main hypothesis and two sub-hypotheses. To start with the main hypothesis, we expected that there should be a clear persistence pattern that was statistically different from what could be expected a random draw. Our results show that this is only partly true for the 15 strategies that we examined. For the two types of persistence, where a company is included in the same portfolio for two consecutive periods (W-W and L-L), a clear majority of the strategies had an observed probability that significantly differed from the assumed ten percent. An apparent pattern that could be observed was that strategies with evaluation and holding periods of equal length in most cases showed the highest probabilities, something that indicates that there is a trend in the return series, which is what momentum profits is all about. On the other hand, the two latter persistence types, where we study the inclusion of companies in two different portfolios for two consecutive periods (W-L and L-W), the result pointed in a different direction. Namely, if there is a persistence pattern, it is only weak, since most of the strategies had insignificant observed probabilities. Thus, we can conclude that there is a persistence pattern of being included in the same portfolio for two periods in a row, whereas the same is not true for the other two combinations.

Among the strategies that we have examined, the results related to hypothesis 3a show that of the six strategies with the shortest evaluation and holding periods (i.e. 1-1, 1-3, 1-6, 3-3, 3-6 and 6-6) five out of these six strategies in the first case and all six strategies in the second case have observed probabilities that are significant at the five percent level. That is considerably better than for the rest of the strategies for the W-W combination, and slightly better for the L-L combination. Thus, we can conclude that we fail to reject hypothesis 3a, based on our results.

For hypothesis 3b, where we argued that the likelihood that portfolios with longer evaluation and holding periods are included in two different portfolios over two consecutive periods is larger than in the sample as a whole, the result pointed in the opposite direction. Our results instead indicate that this is more common among other strategies but the number of cases where the observed probabilities are significant is also very limited. Thus, our expectation that there were going to be a reversal effect after twelve months and that this would be reflected by companies included in one of the two portfolios to switch in the next period, was not realised.

7.4 Additional Testing for Comparability Reasons

All the above testing has been based on the methodology of non-overlapping holding periods. Since most previous studies have chosen to use holding periods that to a various extent are overlapping, one issue with our results is that they are somewhat difficult to compare with earlier findings. Therefore, we will in this section apply the methodology that was used by Söderström (2000) to see if we come up with relatively similar results and thereby can explain some of the discrepancies between our respective results. Moreover, we will also perform sub-sample testing in a similar fashion to

Söderström (2000) by studying the outcome if one exclude the period around the devaluation in 1992 and separately look at the periods before and after this event.

7.4.1 Methodology

In contrast to our methodology in terms of the portfolio construction, which is created in a way that there is only one zero-investment portfolio active at any point in time for a given momentum strategy, Söderström (2000) chooses to create one new portfolio in every quarter without considering the length of the holding period. This implies that for e.g. a 3-3 strategy, there is no problem with overlapping holding periods, whereas for the 12-12 strategy, two consecutive portfolios overlap in nine of twelve months. It should be noted that the methodology used by Söderström (2000) also differs from the one used by Jegadeesh and Titman (1993) who create a new portfolio each month. In line with the norm within this field, we have decided to only focus on the 6-6 strategy in this section which means that the holding periods will overlap 50 percent each time, i.e. three out of six months.

Since we want to replicate the analysis as performed by Söderström (2000) as far as possible, the time periods are chosen in accordance with his study. Thus, the entire period including the devaluation is in this case defined as January 1987 to March 1999 (in Söderström (2000) the period starts in March 1980, but the first years are not captured by our dataset) while the entire period that excludes the devaluation is the same with the difference that the period October 1992 to the end of November 1993 is disregard. Consequently, the pre-devaluation period is defined as January 1987 to the end of September 1992 and the post-devaluation period as December 1993 to March 1999.

7.4.2 Results

The results when applying the methodology used by Söderström (2000), with partly overlapping holding periods, can be seen in Table 12. Similarly to Söderström (2000), we find that the return for all examined time periods are positive but the size of the returns differs somewhat. For the period that includes the devaluation period, the return that we observe is 1.37 percent which is considerably higher than what Söderström (2000) obtained in his study (0.66 percent). Still, both our full period results are significant at the five percent level. As expected, the returns also increase when the devaluation period is disregarded. The monthly return is even significant at the one percent level. Söderström (2000) observes a similar pattern where the monthly return increases in his case to 0.99 percent, this figure is also significant at the one percent level.

Studying the respective periods before and after the devaluation in 1992, our results are consistent with the findings of Söderström (2000) since we observe that the return increases in the second period, from 1.69 to 1.77 percent. However, the results that Söderström obtained differ significantly between the periods. In the pre-devaluation period the return is only 0.71 percent whereas it increases to 1.68 percent in the period after the devaluation (both still significant at the five percent level).

All in all, we observe that the returns obtained are very similar across time periods but slightly higher when excluding the devaluation. For Söderström (2000), the returns are more dependant on the chosen time period but in general considerably lower than the ones that we obtained. However, a slight result difference was expected since neither the entire period nor the pre-devaluation timeframe exactly matched with that of Söderström (2000). Since the post-devaluation returns are in line with what Söderström (2000) observed, we consider our results to be fairly robust and accurate.

Table 12. Momentum returns for a 6-6 strategy when using overlapping holding periods

Time period	Raw returns
Entire period (1987-1999) incl. the devaluation	1.37% (0.043)
Entire period (1987-1999) excl. the devaluation	1.73% (0.009)
Pre-devaluation (1987-1992)	1.69% (0.079)
Post-devaluation (1993-1999)	1.77% (0.023)

The returns for a 6-6 zero-investment strategy when using the same methodology as Söderström (2000) in terms of overlapping holding periods and the treatment of the devaluation of the krona in 1992. The *p*-values are shown in parenthesis.

8. Conclusions

In order to summarise the main findings and test results as provided in the previous section, Table 13 briefly presents our major observations and the outcome of our hypotheses.

Table 13. A summary table of the main findings

Hypothesis		Summary
1	**Conclusion**	9 of 23 momentum strategies have positive and significant returns and these have evaluation periods of 6 to 12 months and holding periods of 1 month to 6 months. We can partly support our hypothesis since 6 of 12 strategies had significant monthly returns for holding periods of 3 to 12 months and evaluation periods of at least 6 months.
2	**Jensen's alpha and beta values**	4 of 25 strategies have positive and significant positive alphas. The best strategies have evaluation periods between 6 and 12 months and holding periods of either 3 or 6 months. The previously best performing strategies with long evaluation periods and a holding period of 1 month no longer yield significant returns. We find that most of the momentum strategies have negative betas and thus the positive returns cannot be explained by high beta values.
	Fama-French	6 of 25 strategies have positive and significant alphas. The alphas are highest when the evaluation period range between 6 and 12 months and the holding period simultaneously lasts 3 to 6 months, plus the 6-12 and 12-12 strategies.
	Fama-French + coskewness factor	Similar results to the Fama-French regression, besides that the 6-12 strategy is no longer significant. The coskewness factor is only significant in 4 of 25 cases, of which it is negative in 3 cases. Thus, the addition of the coskewness factor does not seem to improve the model.
	Conclusion	All our three hypotheses are only partly supported by our results. Hence, the number of strategies that yield significant profits are reduced when undertaking any of these risk-adjustments.
3	**Persistence type 1**	9 of 15 strategies have observed probabilities significantly different from 10%. A clear pattern is that momentum strategies that have an evaluation and holding period of the same length have the highest probabilities.
	Persistence type 2	14 of 15 strategies have significant probabilities. The interval of observed probabilities range from 10% to 21%. The pattern for strategies with evaluation and holding periods of the same length is less evident in this case, even though they all are significant.
	Persistence type 3	A majority of the strategies are in this case insignificant (12 of 15) and most of the observed probabilities are clustered around 10% to 12%. Thus, only very weak signs for this type of persistence. Strategies with evaluation and holding periods of the same length do not overperform other startegies as previously, which also are true for the next persistence type.
	Persistence type 4	5 of 15 strategies have significant observed probabilities and the highest observed one is 14.6%. Only weak signs observed for this persistence type.
	Conclusion	Our results indicate that the main hypothesis is only partly true. For the first 2 types of persistence (W-W and L-L) most of the strategies have significant observed probabilities. The opposite is true for the other 2 types. For hypothesis 3a we find that 5 of 6 and 6 of 6 strategies respectively have significant observed probabilities. Thus, we conclude that our results support hypothesis 3a. For hypothesis 3b our results instead indicate that this is more common among other strategies and hence we reject hypothesis 3b.

Brief summary of the main findings for the 25 zero-investment strategies.

8.1 Concluding Remarks

In an international comparison, the raw returns that we observe are in many instances relatively similar to what previous studies have found, taking into consideration that they have not examined strategies with evaluation and holding periods of only one month. In accordance with these studies, momentum strategies with evaluation periods of six months or more combined with holding periods of three to nine months almost exclusively yield positive and significant returns. But in contrast to what many international studies have observed, we also find that strategies with evaluation periods of six to twelve months combined with a holding period of one month are successful in terms of momentum returns. The question we ask ourselves is whether this is a Swedish phenomenon or if this also would have been observed if previous international studies would have examined these momentum strategies. Considering the similarities to the other results obtained, we find it likely that this also would have been observed when undertaking studies using international data.

Another observation of importance is that we find a short term reversal effect for the 1-1 momentum strategy. This strategy yields negative and highly significant raw returns that, in an absolute sense, is higher than most other combinations of evaluation and holding periods. However, this is not surprising since Gutierrez JR and Kelley (2008) found a clear return reversal in the first weeks after the portfolio formation. More unanticipated is that by exploring this fact, when not taking transaction costs into consideration, a short position in this strategy would actually yield returns superior to most of the other momentum strategies. Regarding transaction costs in general, we have chosen to disregard them in our study as most authors have done. However, Jegadeesh and Titman (1993) briefly touch upon the subject. They find, by considering a 0.5% one-way transaction cost, which in their view is conservative, that the CAPM-adjusted returns are still positive and significant. Hence, based upon this fact, it is likely that some of the momentum strategies, with the highest monthly returns, could be implemented successfully in reality.

In a Swedish context, our results are fairly unexpected since no other study before ours, at least to the best of our knowledge, has found so many strategies with significant raw returns, without making any major adjustment to the data. The only study, to our knowledge, that finds clear indications of momentum in Sweden is Söderström (2000), but only after removing the turbulent period surrounding the devaluation in 1992. The two most apparent reasons for why our results deviate from what other economists have found is, in our view, the use of methodology (non-overlapping holding periods) and the chosen time period. By performing the additional testing reported in section 7.4, we try to investigate this fact and see what is causing the difference in results. Since we focus on the study by Söderström (2000), we will not explicitly comment upon the different conclusions reached by e.g. Rouwenhorst (1998) and Griffin et al (2003), but the results from the additional testing is likely to have explanatory power even in these cases. An interesting observation Söderström (2000) makes is that when he examines the momentum effects in the period before and after the devaluation separately, he notices that the momentum effect is more evident in the latter period. This could be one factor that explains why our raw returns show more clear signs of the existence of a momentum effect than what previous studies have done since our sample to a large extent is based on the period after the devaluation. On the other hand, events such as the EU entrance and the introduction of the euro would, in our view, imply a more efficient market climate and thus reduce the overall presence of momentum effects. However, due to the significance of our results, these factors have apparently not affected the momentum effects to a larger extent.

When replicating Söderström's (2000) study to the greatest extent possible (mainly delimited by the timeframe covered by our dataset), we observed that all the results that excluded the devaluation were relatively similar in size in our case. Therefore, based on this finding, the choice of time period seems to be of less importance. Söderström (2000), on the other hand, observes a sharp increase in returns which potentially could be due to the fact that his pre-devaluation period is considerably longer than ours, whereas for the post-devaluation period the results are very similar. Thus, we can conclude that the successfulness for momentum strategies cannot be said to have shifted in connection with the devaluation, but rather much earlier (probably the first half of the 1980s) since our results are very similar in the period 1987 to the end of 1992. Moreover, we also find that the period in relation to the devaluation has a negative impact on the return of momentum strategies but can also conclude that the event itself cannot change them to such an extent that they become insignificant, which is in contrast to what Söderström (2000) concluded. The major reason for our different results is likely to be due to the choice of time period rather than choice of methodology.

When studying from where this positive momentum returns stem we examine the respective legs of the zero-investment strategies. We notice that the long leg (winner portfolio) performs significantly and consistently better than the market and for the short leg (loser portfolio) the returns in general fluctuate more but on average are in line with or slightly higher than the return of the market. To look in relative terms what differentiates the strategies which yields significant momentum returns, from those who do not, we observe that the difference is primarily due to a worse performance than average for the short leg. This is remarkable because Söderström (2000) finds in his study that the loser portfolios contributes more in the pre-devaluation period while it is the winner portfolio that does so in the post-devaluation period. Since we earlier commented on that our sample is more influenced by the development in the period after the devaluation, one would expect, based on this argument, to find the winner portfolio as the main contributor, but this was apparently not the case. However, one should keep in mind that the performance of the various winner portfolios are almost exclusively very good, so the dependent factor therefore becomes the performance of the loser portfolio.

In terms of the performance of the strategies with significant raw returns, after adjusting for various risk measures, we observe that certain clusters of strategies continue to yield significant returns regardless of the risk model used, whereas others constantly fail to do the same. Of the momentum strategies that were added, by including those with evaluation and/or holding periods of one month, the strategy that seems to be most robust in terms of its significance is the 1-1 strategy. It generates even more negative returns after the risk-adjustment, for all the three risk measures we use.

Another pattern that we observed was that the strategies with an evaluation period of six to twelve months and a holding period of one month no longer yield significant raw returns after any of the tested risk-adjustments, not even at the ten percent level. Thus, the conclusion we can draw is that of the new strategy combinations that we constructed (and thereby extending the number of strategies from 16 to 25) only one turned out to generate significant momentum returns after risk-adjusting them. We also confirmed what many previous studies have observed, namely that there is an apparent short term reversal effect for strategies with very short evaluation and holding periods.

On a more aggregate level, the results that we obtained from the various models, which incorporate different sets of risks, were surprisingly similar in terms of the strategies that yielded significant returns. We expected that CAPM, which only captures the market risk, would be too simplistic to capture the bulk of the momentum profits, but, on the contrary, it actually was the model with the fewest number of momentum strategies showing significant results. One explanation for this finding is that the two additional variables included in the Fama-French model (*SMB* and *HML*) indicate that the risk exposure for momentum strategies to these factors is in fact positive. In other words, the risk-adjustment makes momentum investing to look even more attractive since the adjusted returns are actually higher than the raw returns (Söderström (2008) came to a similar conclusion in his study). We can therefore conclude that the Fama-French model does not seems to capture the risks associated with momentum strategies well. One way to potentially capture this effect would be to add a momentum factor similarly to what Fama and French did in a sequel to their 1993 paper (nowadays referred to as the fourth Fama-French factor), but that is beyond the scope of this thesis. Another aspect that supports that view is that both the *SMB* and *HML* factors in most cases are significant and thus improves the model compared to if they would have been left out completely, as in the case of CAPM. Subsequently, adding the coskewness factor to the conventional Fama-French model had less effect than what we had expected after studying the promising results by Harvey and Siddique (2000). Fewer strategies had significant alphas after taking return skewness into consideration. But looking at the *SKS* factors separately, we notice that the *p*-values in general are rather high and that they are only significant for four out of 25 strategies. The question is whether the measure of skewness that we chose was the optimal one in this case, or if, by choosing another one, the results would have turned out different.

The novel study regarding persistence patterns among the included portfolio companies gave us some unexpected insights in terms of what types of persistence that seems to be most apparent. Both the W-W and L-L observed probabilities show clear signs of persistence whereas the same is less evident for the other two combinations (W-L and L-W). Thus, we find evidence for that winners tend to stay as winners and the same seems to be true for loser companies. The pattern emerges even more clearly for strategies with equal length of *J* and *K* for the W-W and L-L types, which can be explained by the fact that no time gap is created in these instances. On the contrary, strategies which have these time gaps between the evaluation periods run the risk of not capturing all of the remaining momentum. However, that pattern is not observed for the W-L and L-W types but we find in general that the observed probabilities for all examined persistence types are larger than the expected ten percent (even if many are not significantly different from ten percent). Hence, we suspect that these findings could partially be due to the fact that companies included in either of the two portfolios have certain characteristics that make them more probable candidates. Even though this is beyond the scope of our hypotheses, we choose to examine this possibility. This is done by performing paired *t*-tests to investigate whether the market capitalization for the portfolio companies is significantly different from the mean market capitalization for the rest of the sample, over a given holding period. We also undertake the same operation for the trading volume. The results for the former of the two above mentioned tests indicate that the market capitalization tends to be significantly lower than the mean for the rest of the sample for both the winner and loser portfolios in almost all cases (see Table D1 in the Appendix).

In terms of the trading volume, however, the results are less conclusive. For the winner portfolio, the trend is clear; the volume during the holding period is significantly higher than for the rest of the sample. Interesting to note, for the loser portfolios the volume is only larger in two cases. Thus, we can conclude that companies included in both portfolios tend to be significantly smaller in size and also that companies in the winner portfolios are more heavily traded. The fact that companies with small market capitalization tend to have low liquidity is maybe not that surprising since these companies are more exposed to a few trades or alternatively a limited amount of company related events that can lead to large fluctuations in the share price. This kind of extreme returns are often necessary to be included in either of the two portfolio types under investigation. What surprises us is that these characteristics seem to differ so vastly between the two portfolios. Given the above results regarding market capitalization, we find it counterintuitive that the trading volume of the winner portfolios turned out to be significantly larger than for the rest of the sample companies. On the other hand, the fact that companies included in either of the two portfolios tend to have small market capitalizations, was expected since e.g. Söderström (2000) discovered the same. Size is consequently one of the common characteristics among portfolio companies together with low credit rating (Avramov et al (2007)) and low book-to-market ratios (Söderström (2000)) and thus these factors will partially explain the persistence patterns we have observed. Given these observations, the actual probability of having a company, with these characteristics, included in a second consecutive holding period is therefore likely to be larger than the assumed ten percent. But since this is a rather unexplored topic, further studies have to be done in order to find a more appropriate probability.

8.2 Further Research

The aim of this paper has been to find evidence of and explain the presence of momentum returns in the Swedish stock market using data between 1987 and 2008. In our opinion, investigating the effects of transaction costs and similar impediments investors face when trying to implement any of the 25 momentum strategies would be one interesting field of further studies. Given the vast literature that has already tried to determine the impact of transaction costs, bid-ask spreads etc., some interesting conclusions might be drawn when trying to determine the extent to which momentum strategies can be pursued profitably in real life.

Another topic of interest that has only gained limited attention in the past is how the returns from different portfolio combinations, as well as momentum profits as a whole, differs with changing market conditions in Sweden. Specific examples include how a momentum strategy works when the market is experiencing a boom, a recession or just during normal conditions; or frequent changes between the three. Closely related to this topic, and already mentioned in section 3.2, is the impact of macroeconomic events, which is discussed by e.g. Söderström (2000 and 2008). We have already covered the devaluation of the krona in 1992, but also investigating other similar events that might have affected the market conditions, and indirectly the prerequisites for momentum returns, would be an interesting contribution to the topic. Other particular events of interest include the East Asian crisis in 1997 as well as the entrance of the European Union.

A third way to shed further light on the field of momentum effects is to change the frequency of the data observations. In line with most of the reference literature as presented in section 3, we have been investigating the phenomenon using monthly observations. Among the advantages of this procedure is the validity of the assumptions underlying the analysis, such as the ordinary least squares procedure. However, with the necessary statistical corrections, investigating momentum returns using e.g. a weekly frequency could potentially add some notable insights to the field.

Finally, some further studies on how negative return skewness affects momentum strategies using Swedish data would be of interest. Due to the insignificant results obtained when using the *SKS* factor in accordance with Harvey and Siddique (2000), we believe that there still is much that can be explored in this area on the Swedish stock market. Using two alternative approaches when trying to capture the negative skewness effect, the authors find some evidence of explanatory power superior to the procedure as undertaken in this paper. Investigating one or both of these methods could potentially deepen our understanding of how momentum returns are affected by negative skewness in Sweden.

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Appendix A – Descriptive Tables

Table A.1. Descriptive statistics for the return data

Year	Average return	Median return	Standard deviation	Maximum return	Minimum return
1987	-10.8%	-9.5%	19.6%	37.0%	-37.4%
1988	53.1%	49.9%	30.1%	139.4%	7.2%
1989	23.3%	13.4%	40.8%	152.6%	-24.8%
1990	-32.4%	-36.2%	22.2%	21.4%	-77.0%
1991	2.3%	1.6%	38.9%	106.7%	-73.5%
1992	-17.3%	-18.4%	40.2%	76.7%	-98.2%
1993	147.3%	87.3%	152.3%	762.9%	7.1%
1994	24.5%	14.1%	41.8%	233.3%	-50.0%
1995	11.5%	5.8%	40.0%	227.0%	-54.3%
1996	61.7%	50.3%	62.7%	378.1%	-54.2%
1997	26.6%	20.1%	46.2%	196.1%	-63.3%
1998	-3.4%	-14.7%	50.3%	200.7%	-99.6%
1999	70.7%	26.2%	368.4%	5755.9%	-75.4%
2000	-9.4%	-18.4%	64.3%	497.2%	-98.9%
2001	-13.4%	-18.2%	55.7%	332.4%	-99.3%
2002	-27.1%	-31.2%	43.6%	189.9%	-95.4%
2003	50.0%	32.2%	83.9%	482.1%	-92.8%
2004	48.5%	20.7%	233.2%	3739.8%	-87.7%
2005	59.3%	43.7%	77.3%	488.8%	-61.6%
2006	21.8%	18.1%	67.9%	709.5%	-90.0%
2007	-9.4%	-15.9%	54.2%	463.3%	-95.3%
2008	-1.5%	-4.0%	24.2%	281.5%	-64.7%
All	21.6%	9.9%	75.4%	703.3%	-67.2%

Descriptive statistics for the return data for each year in our sample period.

Table A.2. Frequency of delistings for the various winner and loser portfolios

Evaluation period (*J*)	Holding period (*K*)									
	1		3		6		9		12	
	Winner	Loser	Winner	Loser	Winner	Loser	Winner	Loser	Winner	Loser
1	0.0%	0.0%	5.4%	5.2%	8.5%	8.5%	8.8%	9.7%	11.2%	7.9%
3	3.0%	2.9%	4.5%	4.9%	12.1%	11.8%	14.3%	14.5%	8.9%	10.3%
6	3.6%	4.4%	3.7%	4.6%	4.5%	7.7%	5.5%	10.7%	7.5%	13.6%
9	2.0%	3.3%	2.8%	5.1%	3.3%	7.0%	4.6%	10.8%	5.4%	11.4%
12	2.0%	3.5%	2.5%	5.5%	3.4%	7.5%	4.3%	9.3%	4.5%	12.3%

The percentage of times a stock included in either the winner or loser portfolio is delisted or does not meet the requirements in terms of trading volume or market capitalization for all combinations of *J* and *K*.

Appendix B – Robustness Tests

Stationarity

To test whether the series is stationary, a Dickey-Fuller test is performed. Specifically, the augmented Dickey-Fuller test with the null hypothesis of the presence of a unit root is used. That is because the test is less restrictive in the correlation assumptions of the error term. Also, since we in the literature have found no explicit indications of time series trends, [10] the time regressor is removed. Therefore, the following model is estimated:

$$\Delta r_{Z,t} = \alpha + \delta r_{Z,t-1} + \sum_{i=1}^{m} \beta_i \Delta r_{Z,t-i} + \varepsilon_t \qquad \text{(B.1)}$$

As pointed out in Wooldridge (2003), the lag length of m has been determined by the frequency of the data. Since the zero-investment portfolio is updated every K month, the lag length is determined by the strategy under investigation. According to Wooldridge (2003), monthly data should include twelve lags. Analogously, semi annual data should contain at lest two lags. The number of lags used for each length of K when pursuing the Dickey-Fuller test is summarized in Table B.1.

Table B.1. Number of lags used in the Dickey-Fuller test

Holding period (*K*)	**No. of lags (*m*)**
1	12
3	4
6	2
9	2
12	1

The MacKinnon approximate p-values of the tests are summarized in Table B.2.

Table B.2. Outcome from the Dickey-Fuller test

Evaluation period (*J*)	**Holding period (*K*)**				
	1	**3**	**6**	**9**	**12**
1	0.00	0.00	0.00	0.13	0.15
3	0.00	0.00	0.00	0.28	0.08
6	0.00	0.00	0.03	0.03	0.16
9	0.16	0.00	0.03	0.14	0.10
12	0.00	0.00	0.01	0.18	0.29

The MacKinnon approximate p-values from the Dickey-Fuller test for the 25 zero-investment strategies.

[10] Therefore we disregard the potential presence of January effects.

As pointed out in Gujarati (2003), an important assumption underlying the Dickey-Fuller test is that the error terms are independently and identically distributed. The augmented Dickey-Fuller test takes care of the presence of serial correlation in the error term, but this by adding lagged differences of the regressand. We therefore decided to also use the Phillips-Perron nonparametric test to take the possibility of serial correlation into consideration, without adding lagged difference terms.

$$r_{Z,t} = C + \sum_{i=1}^{m} \phi r_{Z,t-i} + \varepsilon_t \tag{B.2}$$

The number of lags used corresponds to Table B.1. The MacKinnon approximate *p*-values of the tests are summarized in Table B.3.

Table B.3. Outcome from the Phillips-Perron test

Evaluation period (*J*)	Holding period (*K*)				
	1	3	6	9	12
1	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00

The MacKinnon approximate *p*-values from the Phillips-Perron nonparametric test for the 25 zero-investment strategies.

Even though some of the investment strategies with relatively long holding periods showed indications of being non-stationary when undertaking the augmented Dickey-Fuller test, the null hypothesis of a unit root could be rejected at the one percent significance level for all 25 zero-investment strategies, when using the Phillips-Perron test. Therefore, we will not undertake any adjustments of the return series based upon non-stationarity.

Serial correlation

To test for the presence of serial correlation, we perform an ARCH(1) test. The reason for testing only the first lag is that we have not found any motivation in the literature for testing lags further back. Also, as Wooldridge (2003) points out, it is common practice to assume that the correlation quickly approaches a level close to zero. The following regressions are therefore performed:

$$r_{Z,t} - r_f = \alpha_0 + \sum_{i=1}^{q} \alpha_i (r_{OMXS,t-i} - r_{f,t-i}) + \varepsilon_t \tag{B.3}$$

$$\hat{\varepsilon}_t^2 = \hat{\alpha}_0 + \sum_{i=1}^{q} \hat{\alpha}_i \hat{\varepsilon}_{t-i}^2 + u_t \tag{B.4}$$

Under the null hypothesis of no ARCH effects, all parameters in equation B.3 will equal zero (excluding the intercept). The *p*-values obtained when testing all 25 zero-investment portfolio combinations of *J* and *K* are summarized in Table B.4.

Table B.4. Outcome from an ARCH(1) test

Evaluation period (*J*)	**Holding period (*K*)**				
	1	**3**	**6**	**9**	**12**
1	0.15	0.83	0.79	0.75	0.91
3	0.00	0.62	0.18	0.83	0.79
6	0.00	0.87	0.41	0.44	0.82
9	0.00	0.34	0.80	0.80	0.88
12	0.04	0.24	0.79	0.36	0.79

The *p*-values from an ARCH(1) test for the various zero-investment strategies.

As can be seen in Table B.4, the null hypothesis of no ARCH effects can only be rejected four times at the five percent significance level (three times at the one percent level). Also, all rejected hypotheses occur when the holding period is one month. For comparative reasons, we therefore choose to correct for the potential presence of serial correlation for all 25 zero-investment strategies. Following the procedure as described in Wooldridge (1989), the residuals from equation 4 are multiplied with the residuals from:

$$r_{OMXS,t} - r_{f,t} = \delta_0 + \varepsilon_t \tag{B.5}$$

$$\therefore \hat{a}_t = \hat{\varepsilon}_t \hat{u}_t \tag{B.6}$$

Then, for any $g > 0$, we define:

$$\hat{v} = \sum_{t=1}^{n} \hat{a}_t^2 + 2\sum_{h=1}^{g} \frac{1-h}{g+1}\left[\sum_{t=h+1}^{n} \hat{a}_t \hat{a}_{t-h}\right] \tag{B.7}$$

The serial correlation robust standard error of β from equation 4 is then defined as:

$$\sigma_{\hat{\beta},robust} = \left[\frac{\sigma_{\hat{\beta}}}{\sigma_{\hat{\varepsilon}}}\right]^2 \times \sqrt{\hat{v}} \tag{B.8}$$

Homoscedasticity

As opposed to the Goldfeld-Quandt test, which "/…/ requires [a] reordering [of] the observations with respect to the [regeressand] that supposedly caused heteroscedasticity" (see Gujarati (2003)), or the Breusch-Pagan-Godfrey test, which is sensitive to the assumption of a normally distributed error term.

White's test does not rely on this assumption at all. As no formal tests of normality have yet been undertaken, we choose White's test to test for the presence of heteroscedasticity in the return series. The following auxiliary regression is therefore estimated:

$$\hat{\varepsilon}_t^2 = \alpha_1 + \alpha_2 (r_{OMXS,t} - r_{f,t}) + \alpha_3 (r_{OMXS,t} - r_{f,t})^2 + u_t \tag{B.9}$$

Then, under the null hypothesis of a homoscedastic error term, the test statistic is asymptotically chi-square distributed with degrees of freedom equal to the number of parameters in B.3, excluding the intercept:

$$n \times R^2 \overset{asy}{\sim} \chi^2_{2,\alpha} \tag{B.10}$$

The *p*-values for all combinations of *J* and *K* are summarized in Table B.5.

Table B.5. Outcome from White's test

Evaluation period (*J*)	**Holding period (*K*)**				
	1	**3**	**6**	**9**	**12**
1	0.73	0.00	0.00	0.00	0.00
3	0.02	0.82	0.00	0.27	0.61
6	0.00	0.00	0.71	0.72	0.29
9	0.01	0.09	0.52	0.01	0.09
12	0.00	0.34	0.82	0.52	0.14

The *p*-values from White's test for the various zero-investment strategies.

As can be seen in Table B.5, the null hypothesis of homoscedasticity in the error term is rejected for twelve zero-investment strategies at the ten percent level. Therefore, the following assumption underlying equation 4 can no longer be assumed to hold:

$$\sigma_\beta^2 = \frac{\sum_{t=1}^{T} \left[\left(r_{OMXS,t} - r_{f,t} \right) - \left(\bar{r}_{OMXS} - \bar{r}_f \right) \right]^2 \sigma_\varepsilon^2}{\left[\sum_{t=1}^{T} \left[\left(r_{OMXS,t} - r_{f,t} \right) - \left(\bar{r}_{OMXS} - \bar{r}_f \right) \right]^2 \right]^2} \tag{B.11}$$

The presence of heteroscedasticity will make us underestimate the standard error of β in equation 4. Therefore, we have to calculate the heteroscedasticity-robust variance of β using equation B.11 which is a valid estimator for heteroscedasticity of any form, including homoscedasticity. The consequence of this procedure is *t*-statistics which are only asymptotically valid. However, due to the large number of observations in the return series, we believe this approximation error will be of minor importance.

$$\sigma_{\beta}^{2} = \frac{\sum_{t=1}^{T}\left[\left(r_{OMXS,t} - r_{f,t}\right) - \left(\bar{r}_{OMXS} - \bar{r}_{f}\right)\right]^{2}\hat{\varepsilon}_{t}^{2}}{\left[\sum_{t=1}^{T}\left[\left(r_{OMXS,t} - r_{f,t}\right) - \left(\bar{r}_{OMXS} - \bar{r}_{f}\right)\right]^{2}\right]^{2}} \tag{B.12}$$

Normally distributed error terms

The fourth and final test pursued in order to determine the validity of an ordinary least squares regression is that of a normally distributed error term. More specifically, to test whether the error term in equation 4 is normally distributed, the Jarque-Bera test (see equation B.13) is performed.

$$JB = \frac{n}{6}\left[S^{2} + \frac{(K-3)^{2}}{4}\right] \tag{B.13}$$

Under the null hypothesis of a normally distributed error term, the test statistic is asymptotically chi-square distributed with two degrees of freedom:

$$JB \overset{asy}{\sim} \chi_{2,\alpha}^{2} \tag{B.14}$$

The corresponding *p*-values for all combinations of *J* and *K* are summarized in Table B.6.

Table B.6. Outcome from the Jarque-Bera test

Evaluation period (*J*)	Holding period (*K*)				
	1	**3**	**6**	**9**	**12**
1	0.00	0.00	0.00	0.14	0.55
3	0.00	0.00	0.95	0.53	0.45
6	0.00	0.57	0.77	0.00	0.50
9	0.00	0.82	0.72	0.65	0.08
12	0.00	0.66	0.00	0.74	0.04

The *p*-values from the Jarque-Bera test for the 25 zero-investment strategies.

As can be seen in Table B.6, a relatively short evaluation or holding period indicates a violation of the assumption of a normally distributed error term. Even though this assumption is not fulfilled for these strategies, both estimators in equation 4 will still be unbiased and have a minimum variance. However, the *p*-values in the *t*-tests will not be as precise as if the assumption of a normally distributed error term was fulfilled. Bearing this in mind, we chose not to undertake any further adjustments of the return series.

Appendix C – Additional Fama-French Tables

Table C.1. Fama-French coefficients

Evaluation period (*J*)	Strategy	Holding period (*K*)				
		1	**3**	**6**	**9**	**12**
1	***SMB***	-0.53	-0.61	0.17	-0.45	0.40
	(*p*-value)	(0.019)	(0.015)	(0.610)	(0.139)	(0.225)
	HML	0.45	0.70	0.94	0.01	0.74
	(*p*-value)	(0.004)	(0.000)	(0.000)	(0.953)	(0.001)
3	***SMB***	-0.68	-0.12	0.49	-1.3	-0.77
	(*p*-value)	(0.012)	(0.584)	(0.391)	(0.013)	(0.086)
	HML	0.81	0.64	0.27	0.66	0.31
	(*p*-value)	(0.000)	(0.000)	(0.117)	(0.005)	(0.127)
6	***SMB***	-0.88	-0.31	-0.52	-1.71	0.57
	(*p*-value)	(0.012)	(0.225)	(0.185)	(0.014)	(0.260)
	HML	0.71	0.48	0.14	0.24	-0.34
	(*p*-value)	(0.000)	(0.000)	(0.365)	(0.378)	(0.218)
9	***SMB***	-0.99	-0.18	0.25	-0.23	1.49
	(*p*-value)	(0.002)	(0.582)	(0.662)	(0.626)	(0.229)
	HML	0.36	0.15	0.76	0.08	0.92
	(*p*-value)	(0.038)	(0.285)	(0.030)	(0.796)	(0.015)
12	***SMB***	-0.98	-0.58	-0.62	-0.83	-0.71
	(*p*-value)	(0.000)	(0.040)	(0.250)	(0.015)	(0.036)
	HML	0.44	0.30	1.09	0.64	0.38
	(*p*-value)	(0.013)	(0.054)	(0.000)	(0.001)	(0.281)

The *SMB* and *HML* factors and their corresponding *p*-values from the Fama-French regression for the 25 zero-investment strategies.

Table C.2. Coefficients for the Fama-French model with the additional coskewness factor

Evaluation period (*J*)	Strategy	Holding period (*K*)				
		1	**3**	**6**	**9**	**12**
1	***SMB***	-0.61	-0.57	0.15	-0.57	0.53
	(*p*-value)	(0.023)	(0.016)	(0.670)	(0.154)	(0.098)
	HML	0.63	0.73	0.94	-0.05	0.78
	(*p*-value)	(0.002)	(0.000)	(0.000)	(0.821)	(0.000)
	SKS	0.04	0.11	0.04	0.15	-0.68
	(*p*-value)	(0.517)	(0.276)	(0.820)	(0.554)	(0.000)
3	***SMB***	-0.81	-0.13	0.55	-1.22	-0.98
	(*p*-value)	(0.003)	(0.567)	(0.308)	(0.017)	(0.016)
	HML	0.87	0.65	0.27	0.64	0.40
	(*p*-value)	(0.000)	(0.000)	(0.105)	(0.007)	(0.018)
	SKS	0.11	0.12	-0.34	-0.30	-0.90
	(*p*-value)	(0.077)	(0.479)	(0.350)	(0.432)	(0.120)
6	***SMB***	-0.86	-0.33	-0.53	-1.62	0.51
	(*p*-value)	(0.013)	(0.221)	(0.198)	(0.038)	(0.313)
	HML	0.79	0.50	0.15	0.22	-0.42
	(*p*-value)	(0.000)	(0.001)	(0.370)	(0.479)	(0.157)
	SKS	0.08	0.16	0.09	-0.54	-0.60
	(*p*-value)	(0.251)	(0.209)	(0.725)	(0.009)	(0.130)
9	***SMB***	-0.87	-0.20	0.32	0.00	1.51
	(*p*-value)	(0.004)	(0.555)	(0.567)	(0.993)	(0.224)
	HML	0.37	0.18	0.86	0.15	1.01
	(*p*-value)	(0.051)	(0.229)	(0.012)	(0.604)	(0.005)
	SKS	0.01	0.17	-0.25	-0.98	-0.47
	(*p*-value)	(0.913)	(0.227)	(0.462)	(0.030)	(0.592)
12	***SMB***	-1.06	-0.69	-0.87	-0.82	-0.83
	(*p*-value)	(0.000)	(0.015)	(0174)	(0.034)	(0.011)
	HML	0.51	0.40	1.14	0.63	0.32
	(*p*-value)	(0.004)	(0.012)	(0.000)	(0.001)	(0.321)
	SKS	0.11	0.16	0.34	-0.06	0.46
	(*p*-value)	(0.039)	(0.244)	(0.310)	(0.853)	(0.061)

The *SMB*, *HML* and *SKS* factors and their corresponding *p*-values from the Fama-French regression for the 25 zero-investment strategies.

Appendix D – Momentum Characteristics Tables

Table D.1. Portfolio characteristics in terms of market value

Evaluation period (*J*)	Holding period (*K*) 1		3		6		9		12	
	Winner	Loser	Winner	Loser	Winner	Loser	Winner	Loser	Winner	Loser
1	L***	L***	L***	L***	L**	L***	-	L***	L***	L***
3	L***	L***	L***	L***	L**	-	L***	-	L***	L***
6	L**	L***	L*	L***	L**	L**	L**	L***	-	L***
9	-	L***	-	L***	-	L**	L*	-	-	L***
12	H**	L***	-	L***	-	-	-	-	-	-

Characteristics of the various winner and loser portfolios in terms of market value. An H indicates that the market value of that portfolio is significantly higher than the period average and L indicate the market value is significantly lower than the period average. *Significant at the 10% significance level, ** significant at the 5% level and ***significant at the 1% level.

Table D.2. Portfolio characteristics in terms of trading volume

Evaluation period (*J*)	Holding period (*K*) 1		3		6		9		12	
	Winner	Loser	Winner	Loser	Winner	Loser	Winner	Loser	Winner	Loser
1	H*	-	H*	-	-	-	H*	L*	-	-
3	H**	-	H**	-	-	-	H*	L*	-	-
6	H***	-	H***	-	-	-	-	-	H*	-
9	H***	-	H***	-	H**	-	H**	-	H**	-
12	H***	-	H***	-	H**	-	H**	-	-	-

Characteristics of the various winner and loser portfolios in terms of trading volume. An H indicates that the trading volume of that portfolio is significantly higher than the period average and L indicate the trading volume is significantly lower than the period average. *Significant at the 10% significance level, ** significant at the 5% level and ***significant at the 1% level.