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Riding the Market

The Applied Momentum Strategy on OMXS

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Abstract

The purpose of this thesis is to determine whether the momentum strategy is applicable on the Nasdaq OMX Stockholm Stock Exchange, between the years of 1995 and 2015, for *the average investor*. We take the average investor's point of view throughout this study by adjusting the methods previously applied, to include some of the market realities facing the individual, e.g. including transaction costs and taxes and by not short selling any stocks. Each portfolio is constructed at the end of each evaluation period and includes the historically top ten performing stocks and is held for a number of months, (either three, six or twelve), which we denote as the holding period. We are unable to find statistically significant excess returns of the applicable momentum strategy when it is compared to the returns of the market portfolio, which represents the option for the average investor to apply a buy-and-hold strategy. However, the findings suggest that while not significant, some portfolios do outperform the market, mainly represented by portfolios with long evaluation and short holding periods.

Keywords: Market Anomaly, Momentum, Trading Strategy, Investment Portfolio, the Average Investor

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"In investing, what is comfortable is rarely profitable."
– Robert D. Arnott (2008)

1. Introduction

The market is continuously fed with new exciting trading theories and strategies, some of which promise quick and easy money, thus naturally attracting attention from the media which spreads the word all the way down to the average investor. There is now a plentiful plethora of strategies that each investor can chose from when trading, or one could develop its own. While some say one should always hold the market portfolio, since it is not possible to beat in the long run, other claim to beat it frequently.

The objective of this thesis is to determine whether a practically applicable momentum trading strategy would be attractive to apply on the Nasdaq OMX Stockholm for the average investor through asking the question: *Has it historically provided significant excess return?*

The momentum strategy builds upon the momentum effect, i.e. the idea that past patterns of stock performance will be likely continue into the future. Therefore, one should short–sell what has recently performed poor and buy past winners, as the theory behind the momentum strategy suggests this pattern will continue.

Jegadeesh and Titman (1993) published what today is probably considered the most influential study within this area of research, finding significant proof that this investment was able to return profits, with literally no initial investment at all, as the stocks purchased would be financed through short selling.

The idea of momentum profits has since then gained interest with several studies replicating Jegadeesh and Titman's (1993) study, examining this phenomenon on different markets, where some are able to confirm its profitability. Grinblatt *et al*. (1995) noted that a high number of fund managers, 77 percent, tended to follow this investing strategy partially as they tended to buy past winners while not short selling recent losers. As this strategy becomes more known, also to the average investor, we see our study relevant to many individuals considering the strategy appealing for themselves. The strategy is straightforward, easy to apply, simple and *seems* profitable.

However, no study has been conducted with the prime target to determine this strategy's feasibility to the average investor, which perhaps could be you. We adjust the previously used methods to address this approach.

Unlike the common procedure to replicate the study by Jegadeesh and Titman (1993), we will primarily focus on the capacity of the average individual investor and thus adjust the method and approach accordingly. Not the least because the average investor exists in a real setting and thus faces real opportunities and limitations. We will also be hesitant to adjust the data and make as few assumptions as possible, as we wish the findings of this thesis to carry real impact for anyone interested in pursuing this strategy on their own.

We create a simple investing rule that only consist of the selection of ten stocks for each portfolio, rather than ten percent of the best performing stocks. We also chose to not make use of short selling, primarily since this would force the assumption that all stocks would be liquid enough to short sell, which is not true. Further, short selling is normally considered more risky as losses can potentially be unlimited.

Besides that, we will extend the momentum strategy by adding transaction costs and taxes, which are too often ignored or assumed to not affect the momentum strategy's feasibility. This subject is interesting since taxes will have both positive and negative consequences on our outcome. Throughout this study, we strive to take the average investor's perspective in order to provide new insights in this area of research and adding the perspective of the *applicable* momentum strategy.

The data is on Swedish stocks during the period of 1 January 1995 to 31 December 2014. The evaluation and holding periods are three, six and twelve months respectively, thus in total constructing nine different sub–strategies. Furthermore, we will compare all the portfolios to a benchmark index (an approximation to the market portfolio), which represents the option for the investor to just buy and hold the market portfolio and any discretion in return here between is denoted *excess return* and is a key concept throughout this thesis. This is also a difference from earlier studies as they tend to contrast the momentum profits toward a theoretical model, thus, they look at *abnormal return*, rather than excess return.

Moreover, it is worth mentioning that since our analyzing period stretches twenty years back, we manage to capture two major market corrections. Because of this rather long period, together with the fact that we choose to compare all our portfolios with the market portfolio, we aim to reflect a reliable and comprehensive study that could be understood and replicated by practically anyone.

We are not seeking to prove a way to make easy money, or develop a new strategy. We will exclusively examine at how a practically applicable investment strategy has historically performed on the Nasdaq OMX Stockholm Stock Exchange, not any other market. We are not considering data from alternative market spaces such as Aktietorget or First North.

The succeeding sections of this thesis are arranged as follows: Section two presents a short analysis of the theoretical framework as well as previous research and literature, consisting of a range of theories such as the traditional ones including the Efficient–Market Hypothesis and CAPM and in addition behavioral finance theories. In section three, we describe both our method and dataset, to facilitate replication in the future. In section four we lay forward our empirical results which are in section five analyzed. Finally, the conclusion can be found in section six.

2. Theoretical Framework and Earlier Research

2.1 Theory

2.1.1 Why Should One Expect Not to Find a Strategy with Excess Return?

2.1.1.1 The Efficient–Market Hypothesis and Random Walk

The **Efficient–Market Hypothesis** (EMH), laid forward by Fama (1970), is one of the most well–known theories concerning the market and how asset prices reacts to new information. At its foundation, i.e. its weak form, it suggests that trading on historical information cannot return long–run excess returns compared to the market portfolio. The reason is that all publicly available information that one base their decision on is also available to everyone else as well, therefore one cannot alone profit from this information. Also, without new suggestive fundamental information about an asset, the price movement of this asset is to follow a **Random Walk**, as defined by Malkiel (1985). This implies that without new fundamental information, the asset's future return cannot be predicted – i.e. an asset's future price cannot be predicted on historical information.[1]

In addition to the weak form of EMH as explained above, the EMH develops two additional kinds of efficient markets; the semi–strong and the strong form. The semi–strong form goes further than the weak form by stating that it is neither possible to profit from new fundamental information, whereas the strong form suggests that no information at all can be profited upon, including insider information. Each piece of information, known or unknown, is already incorporated in the price of each and every asset on the traded market.

[1] Fundamental information differs from technical information in the way that it looks forward rather than backward.

No matter which form one would prefer for discussion in this thesis, the finding of a momentum effect would contradict all three forms of the EMH, as a successful momentum strategy would suggest that future returns can be predicted from historical information, and should consequently not exist according to this theory.

2.1.1.2 Law of One Price

In addition to the EMH and Random Walk theories, the Law of One Price, that relates to Adam Smith's (1776) metaphor of the invisible hand, also suggests that the momentum effect should not be present under the assumption of equal risk.

The Law of One Price stipulates that two different assets, with equal risk, returning the same amount during the same time horizon will trade at the same price. If this was not the case, an arbitrage opportunity would exist. Further on, arbitrage is assumed to be impossible since once discovered it will be exploited and ultimately vanish. Even though the starting point of this logic is the fact that an arbitrage opportunity exists, it eventually leads to a vicious circle where no arbitrage exist at all since someone else has already exploited it before one gets the chance to do so.

In the context of this study, it is implied by the Law of One Price that the momentum strategy as an arbitrage opportunity is not possible. The finding of the momentum effect would suggest the opposite and should therefore not be possible. However, if a portfolio strategy that has excessive returns is found, then that momentum strategy would carry more risk, which justifies the higher return. However, in the sense of an arbitrage opportunity, the momentum effect should be non–existent since any discretion in price will disappear, as the demands for the lower priced asset and for the higher priced assets will converge across markets to an equilibrium.

Now, if one would observe a strategy that outperforms the market, it would suggest that it is either more risky or that the momentum portfolio is too cheap to buy which will correct itself once discovered.

2.1.1.3 The CAPM

The **Capital Asset Pricing Model** (CAPM), developed independently by Sharpe (1964), Lintner (1965) and Mossin (1966), is a widely used pricing indicator and share similarities with the Law of One Price.

According to the CAPM, the expected return for any asset should be equal to the risk–free rate plus the beta–value for the asset multiplied by the market risk premium, as illustrated in Equation 1 below.

$$E[R_i] = r_i = r_f + \beta_i * (E[R_{Mrkt}] - r_f) \qquad \text{(Eq. 1)}$$

For the market portfolio, which is assumed to be efficient,[2] the beta value is by definition equal to one. Any other asset is then compared to this portfolio and the correlation between them is evaluated. The beta is later calculated and corresponds to the difference in what could be perceived as risk. In other words, any difference in expected return can only be explained by a higher risk. The CAPM therefore leads to the conclusion that any excess return observed from the momentum strategy can only be attributable to a higher risk, and the risk–adjusted return cannot be higher than the market's.

2.1.1.4 Summary of Framework Against the Existence of the Momentum Effect

To summarize, the theory behind why the momentum strategy should not be able to return excessive profits, this section starts with the theory of EMH that holds the supposed truth that no long–run excess returns can be gained by trading on historical information, which the momentum strategy clearly does. Further, the Law of One Price states that any two assets, in this case the momentum strategy portfolio versus the market portfolio, must be priced equally when carrying the same level of risk and yielding the same return. The CAPM, which perhaps is the most widely used pricing indicator, continues with this reasoning that any discretion in return must be due to a different level of risk–taking and that the momentum strategy, therefore, does not represent a way of making "easy money".

These theories are widely known, used and accepted by practitioners as well as researches. However, in parts questioned and debated such as the substantial and lasting inefficiencies that have been observed in the EMH, it still remains as a good starting point (Beechey *et al.* (2000)).

Undoubtedly, these strong and traditional theories provide a theoretical framework that deems the momentum strategy as something impossible. However, has not everyone at least once found (or lost) a dollar bill on the ground? Would not this disprove the EMH?

[2] When efficient, it is impossible to diversify further to reach a lower risk.

2.1.2 Why Should One Expect to Find a Strategy with Excess Return?

2.1.2.1 Critique of the Underlying Assumptions of the CAPM and EMH

Traditional finance is based on rational and logical theories, as described through the EMH and CAPM. In this world described above, the market is efficient and investors tend to be rational and thus, incorporate (and value) new information correctly. Therefore there will not be any market inefficiency to exploit. Any attempt to argue for the existence of excessive returns must first of all disprove this utopic world, starting with the underlying assumptions of the CAPM and EMH.

Now, what if the investors are in fact irrational and thus violate the underlying assumptions required for the above–mentioned theories? Humans are humans and, probably, very seldom trade completely rationally. Therefore the possibility of inefficient markets open up.

The CAPM rests upon a few underlying assumptions stated in Berk and DeMarzo (2013, 379–380):

- Investors can buy and sell securities at competitive market prices, without incurring taxes or transaction costs, and borrow and lend at the risk–free rate.
- Investors hold only efficient portfolios of traded securities – portfolios that yield the maximum expected return for a given level of volatility.
- Investors have homogeneous expectations regarding volatilities, correlations, and expected returns of securities (since everyone base their knowledge on the same available information)

These assumptions are subject for criticism, as noted in Pratt and Grabowski (2014). First of all, it is commonly known that investors in general, and the average investor in particular, are subject to transaction costs and taxes. Also, the investors do not have homogenous expectations, neither are they entirely rational. If they were, then everyone would hold the very same market portfolio since no one would perform below average, neither would anyone receive any excess return. Investors are not equally informed and thus do not base their decisions on the same set of information as the assumption requires. The CAPM is therefore a very simplistic model.

According to Berk and DeMarzo (2013, 441), the market would not be efficient if a significant number of investors either do not have rational expectations[3] or care about aspects of their portfolios other than expected return and volatility, and thus are willing to hold inefficient portfolios of securities. Beechey *et al.* (2000) further add that academic research and experience hints to the fact that the EMH is unable to explain important features of the capital market's behavior, which is why the EMH does not necessarily hold at all times.

Accepting that the markets may not be as efficient as earlier assumed opens up the possibility for investors to outperform the market, but also vice versa, as investors deviates from the market portfolio in pursuit of excess returns.

2.1.2.2 Behavioral Finance

Behavioral finance is an area of study which lately has been gaining support, and thus, adding a wider picture of how capital markets work through a social and psychological approach. The studies of behavioral finance also provide many possible explanations for any excess return gained from a trading strategy, as the markets are inefficient in many aspects. The key to prove that there could be a trading strategy that outperforms the market is to first prove the markets to be inefficient,[4] since there are no excess return in an efficient market. Below follows a selection of key biases that make markets inefficient. There are, among many more biases, overreaction, over confidence, sensation seeking, relative wealth concerns, familiarity biases and herd behavior.

De Bondt and Thaler (1985, 1987) suggest that investors tend to overreact to new information since past winners performed worse than past losers, proving that the market is not efficient in incorporating new information. However diametrically contradicting the momentum effect itself, which would support under–reaction, their results failed to prove the EMH and do therefore invite the possibility of a trading strategy which yields excess return.

Overconfidence is a phenomenon that proves investors to be overly confident and believe that they are in control. Just as in any other game, more than half of the players think they will perform above average, or as in the study by Barber and Odean (2000), spectators of a game think they could do it better than the players themselves. In this context, most investors would consider themselves able to beat the market. This phenomenon also relates to sensation seeking where some investors are looking for what can be labeled as excitement or

[3] Irrational expectations: misinterpret information and believe they are earning a positive alpha when they are actually earning a negative alpha.
[4] Market inefficiencies can be used to leverage a trading strategy upon, i.e. exploit.

entertainment (the chance to find or hold a sky rocketing stock) rather than expected return (which is the prime concern for the rational investor). This was put forward by Grinblatt and Keloharju (2009), where it was found that sensation seekers (as measured by the number of speeding tickets) tend to trade more, thus perhaps suggesting that they enjoy the activity of trading more than the actual outcome.

Another bias is the relative wealth concerns where investors might be tricked to think they are earning excess returns, while in fact, they are not. This could be since investors are comparing their returns with their peers' and not the market's. As long as their return is above their peers' (with disregard to the return of the market) they tend to be satisfied. This leads to neglect and unequally informed investors as further developed in DeMarzo *et al.* (2008).

Investors neither base their investment decisions on objective grounds; one bias hereof is the familiarity bias, which leads individuals to invest in familiar assets rather than any objectively unfamiliar better asset Foad (2010). One of the effects of this bias is that the investor is more likely to invest in a business one knows of, perhaps where a friend work or that is frequently mentioned on TV, resulting in suboptimal portfolios.

Herd behavior also contributes to inefficient markets. Herd behavior is when investors do not trade based on their own information but rather trade on others' by following their trading patterns. This could potentially cause financial bubbles, such as the dot–com bubble, where investors bought dot–com stocks because others did, not because their own evaluation showed it to be a good prospect.

2.1.2.3 Summary of Framework Supporting the Existence of the Momentum Effect

These biases would lead investors to deviate from the market portfolio, and therefore the CAPM no longer holds. It also influences investors to trade too much and thus violate the foundation of which the CAPM rests upon, according to Berk and DeMarzo (2011).

Furthermore, all these different kinds of behavioral biases imply that the real world investor is not rational at all times, perhaps making the theories resting on this assumption useless. However, it is easy to avoid these mistakes for each individual investor – by simply purchasing the market portfolio.

Since these biases open up the possibility for investors to earn negative returns, they also open up the opportunity for other investors to take advantage of these inefficiencies, thus allowing space for trading strategies that outperform the market as Berk and DeMarzo (2013) note.

2.2 Earlier Research

2.2.1 Earlier Research of the Momentum Strategy

In this section, we present earlier research that have inspired the thoughts and the approach of this study. However, neither of these earlier works specifically analyzed the same practically applicable momentum trading strategy that is pursued in this thesis, but were generally rather looking at what could best be described as its theoretical existence, i.e. studies with underlying assumptions that risk bias the result for the average investor, which this thesis wish to correct for.

The works presented below are cover a wide array of different result and data, and to some extent also methodology from both an international and a Swedish perspective. What is further noteworthy is that the method of this thesis (explained in detail in the next chapter) will differ substantially from the earlier research laid forward below.

Lately there have been several studies on the momentum effect conducted exclusively on the Nasdaq OMX Stockholm Stock Exchange (OMXS).[5] The main study of reference in this thesis is Jegadeesh and Titman (1993) and most studies presented below use a similar or identical methodology with few modifications and exceptions. They are all unique in their own way; time horizon, markets, definitions, data exclusions etcetera and the overall results are inconclusive whether the momentum effect actually is existent or not.

2.2.2 Evidence of the Momentum Effect's Non–Existence

In 1985 De Bondt and Thaler found evidence of overreaction among the New York Stock Exchange common stocks between 1926 and 1982. This kind of evidence would also be sufficient evidence that the momentum effect, which builds upon under–reaction, was not present. The strategy examined by De Bondt and Thaler (1985) is called a contrarian strategy, simply because it was concluded that past losers outperformed past winners, and this idea is in direct conflict with the underlying idea of the momentum effect which the whole strategy builds upon.

Rouwenhorst (1998), who was explicitly set on exploring the momentum strategy on the European market as an extension of the study conducted by Jegadeesh and Titman (1993),

[5] OMXS was before 2005 referred to as SAX and consists of the main markets in Sweden, i.e. Large, Mid and Small Cap.

failed to prove its existence on what today is referred to as the OMXS.[6] Nevertheless, its existence was proven on the overall European market.

In the last few years there have also been a few studies conducted exclusively on the OMXS, which also failed to prove the existence of a momentum strategy that could return excess or abnormal profits.[7] These studies include Blackestam and Setterqvist (2014) and Krooks and Leu (2014). So did also, Sandstedt and Wojt (2011), however looking on data from the S&P 500.

2.2.3 Evidence of the Momentum Effect's Existence

Building off the results of De Bondt and Thaler (1985), who could confirm the contrarian strategy to work in the short–run, Jegadeesh and Titman (1993) also found that while De Bondt and Thaler (1985) were correct about the short–run, the contrarian strategy was inferior to the momentum strategy in the mid–long–run, (holding periods of 3 to 12 months), which also gives support to the opposite of overreaction.

Jegadeesh and Titman's (1993) result was the first study to become really influential in the debate on the momentum strategy. Their methodology will be explained since it carries weight determining the relevance of their findings and also since most other studies in this area are built upon the same, or at least similar, methodology. Their strategy was to buy the top ten percent best performing stocks (winners) while short–selling the worst performing ten percent (losers). They did find support for the momentum strategy and found that the best way to apply it was to evaluate the stocks during a period of twelve months and having a holding period of three months. This strategy returned an average of 1.31 percent on a monthly basis. Furthermore, this return could not be explained by excess systematic risk. The used data from the New York Stock Exchange and American Stock Exchange between 1965 and 1989 where the portfolio was rebalanced each month to keep the portfolio equally balanced throughout the holding period. Since the long positions were financed by the short positions, the net investment was zero, thus creating a zero–cost portfolio, where only the 3–3 strategy lacked significant results.

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[6] Before 1998 Sweden had two exchange markets. In 1998 these two merged and formed what would eventually be OMX. Later OMX also acquired other Nordic exchanges and eventually also merged with NASDAQ, therefore also adding the 'S' symbolizing Stockholm. For consistency we are denoting the current OMXS and its former equals '*OMXS'*.

[7] Excess return is the difference between actual return versus a benchmark index. Abnormal return is the difference between actual return versus a theoretical model. In this thesis we are looking at excess returns, while many earlier studies looked at abnormal return.

These results are consistent with the theory of underreaction, as earlier in this chapter contrasted against overreaction, and they remained significant with a round–trip transaction cost of one percent included. Jegadeesh and Titman followed up their study a few years later (2001) and confirmed that the momentum effect still existed.

Rouwenhorst (1998) used the methodology of Jegadeesh and Titman (1993) and found the momentum effect to be present also on the European market overall as he studied twelve different countries in Europe. However, while he found significant profits for the momentum strategy in eleven out of these twelve markets, he did not on the Swedish market. OMXS was the only single market where he failed to prove its existence.

Additional recent studies proving the existence of the momentum strategy on the Swedish market include Tsilfidis and Nikolova (2014), Annerstedt and Schönström (2006) who look at the Nordic markets, Söderström (2000),[8] Hagwall and Lundén (2008) (who find some sub-strategies not to work) and Vilbern (2008). A further elaboration of these is provided in Section 2.2.5, in Table 1.

A very interesting result generally proved to be true among many studies above is that when finding significant results for the momentum strategy to work, it is generally the case that the winner portfolio (the long positions) is performing excessive at a significant level while this is rarely the case with the loser portfolios (the short side), as specifically commented upon in Hagwall and Lundén (2008). Hagwall and Lundén (2008) further note that the portfolios with longer evaluation period of six to twelve months and shorter holding periods of mainly three to six months are prone to be more frequent to generate abnormal return.

2.2.4 Transaction Costs and Market Imperfections

The normal setting for research within this field has been assuming perfect markets to some extent, where transaction costs and taxes are generally not accounted for as well as the assumption of always being able to short–sell.

To the average investor, the momentum profits would only be real if they still existed after accounting for transaction costs and taxes. While Jegadeesh and Titman (1993) include a one percent round–trip cost and still prove significant excess returns, it is disputed that transaction costs will not make the momentum strategy unprofitable.

[8] After excluding the devaluation of the Swedish Krona in 1992

Lesmond *et al.* (2004) claim that the excess profits of these strategies are only illusionary and not attainable in a real setting, while Grundy and Martin (2001) do not deem the excess profits to be illusionary per se, but find that a round–trip transaction cost of above 1.5 percent would be enough to offset the strategy's profits. Assuming this is true, and that round trip transaction costs could be as high as 3.77 percent for winners and 6.71 percent for losers, as found by Li *et al.* (2009), the excess returns of the momentum strategy is not attainable in a real setting as Lesmond *et al.* (2004) did suggest.

2.2.5 Summary of Earlier Research

1. Summary of Earlier Research

Authors	Published	Time	Market	Findings
Blackestam and Setterqvist	2014	2006–2012	OMXS – Small and Large Cap	Could not statistically prove that a significant momentum effect took place
Krooks and Leu	2014	1996–2012	Stockholm Stock Exchange	No momentum effect proven significant.
Sandstedt and Wojt[9]	2011	1990–2010	S&P 500	Failed to prove momentum strategy
Hagwall and Lundén	2008	1987–2008	OMXS – all share	Found support for the momentum strategy to work for some constellations.
De Bondt and Thaler	1985 1987	1926–1982	NYSE	Found the *"contrarian strategy"*
Rouwenhorst	1998	1980–1995	12 European Markets[10]	Finds support for the momentum strategy – Except for Sweden
Jegadeesh and Titman	1993 2001	1965–1989	NYSE, AMEX & Nasdaq	Proved the momentum strategy
Tsilfidis and Nikolova	2014	1998–2013	Nasdaq OMXS	Proves the momentum effect
Annerstedt and Schönström	2006	1991–2006	The Nordic Stock Exchanges	Proved momentum on all markets
Söderström	2000	1979–1999	Stockholm Stock Exchange[11]	Proved, when exclude for devaluation
Vilbern	2008	1997–2007	OMXS – Main exchanges	Prove the momentum strategy to work

Table 1: Briefly illustrating some earlier research on the momentum strategy / momentum effect. However, not aspiring to provide an exhaustive picture. The notions used in this table are as expressed in each study, respectively.

[9] Also included transaction costs for robustness

[10] 12 European markets; Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden Switzerland and U.K.

[11] Including "Fondhandlarlistan" and "O–listan"

2.3 Hypothesizes

This thesis focuses on testing the applicable momentum strategy for the average investor, and thus, test the two hypothesis below. The first hypothesizes is excluding transaction costs and taxes for reference and comparison to earlier studies as most of them do not include these market imperfections. It also serves the purpose to contrast the findings of hypothesis 2, where the goal is to test the excess returns for the applicable momentum strategy. As the earlier research or theories do not provide us with a clear indication of whether the momentum strategy will supply us with positive excessive returns, we use double-sided hypothesizes as this is a more robust way of testing for significance. However, for the average investor, any positive excess return is thought to be interesting, which is why we put emphasis on this in our findings and analysis.

2.3.1 Hypothesis 1

H_0: The average excess return from the momentum strategy is not significantly different from zero, when not accounting for transaction costs and taxes.

H_1: The average excess return from the momentum strategy is significantly different from zero, when not accounting for transaction costs and taxes.

Whether H0 is found to be true or not, it should be noted that taxes in Sweden has the characteristics to affect returns by decreasing the profits while on the other hand giving tax reductions in the case of a loss, thus reducing the standard deviation (and variance) of the raw return and therefore affecting the statistical significance. One can question whether adding taxes and transaction costs will affect any results. This is tested in hypothesis 2.

2.3.2 Hypothesis 2

H_0: The average excess return from the momentum strategy is not significantly different from zero, when accounting for transaction costs and taxes.

H_1: The average excess return from the momentum strategy is significantly different from zero, when accounting for transaction costs and taxes.

The findings will help us determine whether the momentum strategy is attractive to the average investor or not. Also, can we add any measure that help us describe what additional risk or movement, as compared to the market, the investor must be willing to face?

If the findings fail to reject our null hypothesizes, which then remain valid, it would be in line with the EMH. However not providing solid evidence that it would hold at all times, these findings would merely support the fact that *if* there are any inefficiencies, then the momentum strategy would not be a good tool to exploit them. However, we cannot conclude whether any other trading strategy would be able to or not.

If the findings are sufficient to reject the null hypothesizes however, it would support the criticism toward the EMH and CAPM as oversimplifications and support the theories of behavioral finance, which provide us with many reasons why a market would not be efficient.

The intuition is also, and supported by the findings of Hagwall and Lundén (2008), that strategies with longer evaluation periods and shorter holding periods should have a greater excess return than the strategies based on short evaluation periods and with longer holding periods. By evaluating the stocks for a longer period of time, temporary and dramatic changes in price is less likely to affect the selection as these fluctuations would eventually correct themselves in a functioning market. Thus, making the portfolios more likely to consist of more stable stocks. In addition, by holding the portfolios for a shorter time, any fluctuating stock that was unluckily added to our portfolios is less likely to have a market price correction than if compared during a longer period. Thus, holding a portfolio for a longer period of time would increase the risk of experiencing dropping prices.

Even though transaction costs are expected to affect the most frequently traded portfolios the most, we still expect the shorter holding periods to be more attractive than longer ones.

3. Methodology

3.1 Method

3.1.1 Definitions and Assumptions

One of the core pillars of this thesis is the notion of the average investor. This person could be you or any person on the street. Therefore, corporations and funds that might be subjects to 1) other taxation laws and/or 2) *larger* investments are excluded. The average investor is subject to Swedish taxation laws and the trading calls of this individual will not affect the prices on the market. The trading volume is neither as big as to make transaction costs irrelevant, as might be the case for fund managers.

For the calculations to follow a predictable pattern, a few assumptions need to be made of the average investor's tax situation as these situations are varying across individuals. The full capital gains and losses for the individuals are assumed to be stemming from the chosen momentum strategy. This means that the average investor does not have any other investments or deductible items affecting the tax situation for the momentum strategy portfolios. It is also assumed that this average investor has other income stemming from employment enough to make use of any tax breaks (deductions) that any capital loss might result in. All taxes are assumed to be paid at the end of the year (as of December 31st) and all tax–breaks are also assumed to be available at the same time.

What is denoted as excess return, for a number of periods, is defined as the difference between the return of the momentum strategy versus that of the market portfolio.

$$\text{Excess Return} = \mathrm{r}\left(\text{Momentum Strategy}_{\mathrm{i,t}}\right) - \mathrm{r}(\text{Market}_{\mathrm{t}}) \qquad \text{(Eq. 2)}$$

$$\text{Where,} \quad \mathrm{r}\left(\text{Momentum Strategy}_{\mathrm{i,t}}\right) = \frac{\mathrm{PI}_{\mathrm{portfolio,t}}}{\mathrm{PI}_{\mathrm{portfolio,t-1}}}$$

$$\text{And,} \quad \mathrm{r}(\text{Market}_{\mathrm{t}}) = \frac{\mathrm{PI}_{\mathrm{Market,t}}}{\mathrm{PI}_{\mathrm{Market,t-1}}}$$

The average excess returns of the momentum strategies can be discussed in both in terms of geometrical and arithmetical values. This thesis mainly discuss the arithmetical values, as it clearly illustrates the differences and is the primary way of illustrating the

difference in earlier studies. It is also somewhat simpler, and is calculated as the accumulated return of the momentum portfolio where the accumulated return from the market portfolio is deducted. This difference is the accumulated excess return and can subsequently be divided up terms of years or months.[12] In terms of raw returns the geometrical values are used.

For illustrative reasons, we noted that the average Swedish household, in 1995, had savings in asset portfolios of approximately SEK 100,000, which we are also assuming to be the amount invested by the average investor in the beginning of the period.[13]

3.1.2 Portfolio Construction

The monthly returns of each stock were calculated from the dataset. These returns were then used for ranking the stocks in terms of accumulated return during the different evaluation periods. Subsequently, constructing investment portfolios with different evaluation and holding periods. The return was calculated on each stock's price index, as illustrated in Equation 3.[14]

$$\text{Return}_{i,t} = \text{PI}_{i,t} \,/\, \text{PI}_{i,t-1} \qquad \text{(Eq. 3)}$$

The evaluation period denotes the time before the stock was added to the portfolio. In this study three different evaluation periods are used: three, six and twelve months. The holding period is the length of time for which the stock is kept in the portfolio, thus holding the stock for three, six or twelve months. The evaluation period is directly followed by the holding period, with no time gap between. If a stock was delisted during the holding period the last available trading value was converted into cash, ready to be reinvested at the next time of rebalancing.

Combining the different evaluation and holding periods the result is nine possible portfolios, as shown in Table 2 below.

[12] In Appendix (5 and 6), the corresponding geometrical values can be found for reference.
[13] See Appendix (1) for more details on this average investment.
[14] The reason why the price index was used rather than the nominal price will be explained in Section 3.2.1

2. The Constructed Portfolios

Holding Period	Evaluation Period 3 months	6 months	12 months
3 months	3–3	6–3	12–3
6 months	3–6	6–6	12–6
12 months	3–12	6–12	12–12

Table 2: Illustrating the different portfolios and how they are denoted for the rest of this thesis.

Each portfolio contains equally weighted long positions of the top ten performing stocks for each evaluation period (denoted winners) and is held for a holding period of three, six or twelve months, with the portfolios being rebalanced at the beginning of each holding period.

At the end there were naturally different numbers of portfolios for the different strategies. For the strategies with a holding period of three months there was 80 portfolios in total, strategies with a holding period of six months, had 40 different portfolios. The strategies with a holding period of twelve months consisted out of 20 different portfolios during the 20 years' time.

These different portfolios represent their own investment sub-strategy and the return of these strategies was tracked during twenty years' time and then compared to the return of the selected market index to see if any of these strategies outperformed the market portfolio.

The returns were compared to the index, and the discrepancy is noted as excess return.

3.1.3 Testing the Findings for Significance and Considering Beta

3.1.3.1 Testing for Significance

To make sure any seemingly excessive return was just not generated by chance and assure a higher accuracy in this study's conclusion, the findings need to be tested for its statistical significance. The statistical significance is determined by applying the Student's T–test, which tests the average returns of each portfolio as compared to the benchmark index used for comparison, i.e. if the average excess return is statistically different from zero or not.

The t–statistic is as follows: $t_{obs} = \frac{\bar{x}-\mu}{(S/\sqrt{n})} \sim t_{n-1,\propto}$ (Eq. 4)

Where: $\bar{x}$ = sample mean, μ = test value, n = sample size.

s = std. dev. of the sample returns

The data tested should ideally follow a normal distribution when using the t-test, which can be approximated using The Central Limit Theorem when there are more than 30 observations. We noted the returns of each portfolio each quarter, thus having 80 observations in total during the twenty years' time. This do allows us to approximate the returns to follow a normal distribution. We use a two–tailed T–test as motivated in Section 2.3.

Before testing for significance it is also necessary to know if each of the momentum portfolios' and the index's returns are homoscedastic or not, this is determined through the F–test.[15]

The F–statistic is as follows: $F = \frac{\sigma_1}{\sigma_2}$ (Eq. 5)

Where, $\sigma_1 > \sigma_2$

3.1.3.2 Calculating Beta

Beta was calculated on the daily stock price index of each stock during the preceding 180 trading days of each portfolio construction. This beta value is thus illustrating the risk,[16] compared to the market, the investor must be willing to face in order to purchase each stock or the combination of stocks in a portfolio.

This measure was chosen since it describes the momentum strategies' movements compared to the market. This is also the comparison we do throughout the study, the momentum strategies are continuously compared to the market, why we believe beta is beneficial to our scope. It was also chosen as it is not normally used in this context, thus widening the landscape of momentum descriptives.

Beta is calculated as follows: $\beta_i = \frac{COV(R_i, R_{index})}{VAR(R_{index})}$ (Eq. 6)

Where, R_i is the return for each stock

And, R_{index} is the return of the index for the corresponding time

[15] The F-test is used, and not the Chi-Square Test, since we wish to test whether the different populations variances are equal to each other and not to a pre-specified value.

[16] Some would disagree to denote Beta as a measure of risk in this way. We do however believe it is a clear and simple characteristic as a measure for risk.

3.1.4 Considering Transaction Costs and Taxes

Since the aim of this study is to determine whether a practically applicable momentum strategy has generated an excessive (note that an excessive return can be both positive and negative), and statistically significant different return for the average investor, it is important to consider market realities and its frictions, represented by transaction costs and taxes in this thesis. This study is considering a 0.5 percent one way transaction fee for each trade of shares, even though Berkowitz *et al.* (1988) estimated this level to be conservative, we believe it can be beneficial for comparison reasons to work with this cost as Jegadeesh and Titman (1993) use this same percentage level. The average investor is normally facing a much lower variable cost than this today, but also needs to face a fixed brokerage for each transaction.

Considering taxes, the calculations comply with the Swedish taxation law, Inkomstskattelagen (SFS 1999:1229, IL), as of December 31st 2014.

If the overall net gain is positive, it is subject to capital taxation which is a flat rate of 30 percent. If the overall gain is negative (a loss), 70 percent of this loss will be converted into a base for tax–break calculations from other taxable incomes (from employment for example). The magnitude of this reduction of other taxes depends on the size of the loss and is 30 percent of the calculation base for losses up to 100 000 SEK and 21 percent for losses greater than that.[17] IL states that any transaction costs the investor is facing is deductible.

Any tax due reduces the investment available for the next period while any reduction increases the investment, compared to the balance available for investment at the end of the year.

The buy–and–hold portfolio represents a passive investment strategy and is thus only purchased once, at the beginning of 1995. At the period's end, to allow for a fair comparison to the momentum portfolios' returns, taxes must be accounted for as a tax liable.

3.1.5 Method Compared to Earlier Research – Our Contribution

Most earlier studies use similar (or identical) methodology as Jegadeesh and Titman (1993), and the main differences will now be commented, setting this study apart from the earlier research and making it more applicable and more interesting for anyone interested in momentum trading.

[17] See Appendix (2) for a graphical layout on how the taxation work

3.1.5.1 Top and Bottom Deciles versus Top Ten Stocks

When building each portfolio Jegadeesh and Titman (1993) took long positions in the top performers (winners), defined as the top decile of stocks, while taking short positions in the worst performers (losers), defined as the bottom decile, when ranked with regard to past performance over the evaluation period.

As the scope of this thesis is to evaluate the momentum strategy as a portfolio strategy for the average investor, the method must be adjusted accordingly. Therefore a simple and graspable investment rule such as only taking long positions in the top ten performers is preferable.

3.1.5.2 Short–Selling versus Not Short–Selling

Continuing on the first point, losers are not short–sold. One should be reluctant to do so since this would force very strong assumptions on the dataset which are simply not true. One of these assumptions is that all stocks traded on the stock market are liquid enough to be short–sold, which is not the case. To be able to short sell, someone have to be willing to buy that same amount. Smaller stocks do not have analyst coverage why many institutional investors are not trading in those stocks, resulting in lower trading volumes and turnover of these assets. Subsequently, reducing the liquidity and possibilities to short sell the stocks. Earlier studies have circumvented this strong assumption by reducing their dataset to only include stocks that have a certain trading volume and/or market capitalization, which is not manipulated for in this thesis as it pursues to adjust the data as little as possible. In addition, it is not believed that the average investor would consider these factors when trading.

Furthermore, short–selling (when possible) is generally more expensive than taking long positions, why it would be more problematic to handle the transaction cost. In addition, short selling is considered more risky as losses could potentially be unlimited. It is therefore assumed that the average investor is not likely to make use of any short–selling. This, in turn, leads the average investor to require an initial investment as the long positions are not financed by any short positions, as is the case in earlier studies applying a zero–investment approach. In addition, earlier studies that found significant support for the momentum strategy to work, found that it was the long side which provided the most returns, as in Hagwall and Lundén (2008).

3.1.5.3 Perfect versus Imperfect Markets

Finally, the conclusion that the momentum strategy would yield excess returns for the average investor would be inconclusive and the result would have little impact if one were to neglect realities such as transaction costs and taxes.

3.2 Data

3.2.1 The Market Portfolio and Corresponding Index

All data was gathered through Thomson Reuters Datastream, where the monthly and daily closing price–adjusted share indices for all listed common stocks[18] on the Stockholm Stock Exchange (OMXS) were found for calculating the price–adjusted stock return over the selected time periods. The monthly indices were used for ranking the stocks, while the daily indices were used for the beta calculations, as explained below. Each stock's price index, rather than its nominal price, was used since the price–adjusted indices also include capital changes such as dividends and stock repurchases. This way the accurate returns and values of the shares are identified, as internal–structural changes otherwise could trick one to perceive a higher or lower return.[19]

The index used for comparison, and also the approximation of the Market Portfolio, is the OMXS Price Index[20], which also included capital changes on the stock market and was retrieved from Datastream. Included in this index were all the listed companies on the OMXS, weighted in terms of market capitalization.

3.2.2 Time Horizon

The selected time horizon of this study is 1st of January 1995 to 31st of December 2014, equal to twenty years' time, in order to avoid temporary market fluctuations and other periods heavily influenced by special events such as strong recessions and market booms.

By starting in 1995, the time which was effected by the devaluation of the Krona in 1992 is excluded, an event that possibly could bias the final results, as proved in Söderström

[18] Common stocks, a.k.a. *ordinary* shares, excludes, among other things, preferred stocks and rights issues that could also be traded on the stock markets.
[19] If one buy a stock at SEK 10 before its dividend date and sell it for SEK 8 the period after, one might believe one lost (-) 20 percent on this trade. If, on the other hand, the dividend received was SEK 3, then the true return is + 10 percent.
[20] Short name in Datastream is: SWSEALI

(2000). In addition, during this period of time, two big recessions as well as their corresponding rises occurred – the IT–bubble that burst in 2000 and the subprime–crash starting in 2007. Such a long period of time is aiming to allow for an accurate and reliable result where representable data is used.

3.2.3 Remarks on the Data

Inflation is disregarded since this thesis is only interested in looking at the differences concerning the returns of the momentum strategy and the corresponding market portfolio (index) – not comparing outside components.

To avoid survivorship bias,[21] the firms that went delisted during the period are included in the dataset, the same is true for firms who went listed during this same period. The reason for this is that it demonstrates a realistic scenario rather than simplifying the amount of data and possibly get misrepresenting results.

Furthermore, when one firm had more than one kind of share class listed, such as both an A–class share and a B–class share, the A–class share were disregarded and only the B–class shares were considered. This is because it is assumed that the majority of the private investors is interested in the underlying asset and its development, and not in additional voting rights. It can also be noted that the movements of such matching pairs of shares usually correlate heavily. In Appendix (3), the results of a correlation test between A and B shares is presented.

3.3 Critique of Method and Data

Even though the aim of this thesis is to determine the attractiveness of the applicable momentum strategy to the average investor the results of this thesis might not be relevant for everyone as it has limits and simplifying that was necessary in order to get any results at all.

For example, each investor faces different transaction cost and 0.5 percent might not be representable for everyone. The same goes for taxes. First of all, all investors are not subject to Swedish taxation laws since 1) they might not be Swedish tax residents or 2) are exempts from the general capital taxation since they might be trading through a Kapitalförsäkring or an

[21] Survivorship Bias: Choosing data, which only includes companies that persisted during the whole period, will ultimately distort the results in an overly positive way.

ISK account.[22] Second, investors might neither have the opportunity to capture the full tax reduction from trading losses since they might have a low or non–existent income from employment.

This study was furthermore conducted on the OMXS where the selection of stocks is smaller than, for example, New York Stock Exchange and the liquidity and trading volume is much smaller than many other markets, which might affect the outcome and the generalizability of the results. Moreover, critique is continuously brought forward in this study as we make assumptions or discuss the available options, and is thus not limited to this section.

[22] These two types of accounts are subject to different taxation rules. The rules will not be covered as these are out of this thesis scope. The main idea of these two accounts is however, that profits are not taxed while losses are, in symmetry, not deductible. A fixed percentage of the account's total value is paid in tax, no matter whether the investor is losing or gaining value.

4. Findings

4.1 The Buy–and–Hold Strategy

During January 1st 1995 to December 31st 2014 the index of comparison, which is also the approximation to the market portfolio, yielded an accumulated return of 455 percent, excluding transaction costs and taxes, and a return of 288 percent when including these two imperfections.

3. The Market Portfolio's Accumulated Return

Index	Accumulated Return (%)	Avg. Annual Return (%)	Avg. Monthly Return (%)	Ending Value (SEK)
(1) Excl.	454.65	8.94	0.72	554,650
(2) Incl.	288.25	7.02	0.57	388,250

Table 3: Illustrating the market portfolio's accumulated return, its annual and monthly geometrical average returns together with corresponding ending value in SEK with an initial investment of 100,000 SEK. (1) Without accounting for transaction costs or taxes and (2) accounting for transaction costs and taxes. For a graph over time, see Appendix (4).

4.2 Findings: Excluding Transaction Costs and Taxes

4.2.1 Results

4. The Momentum Strategies' Return

Strategy (Evaluation–Holding)	Accumulated Return (%)	Avg. Annual Return (%)	Avg. Monthly Return (%)	Ending Value (SEK)
3–3	310.95	7.32	0.59	410,953
3–6	143.07	4.54	0.37	243,068
3–12	90.02	3.26	0.27	190,019
→ 6–3	1,913.27	16.20	1.26	2,013,271
6–6	396.25	8.34	0.67	496,249
6–12	12.99	0.61	0.05	112,988
→ 12–3	2,428.67	17.53	1.36	2,528,675
→ 12–6	855.91	11.95	0.95	955,912
12–12	28.15	1.25	0.10	128,154
Market Portfolio	**454.65**	**8.94**	**0.72**	**554,647**

Table 4: Illustrating each strategy's accumulated return, their annual and monthly geometrical average returns together with corresponding ending value in SEK with an initial investment of 100,000 SEK. Excluding transaction costs and taxes. Arrows indicate the strategies outperforming the market portfolio.

5. The Momentum Strategies' Excess Return

Strategy (Evaluation–Holding)	Accumulated Excess Return (%–points)	Avg. Annual Excess Return (%–points)	Avg. Monthly Excess Return (%–points)	Excess Return (SEK)
3–3	-143.69	-7.18	-0.60	-143,693
3–6	-311.58	-15.58	-1.30	-311,578
3–12	-364.63	-18.23	-1.52	-364,627
→ 6–3	1,458.62	72.93	6.08	1,458,624
6–6	-58.40	-2.92	-0.24	-58,398
6–12	-411.66	-22.08	-1.84	-411,658
→ 12–3	1,974.03	98.70	8.23	1,974,028
→ 12–6	401.27	20.06	1.67	401,266
12–12	-426.49	-21.32	1.78	-426,493

Table 5: Arithmetical values. Illustrating the excess returns for each strategy (accumulated, average annual and monthly, as well as nominal excess ending value), excluding transaction costs and taxes. Corresponding geometric values can be found in Appendix (5). Arrows indicate the strategies outperforming the market portfolio.

4.2.2 Testing for Significance: Hypothesis 1

F–test findings:

6. F-Test Findings

F–Test	3–3	3–6	3–12	6–3	6–6	6–12	12–3	12–6	12–12
F–stat.	33.232	3.116	3.871	12.194	4.241	2.689	4.096	2.608	2.854
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 6: Illustrating the outcome of the F–test (testing two variances for homoscedasticity). Excluding transaction costs and taxes.

We note that we can reject the null-hypothesis of the variances to be equal and we therefore run the t–test for heteroscedastic variances.

7. T-Test Findings

T–Test	3–3	3–6	3–12	6–3	6–6	6–12	12–3	12–6	12–12
T–stat.	0.746	0.060	0.096	1.056	0.512	-0.291	1.175	0.691	-0.258
P–value	0.458	0.952	0.923	0.294	0.610	0.772	0.242	0.491	0.797

Table 7: Illustrating the outcome of t–test (assuming unequal variances). Noting that none is significant at any conventional level (1, 5 or 10 percent). Excluding transaction costs and taxes

4.3 Findings: Including Transaction Costs and Taxes

4.3.1 Results

8. The Momentum Strategies' Return

Strategy (Evaluation–Holding)	Accumulated Return (%)	Avg. Annual Return (%)	Avg. Monthly Return (%)	Ending Value (SEK)
3–3	125.39	4.15	0.34	225,939
3–6	217.24	5.94	0.48	317,244
3–12	260.33	6.62	0.54	360,330
→ 6–3	589.74	10.14	0.81	689,743
6–6	284.52	6.97	0.56	384,520
6–12	135.37	4.37	0.36	235,373
→ 12–3	611.06	10.31	0.82	711,057
→ 12–6	446.38	8.86	0.71	546,382
12–12	224.38	6.07	0.49	324,927
Market Portfolio	**288.25**	**7.02**	**0.57**	**388,253**

Table 8: Illustrating each strategy's accumulated return, their annual and monthly geometrical average returns together with corresponding ending value in SEK with an initial investment of 100,000 SEK. Including transaction costs and taxes. Arrows indicate the strategies outperforming the market portfolio.

9. The Momentum Strategies' Excess Return

Strategy (Evaluation–Holding)	Accumulated Excess Return (%–points)	Avg. Annual Excess Return (%–points)	Avg. Monthly Excess Return (%–points)	Excess Return (SEK)
3–3	-162.86	-8.14	-0.68	-162,859
3–6	-71.01	-3.55	-0.30	-71,008
3–12	-27.92	-1.40	-0.12	-27,923
→ 6–3	301.49	15.07	1.26	301,490
6–6	-3.73	-0.19	-0.02	-3,732
6–12	-152.88	-7.64	-0.64	-152,880
→ 12–3	322.80	16.14	1.35	322,804
→ 12–6	158.13	7.91	0.66	158,129
12–12	-63.33	-3.17	-0.26	-63,325

Table 9: Arithmetical values. Illustrating the excess returns for each strategy (accumulated, average annual and monthly, as well as nominal excess ending value), including transaction costs and taxes. Corresponding geometric values can be found in Appendix (6) Arrows indicate the strategies outperforming the market portfolio.

For the portfolios accumulated return over time, see Graph A1-3 in Appendix (7).

4.3.2 Testing for Significance: Hypothesis 2

F–test findings:

10. F-Test Findings

F–Test	3–3	3–6	3–12	6–3	6–6	6–12	12–3	12–6	12–12
F–stat.	17.851	3.013	2.883	6.626	3.329	2.139	2.892	2.162	2.337
P-value	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000

Table 10: Illustrating the outcome of the F–test (testing two variances for homoscedasticity). Including transaction costs and taxes.

Once again it is noted that no portfolio strategy is likely to have a homoscedastic variance, and the t-test is also now run for heteroscedastic variances.

11. T-Test Findings

T–Test	3–3	3–6	3–12	6–3	6–6	6–12	12–3	12–6	12–12
T–stat.	0.527	0.170	0.217	0.697	0.339	-0.126	0.534	0.327	0.085
P–value	0.599	0.865	0.829	0.487	0.735	0.881	0.594	0.764	0.932

Table 11: Illustrating the outcome of t–test (assuming unequal variances). Noting that none is significant at any conventional level (1, 5 or 10 percent). Including transaction costs and taxes

4.4 Characteristics of Portfolios

4.4.1 Beta

Results as below:

12. Beta Descriptives

Strategy	3–3	3–6	3–12	6–3	6–6	6–12	12–3	12–6	12–12
Avg.(**β**)	0.607	0.728	0.982	0.795	0.829	0.981	0.858	0.837	0.973
Median(**β**)	0.51	0.55	0.67	0.61	0.67	0.67	0.62	0.62	0.60
St. dev.(**β**)	2.815	4.034	5.375	3.976	4.132	5.355	3.907	4.011	5.347

Table 12: Illustrating the average betas and corresponding standard deviation of each portfolio strategy. Not adjusted for outliers

Table 13 below, illustrates the new beta values when corrected for outliers:

13. Beta Descriptives when Corrected for Outliers

Strategy	3–3	3–6	3–12	6–3	6–6	6–12	12–3	12–6	12–12
Avg.(**β**)	0.52	0.54	0.62	0.61	0.67	0.61	0.67	0.67	0.60
Median(**β**)	0.51	0.55	0.67	0.61	0.67	0.67	0.62	0.62	0.60
Std. dev. (**β**)	0.88	0.78	0.79	0.95	1.23	0.74	0.70	0.74	0.66

Table 13: Illustrating the average betas and corresponding standard deviation of each portfolio strategy, when adjusted for outliers.

Finding the 95% confidence intervals for the betas of $\mu \pm 1{,}96\sigma$:

14. The 95 Percent Confidence Interval for Beta

Strategy	3–3	3–6	3–12	6–3	6–6	6–12	12–3	12–6	12–12
Max.(**β**)	2.26	2.07	2.17	2.47	3.08	2.07	2.04	2.12	1.88
Min.(**β**)	-1.21	-0.99	-0.93	-1.25	-1.74	-0.84	-0.70	-0.78	-0.69

Table 14: Illustrating the 95% confidence interval of the betas, when adjusted for outliers.

4.4.2 Standard Deviations: Before versus After Transaction Costs and Taxes

15. Standard Deviations Before and After Transaction Costs and Taxes

Strategy	3–3	3–6	3–12	6–3	6–6	6–12	12–3	12–6	12–12
(1) No Tax	0.685	0.210	0.234	0.415	0.245	0.195	0.240	0.192	0.201
(2) With Tax	0.502	0.206	0.202	0.306	0.217	0.174	0.202	0.175	0.182
(2) < (1)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 15: Illustrating the standard deviations of the momentum portfolios nominal raw return before and after transaction costs and taxes. Noting that these imperfections lower the standard deviation.

5. Analysis

5.1 Excluding Transaction Costs and Taxes

First, looking at the results in Section 4.2 (excluding transaction costs and taxes), it can be noted that the realized raw returns are varying greatly between the different momentum strategy portfolios, ranging from a high accumulated raw return of 2,428.67 percent (the 12–3 strategy) to a low of 12.99 percent (the 6–12 strategy).

Second, only three momentum strategies seem to have outperformed the market during the selected period of time, notably the 12–3, 6–3 and the 12–6 strategies, as indicated by the arrows in Table 5.

The excess returns found when excluding transaction costs and taxes, both negative and positive, are not statistically significant, where the lowest p–value was as high as 0.458. H_0 cannot be rejected, which thus remains valid and is in line with the traditional theories of the EMH and Random Walk. I.e. there is no support for the applicable momentum strategy to be appealing for the average investor in terms of excess return.

The appearance of imperfect capital markets, (in this thesis represented by transaction costs and taxes), affects the returns of the momentum strategy portfolios, and therefore also its standard deviation. Taxes are cushioning the returns of each year by cutting the highs (by taxation) and level out the drops (by tax reductions). This implies that even though not significant at any meaningful level *without* transaction costs and taxes, it might still turn out to be significant when accounting for taxes as we also did.

5.2 Including Transaction Costs and Taxes

When now considering transaction costs and taxes, it is noted that the realized raw returns are still varying greatly between the different momentum strategy portfolios, ranging from a high accumulated return of 611.06 percent (the 12–3 strategy) to a low of 125.39 percent (the 6–12 strategy).

Still, only three momentum strategies, the same ones as before, seem to have outperformed the market, namely the 12–3, 6–3 and the 12–6 strategies, as indicated by the arrows in Table 9. The market imperfections, mainly the taxes, did cut the accumulated return of the winning strategies as anticipated but it also pushed up the worst performing strategy to 125.39 percent as compared to 12.99 percent before. Taxes clearly affect the returns and must

be considered when determining the momentum strategy's applicability to the average investor.

5.3 Overall Comments on Findings

As predicted in Section 2.3.1 the taxes decrease the standard deviation of the portfolios' raw returns. However, the lowered standard deviation did not affect the results enough in order to be able to find statistical significance for any momentum strategy at all, and the empirical results firmly suggest that the applicable momentum strategy is not appealing for the average investor, no matter whether facing transaction costs and taxes or not.

The best performing strategies were 12–3, 6–3 and 12–6, as ranked in descending order, with excess returns of 322.80, 301.49 and 158.13 percent respectively. The fact that these portfolios yielded the highest return, however not significantly different from the market portfolio, is in line with the findings of Hagwall and Lundén (2008) that longer evaluation periods would be beneficial over short ones and that short holding periods would be more beneficial over longer ones. The reason, we believe, is that by evaluation during a longer period of time, one is less likely to select stocks that has rocketed right before the portfolio formation, thus selecting more stable stocks. In addition, by holding the portfolios for a shorter period, any stock that has its reversal approaching is less likely to experience this reversal while held in the portfolio, as the holding period is shorter the risk of holding the stock at its reversal decreases.

When comparing the 12–3 and 12–6 strategies and their returns, it is interesting to note that this additional holding time of three months reduces the excess return to less than half (322.80 versus 158.13 percent). If we add another three months to the holding period we find the decreasing trend to continue, the 12–12 strategy has an excess return of -63.33 percent. This same negative pattern between return and holding period can be identified on the strategies with an evaluation period of six months with returns of 301.47, -3.73, -152.88 percent for the 6–3, 6–6 and 6–12 respectively. However, as we look at the portfolio strategies with a shorter evaluation period (three months) the direct contrary trend can be found, with better returns for the portfolios with longer holding periods.

The momentum strategies are however not feasible to pursue over simply holding the market portfolio, no matter whether one is facing transaction costs and taxes or not. One might still ask what kind of characteristic each strategy has, in terms of volatility and risk[23].

5.4 Characteristics of the Momentum Strategy Portfolios

To get a descriptive of the portfolios and also an indication of the average risk, for each strategy, which the average investor must be willing to face in order to pursue any of these strategies, we decided to calculate beta for these portfolios representing the time before the holding period. This is discussed in terms of beta since it describes the movements, and also risk to some extent, compared to the market portfolio. The raw returns and their standard deviations would have been a better measure if we were to compare the momentum strategy and its movements to the base case of holding cash, and thus not comparing to holding the market portfolio.

Intuitively, one might assume that the portfolios would not show a tendency to correlate well with the overall market since we are constantly picking the stocks, which have outperformed the market. These stocks should be more volatile and thus carrying more risk, which the initial average betas contradict. However, noting a high standard deviation suggest that the volatility of the betas is high and that this data might be highly influenced by extreme values that might skew the result. This scenario was also found to be the case and the data was corrected for these outliers accordingly.[24] Table 13 illustrates the new findings.

The new findings do support the intuition that the portfolios do not have a tendency to correlate as heavily, now about 50–70 percent, to the movements of the market portfolio, however this could still be considered surprisingly high.

One cannot look at the average beta alone but also needs to incorporate the standard deviation, which is high in relation to the average, suggesting the strategies have been rather independent from the market for many periods.

Considering the standard deviation of the betas facing the average investor, which need to be accepted in order to proceed with these strategies, one can note that the betas tend to be volatile and that the portfolios fluctuate more than the market. The average investor must thus

[23] Some would disagree that beta is a measure of risk, why the returns' standard deviations are included in Appendix (8) and in Section 4.4.2. The value of beta is determined on how an asset is moving compared to selected index.

[24] The outliers was adjusted for by winsorising the data on the 90 percent level. Thus, replacing the most extreme 5 percent on each side of the distribution with the values of the 5th and 95th percentile respectively.

be willing to purchase stocks and portfolios that have rather high (absolute values) in terms of beta.

The intuition that longer evaluation periods would result in a selection of more stable stocks (and thus also more stable portfolios) are supported from the betas, as they tend to have a tighter confidence interval compared to the shorter evaluation periods. The 12–3 strategy, for example, is the strategy that showed to be the most profitable sub–strategy and has a beta interval of +2.04 to -0.70 which is also the tightest interval of them all. This strategy is thus the one which seems to have the most potential to beat the market, *if any*.

5.5 Compared to Theoretical Framework and Earlier Research

The empirical findings of this study are in line with the traditional and established theories of finance, holding the market as efficient where Adam Smith's (1776) invisible hand is hovering to correct any mispriced assets and also the EMH. The result support these theories, but we must beware when interpreting these findings. This study merely looks at the momentum strategy, and it can thus only be claimed that the evidence found support the fact that the applicable momentum trading strategy is not an appealing way to leverage upon any market inefficiency, if any inefficiency exist at all, for the average investor. This study is not in line with the theories of behavioral finance, while not stating anything whether the market is actually inefficient or not. Our results merely hold the fact that if market inefficiencies exist at all, as the theories behind behavioral finance suggest, the momentum trading strategy is not an attractive way for the average investor present on the Swedish market to exploit them. Thus, our results support the EMH and its theories that long term profits cannot be made when trading on historical information, but we cannot say whether the EMH is true, generally, or whether the momentum strategy is only a powerless tool to exploit the market inefficiencies if they exist.

The empirical findings are also in line with recent studies by Krooks and Leu (2014), who are however looking at the performance of winners versus losers (the zero-investment approach), which decrease the comparability between these two studies. The same goes for Blackestam and Setterqvist (2014). To some extent also consistent with Hagwall and Lundén (2008), who find some momentum strategies which work and some which do not work (also the zero-investment approach). Our results are consistent with theirs (Hagwall and Lundén's, 2008) as both our findings suggest that shorter holding time is beneficial over longer ones and

longer evaluation period is beneficial. This study is also in line with Sandstedt and Woijt (2011), who are however not looking at the Swedish market but rather the S&P 500, where they conclude that the momentum strategy, as developed by Jegadeesh and Titman (1993), did not work well with their data. This is also true for this study.

Unable to find support for the findings of Jegadeesh and Titman (1993, 2001) among others, we deem the momentum effect proved by these studies as illusionary to the average investor present on the Swedish market, but not in the same way Lesmond *et al.* (2004) do (as laid out in Section. 2.2.3). Lesmond *et al.* (2004) are commenting on the found momentum profits as illusory when adding transaction costs, while we claim the momentum profits as found by Jegadeesh and Titman (1993), among others, to be illusory when taking the perspective of the average investor, no matter whether transaction costs and taxes are added or not. In addition, one has to consider that we are using another method that, for example, disregarded the use of short selling, which means that the number of comparable studies is limited. Hence the finding of this thesis cannot be directly compared to earlier studies.

6. Conclusion

6.1 Conclusion

This study originated from the perspective of the average investor and the lack of studies on the momentum strategy that took the average investor's point of view. Earlier studies have looked at something which we consider to primarily be the momentum effect's theoretical existence, and not how an applicable approach would actually perform. This view led to the incorporation of transaction costs and taxes, representing some of the market realities facing the average investor, as was further defined in Section 3.1.1. Also, to keep the results more applicably relevant we chose to consider excess return over abnormal return. The excess return is the discrepancy between the momentum strategy portfolios and the benchmark, being the market portfolios (as approximated by index) while the denotation of abnormal return is a measure comparing its returns to a theoretical model, such as the CAPM. Therefore, we believe our results to be relevant for any individual who fall within the average investor category and who is interested in pursuing "easy money" by applying the momentum strategy. As the prime scope of this study was to provide this individual investor with as accurate and reliable results as possible, in a real setting, we hesitated to make assumptions in

general and carefully evaluated the alternatives before we did so. Thus, as few modifications of the dataset as possible has been done. While a few simplifying assumptions naturally had to be made, it is our belief that this study does measure the applicable momentum strategy in a satisfactory way. The performance of the shares are evaluated on historical data and there is little room for subjective interpretations of this.

The empirical findings of this study do not find statistically significant evidence supporting the ability to generate excess returns using any of the momentum strategies that was constructed on the Nasdaq OMX Stockholm, during the period of January 1st 1995 to December 31st 2014. Thus, the applicable momentum strategy is not a better investment opportunity than holding the market portfolio. Although three strategies managed to generate large returns over this period, they were not found statistically significantly different from the buy–and–hold strategy, and any conclusion that the momentum strategy would be appealing to the average investor would be highly uncertain. These three strategies are however worth mentioning as the investors who had followed this method for the last 20 years had been generating an *excess return* of 322.80, 301.49 and 158.13 percent for the 12–3, 6–3 and 12–6 sub–strategies respectively, although this excess return is, once again, statistically insignificant. The market portfolio generated a return of 288.25 percent. [25]

Overall, the lack of significance is due to the high degree of uncertainty, and thus a high standard deviation. To some extent, this can be illustrated through the beta measure. The beta findings, after adjusted for outliers, suggest that the applicable momentum strategies do not tend to follow the movements of the market, suggesting the individual investor must have a strong character and determination if pursuing any of these momentum sub-strategies at all. The investor needs to be prepared to have its portfolio eroded to a large extent, even in good times, and cannot bail out half way, as our findings are assuming the strategy was pursued for the full 20 years' time. Even though these excess returns are appealing, few average investors are likely to receive them.

6.2 Critique and Suggestions for Future Research

The results are based on Swedish data and might not be representable for other markets as many are, for example, more liquid, include stocks with other characteristics, and countries also have different taxation laws. This is also true for transaction costs as they differ between different brokers and banks. In addition, simplifying assumptions had to be made regarding

[25] Values expressed as arithmetical values, when accounting for transaction costs and taxes

the average investor's tax situation and trading capabilities. For example, the average investor is assumed to not be able to affect market prices, even though some of these shares could be volatile due to a low trading volume, and therefore potentially sensitive enough to have their market prices affected by single traders.

In further research, it would be beneficial to consider this by perhaps reducing the dataset with the most illiquid stocks and also consider the ask–bid spread, as this is also a transaction cost to some extent.

The one way trading cost in this thesis was set to 0.5 percent, which is not applicable to everyone, depending on how and where the trades are made. Daily data for returns and performance could also provide higher levels of significance, why daily data could be used in the future. This thesis, together with earlier research, leaves some middle ground untouched in terms of method. While this study fully exclude the possibility to short sell, some stocks are available for this and could thus be short sold.

We believe a study using this method, while still considering the applicable momentum strategy, has the potential to be impactful on how one perceive its attractiveness, especially for the average investor.

It would also be interesting to see how the momentum strategy will perform in the near future, especially since many markets are valued at all–time high levels, as of late 2014 and beginning of 2015. Continuing this study and further analyzing the change, perhaps upon yet another potential market correction, could potentially find results that differs from ours.

Furthermore, there is also the possibility of examining how the selection of stocks would affect the feasibility of the strategy. Perhaps reducing or increasing the number of stocks in each portfolio, or use a staggered portfolio where the stocks are gradually exchanged over time. Another interesting adjustment would be to build off the findings that shorter holding periods together with longer evaluation periods show most potential to be attractive, and to further decrease the holding period while perhaps extending the evaluation period. Also, is the intuition correct about *why* longer evaluation and shorter holding periods tend to perform better than the portfolios with the opposite composition?

The final remark on this study is that we could conclude that the applicable momentum strategy is not attractive to the average investor as it has not proven a statistically significant excess return, compared to the market portfolio, on the Nasdaq OMX Stockholm Stock Exchange, between 1995 and 2015. We deem the momentum strategy's earlier proven profits (in earlier studies) as illusory to the average investor.

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Appendix

1 The Average Investors Investment Space

Below are the total amounts for Swedish households invested in stocks and funds in 1995. (SEK)

Stocks:	271 951 000 000
Funds:	128 292 000 000

Total:	400 243 000 000	Number of households in Sweden (1995): 4 244 000

Source: Statistiska Centralbyrån (2015a, 2015b)

Therefore the average invested amount for each household is: **SEK 94 308**

In line with the primary objective of this thesis, to be simple, we approximated to an initial average investment of SEK 100 000.

2 Inkomstskattelagen (IL) / the Swedish Capital Taxation Procedure

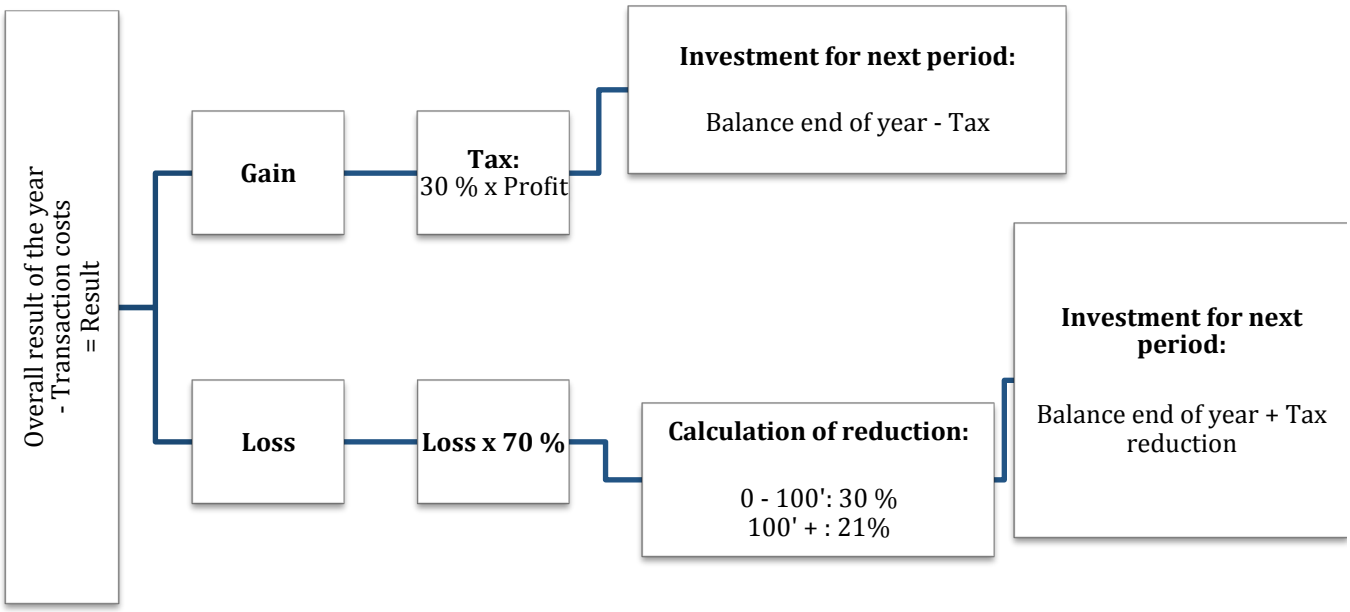


Table A2: Graphically showing the structure of Inkomstskattelagen (IL) as of 2014 (Swedish taxation for capital income).

Source: *Inkomstskattelagen (SFS 1999:1229)*

3 Correlation Test: A and B shares

Firms identified with A and B shares		AVERAGE CORR. = 98.78 %
ABB ACAP INVESST ASTRA ATLAS COPCO BPA BTL BILSPEDITIONEN CATELLA ELECTROLUX ERICSSON ESSELTE EVIDENTIA FORENINGS BKN. FRIGOSCANDIA GAMBRO GOTLANDS REDERI HASSELFORS FRV HOLMEN	HUSQVARNA INDL. & FINL.SYS INVESTOR JP BANK KINNEVIK KINNEVIK IND KORS S SCA SCANCEM SCANIA SIAB SKANE–GRIPEN SKF SSAB STORA SVENSKA HANDELSBKN. SWECO TELE2 VBB VOLVO	In order to prevent investing in the same underlying asset twice, only the B–share was considered for all the firms which had more than one kind of common stock listed on Nasdaq OMX Stockholm. To back up our assumption, for the A and B shares to correlate, we gathered all the firms for the last 20 years which had both an A and a B share listed and analyzed, through a correlation test in Excel, the tendency these two shares had to correlate. The finding was that the correlation rate was 98.78 %, which means the assumption is valid and accurate. The main reason for the small difference is that A–Stocks are usually less traded compared to B–stocks, but in the end have the same return. Sometimes one was delisted, for any reason, which resulted in errors–values. We excluded these "errors" in our calculations and subsequently found a heavy correlation between the A and B stocks' movements.

Table A3: Illustrating the results of the correlation test between the A and B stocks on Nasdaq OMX Stockholm

4 The Buy–and–Hold Strategy's Accumulated Return over Time

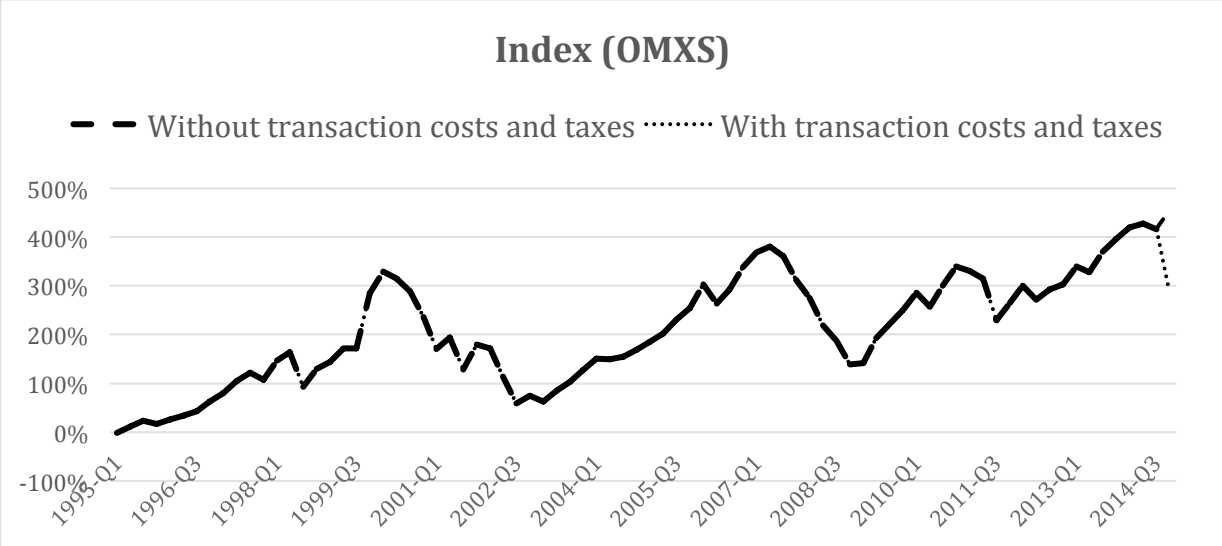


Table A4: Illustrating the returns of index (OMXS) over the selected period of time, both including and excluding tax effect.

5 Geometrical Average Values for the Momentum Strategies Excluding Transaction Costs and Taxes

STRATEGY (EVALUATION–HOLDING)	ACC. EXCESS RETURN (%)	AVG. ANNUAL EXCESS RETURN (%)	AVG. MONTHLY EXCESS RETURN (%)	EXCESS RETURN (SEK)
3–3	-25.91	-1.49	-0.12	-143 693
3–6	-56.18	-4.04	-0.34	-311 578
3–12	-65.74	-5.22	-0.45	-364 627
→ 6–3	262.98	6.66	0.54	1 458 624
6–6	-10.53	-0.55	-0.05	-58 398
6–12	-79.63	-7.65	-0.66	-411 658
→ 12–3	355.91	7.88	0.63	1 974 028
→ 12–6	72.35	2.76	0.23	401 266
12–12	-76.89	-7.06	-0.61	-426 493

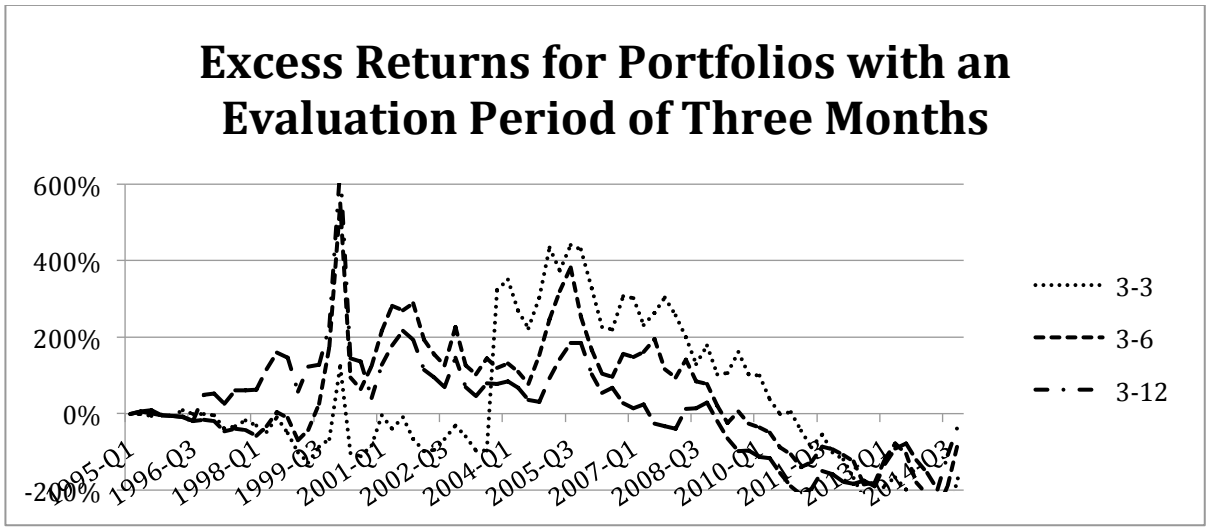
Table A5: Geometrical values, showing the excess return for each strategy (accumulated, average annual and average monthly), excluding transaction costs and taxes. Arrows indicate the strategies outperforming the market portfolio.

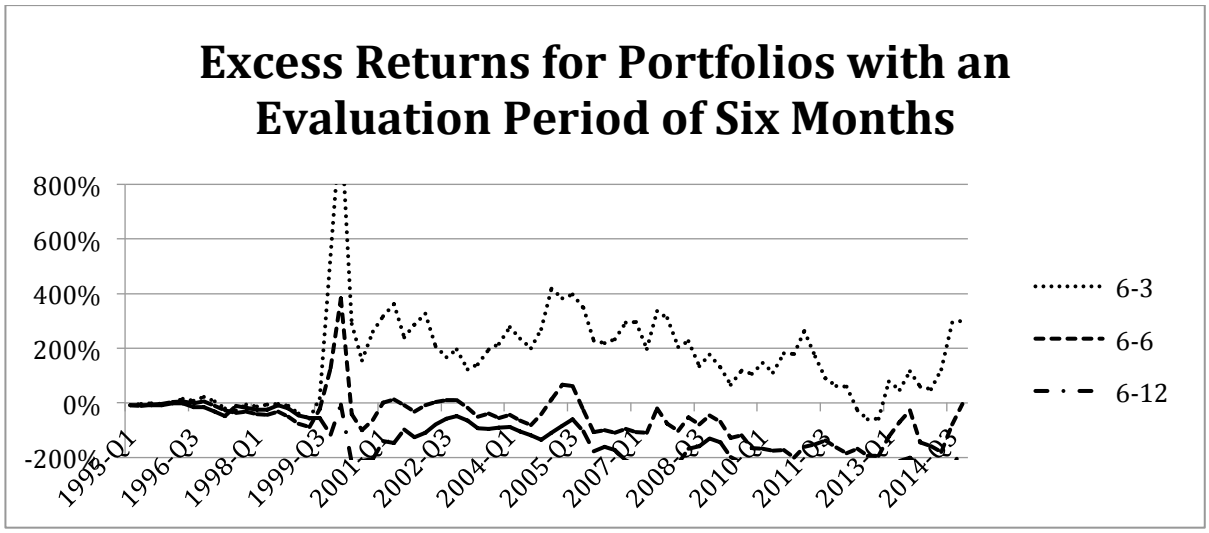
6 Geometrical Average Values for the Momentum Strategies Including Transaction Costs and Taxes

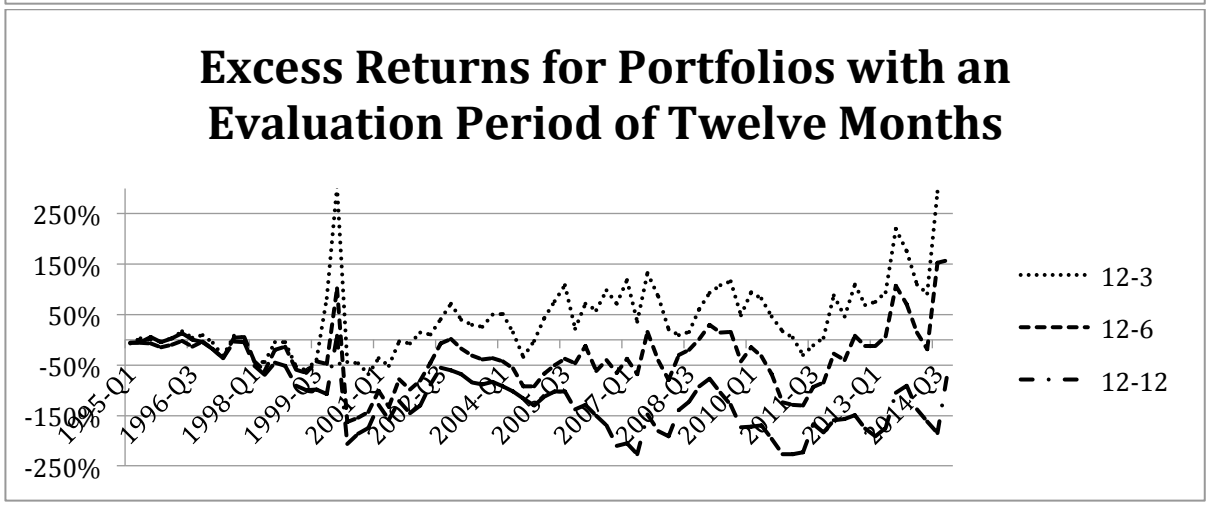
STRATEGY (EVALUATION–HOLDING)	ACC. EXCESS RETURN (%)	AVG. ANNUAL EXCESS RETURN (%)	AVG. MONTHLY EXCESS RETURN (%)	EXCESS RETURN (SEK)
3–3	-41.95	-2.68	-0.23	-162 859
3–6	-18.29	-1.00	-0.08	-71 008
3–12	-7.19	-0.37	-0.03	-27 923
→ 6–3	77.65	2.91	0.24	301 490
6–6	-0.96	-0.05	0.00	-3 732
6–12	-39.38	-2.47	-0.21	-152 880
→ 12–3	83.14	3.07	0.25	322 804
→ 12–6	40.73	1.72	0.14	158 129
12–12	-16.31	-0.89	-0.07	-63 325

Table A6: Geometrical values, showing the excess return for each strategy (accumulated, average annual and average monthly), excluding transaction costs and taxes. Arrows indicate the strategies outperforming the market portfolio.

7 Accumulated Excess Return Over Time. Including Transaction Costs and Taxes.







Graphs A1–3: The Excess Returns for each momentum portfolio including transaction costs and taxes. Arithmetical returns.

8 The Raw Return's Standard Deviations

Strategy	3–3	3–6	3–12	6–3	6–6	6–12	12–3	12–6	12–12
No Transaction Costs or Taxes									
Mean	1.087	1.030	1.032	1.080	1.044	1.021	1.064	1.046	1.022
St. dev.	0.685	0.210	0.234	0.415	0.245	0.195	0.240	0.192	0.201
Transaction Costs and Taxes									
Mean	1.059	1.033	1.034	1.054	1.038	1.026	1.043	1.036	1.031
St. dev.	0.502	0.206	0.202	0.306	0.217	0.174	0.202	0.175	0.182

Table A8: The raw returns' standard deviation and mean. Arithmetical values.