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The impact of transaction costs on fundamental indexation on the Finnish stock market

Bachelor's thesis
International Business Administration, Finance and Accounting

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I hereby declare that I have compiled the thesis independently
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has not been previously presented for grading.
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ABSTRACT

This bachelor's thesis investigates how transaction costs affect the performance of smart beta strategies in the case of the Finnish stock market. A large number of previous studies, including studies based on Finnish stock market data, report that both fundamental indexation and smart beta strategies outperform the broad market. However, the majority of these studies do not account for the effect of transaction costs or model its effect in a simplistic way. The present study addresses this shortcoming by accounting for the transaction fees and losses associated with the bid-ask spreads. The latter is modeled based on the data on overnight gaps that proxy stock-specific liquidity. Using the data from 2006 to 2019, the study estimates the performance of three single-factor strategies, value, size, and momentum, while a market capitalization-weighted index is used as a benchmark. The results show that larger profits suffers the most from transaction costs and that high volatility strategies lack the ability to recover post-crisis.

Keywords: Smart Beta, fundamental indexation, the Finnish stock market, alternative beta, stock market indices, transaction costs

INTRODUCTION

During the past ten years, the specific investing strategies, whether it is Smart Beta, Alternative Beta, or Fundamental Indexation, have attracted large amounts of capital. As a result, exchange-traded funds (ETFs) that operate on these strategies have seen a spike in their total assets under management, and a substantial increase in the number of such funds (Murphy, 2019). This is partly due to the increasing popularity of passive investing during the same period. However, traditionally passive investing is done by investing in a market capitalization weighting method index, not alternatively weighted index funds. Thus, the increase in popularity of mentioned above strategies cannot be solely attributed to the popularity of passive investing.

Fundamental indexation and Smart Beta are terms that are often thrown around as benchmark beating strategies, especially in financial advertisements. However, the problem with the majority of studies that show Smart Beta better-than-benchmark performance is that they more often than not fail to take transaction costs into account. Thus the question remains if these strategies as good as they have been branded to be or is it just another theoretical pipe dream.

This study aims to investigate the after fees performance of three one-factor Smart Beta strategies (size, value, and momentum) using the Finnish stock market data over 2006-2019. In addition, a market capitalization-weighted benchmark index is constructed alongside the Smart Beta strategies. Specifically, the thesis asks if considering transaction costs nullify the outperformance of fundamental indexation strategies reported in previous studies. Furthermore, the thesis asks which of the aforementioned strategies is the optimal investing strategy when considering the relationship between transaction costs and the outperformance of fundamental indexation. The study utilizes a common threshold of transaction fees and estimates the potential losses due to bid-ask spread based on the overnight gaps of the selected stocks.

The paper is organized as follows. Section 1 reviews the relevant literature, while Section 2 discusses the data and methodology used in the study. Then, Section 3 presents the empirical results. The final section concludes.

1. LITERATURE REVIEW

1.1. Theoretical background

The origins of factor investing can essentially be traced to the Modern Portfolio Theory by Markowitz (1952), as this acted as the foundation on which the factor investing models were later built. The Modern Portfolio Theory or (MPT) was the first mathematical model to look into the risk-return relationship; in other words, through maximizing diversification possibilities and minimizing variance, one could maximize expected returns in a given level of risk. MPT assumes that investors are risk-averse, and thus, given two portfolios with the same expected returns, investors will opt for the one that has lower risk. Furthermore, this theory assumes that an investor will only take on more risk if the expected returns are larger. Therefore the exact trade-off will be the same for every investor, but different personal risk aversion characteristics will determine the difference between individual investors.

Efficient Market Hypothesis or (EMH) is the hypothesis that assumes asset prices reflect all the information available. In other words, it states that at any given time, an investor can not beat the market consistently on a risk-adjusted basis since markets should always and only react to new information. Therefore the EMH suggests that at any given situation, the information available is already adjusted to the price of a stock and that there should not exist situations where a market anomaly could occur. A market anomaly is simply a situation where the predictability is inconsistent with risk-based theories asset of asset prices, *i.e*., the risk-based models fail to explain the price movement of an asset. Due to risk adjusting being central in EMH, but the hypothesis itself does not present a model of risk, the EMH is untestable. Despite this, it provides a basic logic for risk-based asset pricing theories. The EMH is often credited to Fama (1970) for his review of empirical research and theory. However, the idea of market returns being hard to predict can be traced back to Bachelier (1900), Mandelbrot (1964) and Samuelson (1965).

The Capital Asset Pricing Model (CAPM) was introduced in the 1960s by (Treynor 1961; Sharpe 1964; Lintner 1965 and Mossin 1966) and can be thought of as the first mathematical factor investing model as it accounts for one variable that is systematic risk, (Beta – β). Therefore it is a single-factor model. In other words, CAPM takes into account the asset's sensitivity towards systematic risk, and the β is the measurement of this risk as well as the expected return of the market and the expected return of a risk-free asset. As this model is based on systematic risk, therefore the idea behind it is that an investor needs to be compensated for the risk that can not be diversified, which is systematic risk and thus requires compensation in the form of a risk premium. This risk premium is the rate of return that is greater than the risk-free rate; in essence, it is the additional return an investor expects to receive from holding a riskier portfolio in comparison to holding risk-free assets. Thus fundamentally, CAPM has its roots in MPT as in order for CAPM to function, it requires that the unsystematic risk has been removed via diversification. Even though CAPM has been widely adopted since its introduction, there have been empirical studies made which question its functionality in reality. "The empirical record of the model is poor—poor enough to invalidate the way it is used in applications." (Fama and French 2004, 25)

Arbitrage Pricing Theory (APT) was proposed by Stephen Ross in 1976. This model is an extension of CAPM in the sense that it builds upon the CAPM's ability to price assets, but instead of using a single factor based on the systematic risk of market movements, it integrates several factors to explain returns. This is achieved by modeling the expected return of a financial asset as a linear function of multiple factors or theoretical market indices, that is presented by a factor-specific beta coefficient which investigates the sensitivity to changes in each individual factor. Where the CAPM assumes that markets are perfectly efficient, the APT assumes that sometimes markets are not performing efficiently, thus sometimes there are mispriced securities available for a short period of time. Furthermore, investors who use APT are hoping to take advantage of any deviations in the fair market value according to this theory. However, while the APT is extremely flexible compared to CAPM, it is more complex, as the CAPM only takes into account a single factor, which is systematic risk, where the APT formula has multiple factors. Because of this, it requires an extensive amount of research to determine how much sensitivity given security weighs to a multitude of different macroeconomic risks.

In 1993 Fama and French extended the earlier theories of CAPM and APT and came up with a three-factor model, simply known as the Fama and French three-factor model. The authors observed that, historically, two classes of stocks tend to perform better compared to the market,

which are small-cap and stocks which have a high book-to-market ratio. In other words, this model added size risk, which is the small-cap stocks, and value risk, which is the book-to-market ratio, along with the market risk ratio of CAPM to create the three-factor model. Thus the model assumes that the value and small-cap stocks outperform the market on a regular basis, and by including these two factors, the model adjusts to these outperforming tendencies.

The Carhart four-factor model added a factor called momentum to the foundation of the Fama and French three-factor model. This was introduced by Carhart (1997). The momentum factor, in essence, is the tendency of a stock price to continue rising when it is rising, and when the stock price is declining, the price is going to continue declining. The one-year momentum anomaly was first discovered by Jegadeesh and Titman (1993), and Carhart combined the three factors from Fama and French model, which are market risk, value, and size, with the momentum factor to come up with this model.

The Fama and French five-factor model is directed towards capturing market risk, size, value, profitability, and investment. This model was introduced in Fama and French (2014), and it was built on the older three-factor model, as the authors realized that by adding extra factors, the model would perform better. The specific factors added to this newer model are profitability and investment patterns.

1.2. Indices

An index is a statistical measure of the change in the securities market. This means that an index is a given group of securities chosen to track a certain market, sector, asset, or industry. Thus as an investor, you can not directly invest in an index or indices, as they operate more like a benchmark for the market or for the entity the index is tracking. Generally, each index differs from one another based on the calculation methodology and the investment options they are representing. Indices are an extremely popular tool of representation in finance as they allow investors to compare different assets to the performance of market indices so the participants of the market will have a better understanding of how the individual asset has performed in comparison to the market. Furthermore, indices can be used to compare different markets by analyzing the results of performance between different market indices. This is extremely useful for the market participants as the securities market contains a vast amount of different securities,

so with indices participants can just follow the index to see the trends and performance at a given time, instead of combing through the vast securities universe to gather necessary information.

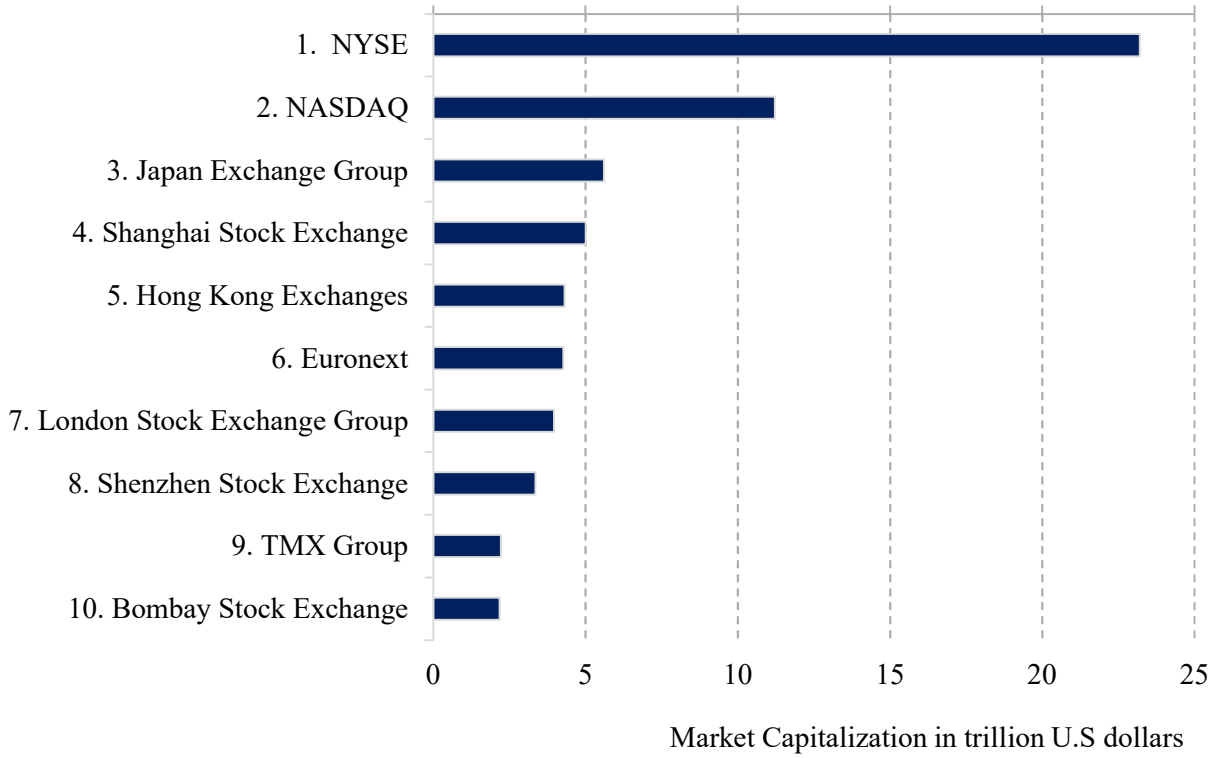

Figure 1. Largest stock exchanges in the world by market capitalization in 2019

Source: statista.com (2019)

The figure above illustrates the size of different stock exchanges around the world by market capitalization. Each of the stock exchanges also have their own major index that tracks the performance of the different markets listed above. By market capitalization, the United States of America has the largest and second-largest exchanges. Furthermore, China has three different exchanges on the list, ranked fourth, fifth, and eighth in the figure above. Where Europe has two different exchanges on the list, which are Euronext and London Stock Exchange Group. Last but not least, Japan has the third place in terms of market capitalization in the list with Japan Exchange Group, Canada and India are ninth and tenth respectively in the figure, with TMX Group and Bombay Stock Exchange. The indices that are listed are the major indices that track the performance of the exchanges, with the exception of the S&P 500, which uses components from multiple exchanges from the USA but is frequently quoted as an overall performance tracker of

the American markets. In addition, the S&P/TSX Composite Index represents 70% of the market capitalization of the Canadian exchange, which is the Toronto exchange.

However, an index is not limited to stocks or even securities as for example, the CBOE Volatility Index (VIX) is a benchmark for the expected volatility in the stock market in the near future. In fact, there are currently 2.96 million indexes globally, which is a decrease of 20% compared to last year, the surveys that were done in 2017 and 2018 reports that the total amount of indices was 3.29 million and 3.73 million respectively. This research was done by (Index Industry Association 2019). To further put this into perspective, according to the World Bank in 2018, there were 43,342 public companies registered, meaning that there are significantly more stock market indices than there are listed stocks across the globe. By default, there are generally three key approaches to indexing, which are market-capitalization weighting, equal weighting, and fundamental weighting. Some indices such as the Dow Jones Industrial Average and the Nikkei 225 are price-weighted indices, which could be considered as the fourth method of indexing. As you can see from the list above, most of the aforementioned indexes are, in fact, weighted by market capitalization, which is currently the most popular method of index weighting, according to Shaw (2008).

Market capitalization weighting, in essence, means that the components in the index are weighted according to the total market capitalization – or value of their outstanding shares. In other words, every day an individual stock goes through price changes and thus it changes the stock index's value, where the impact that individual stock's price fluctuation has on the index is proportional to the overall market value of the company, which is calculated by multiplying the share price by the number of outstanding shares in a capitalization-weighted index. A common method of adjustment in market-cap-weighted indices is the free-float weighting. With this method a floating factor is assigned, this factor represents the proportion of outstanding shares that are held by the general public, as opposed to closely-held shares that could be classified as shares owned by the government, royalty, company insiders or by other means which causes the stock to be locked-in from the general public. For example, the Standard & Poors 500 index is weighted by free-float capitalization. Therefore it uses only the number of shares available for public trading and excludes the shares that are closely held. However, while market capitalization and free-float adjustments are the prevailing methods of index weighting because the weighting is done by market capitalization, this means that large companies dominate the index and the performance of it. According to Shaw (2008), this leads the performance to be momentum biased. Furthermore, the method of market capitalization systematically overweights overvalued stocks and simultaneously

it underweights undervalued stocks, this has lead to some research questioning the performance of market capitalization weighting, such as: “The traditional capitalization-weighting scheme is likely to be sub-optimal if prices are noisy and do not fully reflect firm fundamentals. We provide detailed mathematical proof for this claim and show that the cost of sub-optimal cap-weighting is equal to the square of the noise in the stock prices. Non-cap-weighted portfolios constructions do not suffer from this natural negative alpha associated with cap-weighting. We demonstrate this natural negative alpha empirically to support our claim.” (Hsu 2004, 16-17)

Another method of indexing is the equal weighting method, which, as the name states, is a method where the individual components in the index are weighted equally, so each company is represented in the same amount in the index. This method removes the overweighting and underweighting features that are present in market capitalization weighting. Where the market-cap approach is known to favor larger companies the equal weighting method is more favorable for smaller companies as they are of equal weight inside the index so this gives the opportunity for smaller companies as they have more power in the equal-weighted index than they would have in one weighted by market capitalization. However, since the role of small-cap stocks is greater in this method, this typically leads to higher volatility in the index. Furthermore, as this method requires constant selling and buying of stocks in order to keep the weight equal based on the performance of the individual stocks, this method also leads to higher transaction costs and expenses, simply because it requires much more trading, compared to market capitalization weighting. An example index using this method is the Standard & Poor’s 500 Equal Weighted Index (EWI), which was introduced in January 2003. According to Dash, Loggie (2009), the equal-weighted index tends to underperform compared to market cap weighting during strong bull markets but will perform better during bear markets. Additionally, in comparison to market-capitalization weighting, this method creates a different set of risk factor exposures and randomizes factor mispricings in the market.

The third method of approach is the fundamental weighting of an index. This means that there are fundamental criteria that are based on factors that could be, for example, dividends, sales, book value, earnings, *etc*. The key in fundamental weighting is that they can offer a higher potential return based on aggregate fundamental measures of the market as compared to an index that would be weighted by using market capitalization. According to Arnott, Hsu & Moore (2005), multiple fundamentally-based portfolios were able to outperform the S&P 500 by an average of 1,97% per annum over the 43-year test period. In the research, the authors offered four different explanations

as to why the fundamentally weighted index was able to outperform, which are superior market portfolio construction, price inefficiency, additional exposure to distress risk, and a possible mixture of the aforementioned explanations.

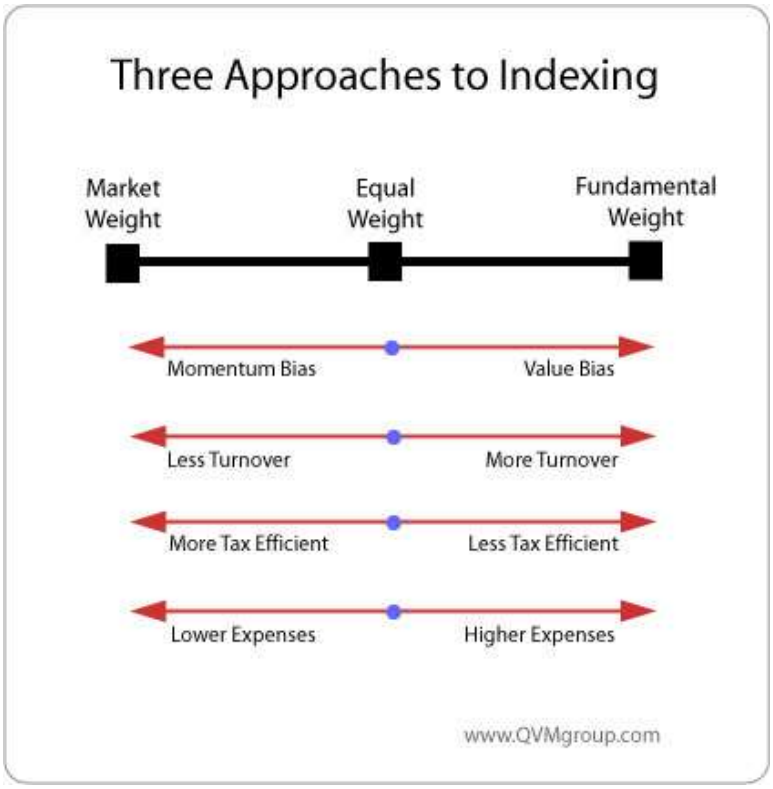

Figure 2. Three approaches to indexing
Source: Shaw (2008), QVMgroup.com

The figure above further illustrates the key approaches to indexing and how they perform. As mentioned earlier, the fourth approach to indexing would be price-weighted indices. A price-weighted index essentially means that the higher the individual stock price, the higher the weight of that stock is going to be in a price-weighted index, regardless of the actual size of the company or the number of shares they have outstanding. For example, in a price-weighted index, when one of the highly-priced stocks has a price increase, this tends to make the whole index increase in its value, even if the other stocks that are in the index would decrease in value simultaneously.

1.3. Smart beta investing

Traditionally diversification is made by obtaining different assets and asset classes to a portfolio, and thus minimizing risk; this diversification can be anything from just selecting a different sector

or industry, real estate, bonds, or even emerging markets. However, with smart beta strategies, diversification is focused across factors rather than assets or asset classes (FTSE Russell 2016). In other words, the goal of a smart-beta strategy can be defined as obtaining alpha – α, lower risk, or increase the diversification at a cost that is much lower than in traditional actively managed funds whilst being only marginally higher than in passively managed index funds. These strategies aim to capture excessive returns by using fundamental factors from factor investing, such as value and size, momentum, *etc*. The factors can be implemented as a single-factor or multi-factor models. A smart-beta investment strategy is most commonly used in equities but can be applied to fixed income, commodities, and multi-asset classes as well. UBS Asset Management defined smart beta as follows: "A smart beta ETF is one based on an index that has been custom-designed using stocks that have been selected for their potential to out-perform a specific market – rather than to simply replicate a market like a traditional ETF. A high-IQ version of an index fund, if you like." (UBS Asset Management 2017).

According to www.etf.com (2019), by asset under management (AUM), the most trending factor has been value as the Vanguard Value ETF (VTV). This is the most popular smart-beta ETF at the market, with $52 billion in total AUM. Another factor that has gained popularity during the past year in smart-beta strategies is low-volatility and the IShares Edge MSCI Min Vol U.S.A ETF (USMV), which has $36 billion in total AUM. These two are single-factor exchange-traded funds (ETFs). So while the smart beta strategy is not a new phenomenon in the field of finance, it has certainly attracted inflows of capital during the recent years. This is at least in part because the smart-beta strategy aims to mix and match the classical benefits of the active and passive style of management, where it has significantly lower costs due to the systematic nature of its core philosophy combined with optimization techniques traditionally reserved by active managers.

In smart beta strategies, the human element, such as day to day management and personal stock picking and attempt of market timing, which are common in actively managed funds, are removed by implementing algorithms and computerized company assessments as well as other technology-related tactics. Consequently, it is a mix and match and falls between a passive and an active strategy. Because of the heavy tech and quantitative nature of the smart beta strategy, it can offer risk-return potentials that from the investor's perspective are more attractive than a plain passive or active investment product. Furthermore, the smart beta strategies often rely on generic and publicly available factors, rebalancing periods that are pre-specified as well as weighting methods that are generally adequately simple in nature. According to Jacobs & Levy (2014), the simplicity

and the transparency of the smart beta strategy is likely the reason why the management costs are lower, and these attributes also make the strategies more accessible, especially for the less-sophisticated investors. As an example, the VTV ETF has an expense ratio of 0,04%, and the Vanguard S&P 500 ETF, which is a passive index fund tracking the S&P 500, has an expense ratio of 0,03%. Where the actively managed Vanguard funds, depending on the type and assets, the funds have expense ratios between 0,09% to 1,8%. This clearly demonstrates that the smart beta strategies aim to compare elements from each asset management style, and it certainly is a much cheaper alternative to active management in terms of expenses. It is also important to note the statistical fact, as mentioned in (O'Shaughnessy 2013), that investment into an average active manager has statistically been and will most likely be in the future a losing scheme.

1.3.1. The risks of smart beta strategies

Where the smart beta indices are created to be a more optimal method of indexation as compared to capitalization-weighting methods, and they try to receive excessive profits compared to market capitalization-weighted indices while reducing the bias that is the market capitalization, they are not risk-free or unbiased. For example, according to Amenc, Goltz & Martellini (2013), all the smart-beta strategies analyzed in the research exhibited a significant exposure to equity risk factors other than the market factor. Furthermore, strategies that operate on the fundamental of low volatility are well documented to be biased towards the least volatile stocks in the market. Additionally, the S&P 500 Low Volatility ETF (SPLV), which is a low liquidity ETF, is overweighted with less-cyclical sectors with stable cash flow, such as utilities, real estate, investment trusts, and consumer staples. These sectors are also known to operate as bond proxies, meaning that they act as government bonds, and generally offer higher yield compared to actual bonds. Interest rates and bond proxies have an inverse relationship, so when interest rates have been raised, or are scheduled to rise, it tends to hurt those sectors as investors are more likely to stay away from them.

The same could be claimed against strategies using momentum factor as the assets that have high momentum might soar and gain extensive profits only to see them diminish rapidly. Also, momentum as a factor is extremely tricky to master as transaction costs can make matters worse when rebalancing the portfolio, and where momentum stocks tend to have high returns, they also have high turnover as well. Therefore, if a portfolio is built on the basis of chasing price movement

rather than fundamentals, the portfolio will go through a lot of rebalancing, which in turn will continue to diminish the actual profits as the transaction costs proportionally increase. And to add insult to injury, if the global market goes through periods of high volatility, the momentum stocks tend to see price drops that are worse compared to the broader market. In addition, when considering value factor, unless the fund or index has worked through fundamentals, the portfolio in question might just be loaded with junk stocks that are ridiculously cheap for a reason, and as the technology has developed significantly over the past fifty years, a company that is in the information technology sector has a lot of patents or large brand reputation, *i.e*., has large intangible assets, the price-to-book ratio might not be applicable to the company in question, raising further questions about the authenticity of the smart-beta strategy itself.

1.3.2. The performance of smart beta strategies

While the strategy itself has seen a lot of research in the academic environment and in the finance industry, the actual performance of these smart beta portfolios compared to what academic studies have suggested has been inconclusive or at least questionable. According to (Malkiel 2014), The results of smart beta funds and ETFs that run with real money have generally been not producing the results that are suggested in academic studies. In the research, the author pointed out that the returns of funds with value and growth factors starting from the mid-1930s showed that both funds, in comparison, had relatively similar 70-year average annual returns. Where the growth factor managed to outperform until the mid-1960s, and the funds that used value factors outperformed through 2005. Furthermore, the ETF returns from the period of 1992 to 2013 show a similar pattern, as mentioned earlier. With the ETFs that had a value or growth fundamentals, the difference between these two fundamentals was only the fact that they had alternating periods of outperformance, but for the overall returns from the whole period, the outcome, in the end, was quite similar to each other. In addition, there was substantial volatility in the relative returns of small and large-cap portfolios. The study showed that the 30-year returns for Russell 1000 and 2000 indices are almost identical in nature and that there was no evidence that the outperformance in either of the indices would be consistent in the period that was chosen for the research. The only major difference between small and large-cap in the study was the fact that smaller companies had produced greater average annual returns compared to the larger companies during the period. The difference in percentage points was almost one percent for the period. It should be noted that this difference was from the data period of 2004 to 2013 when the ETFs were available for the Russell

1000 and 2000 indexes. It was also concluded in the aforementioned research that low-beta and momentum ETFs did not demonstrate any signs of admirable performance compared to the benchmark index.

However, Raza & Ashraf (2019), researched how market capitalization-weighted and smart beta strategies operated under Shariah-compliant equity portfolios. The research found out that where the market capitalization weighting methods lead to underperformance, the smart beta strategies had a positive result in terms of performance. Specifically, fundamental weighting and low-risk strategies increased the ability of Shariah-compliant equity portfolios to withstand an economic downturn by demonstrating resistance to market drawdowns. The data period for the research consisted of the period between 2003 and 2016. Where Tomberg (2019) researched the Baltic stock market and found out that low-risk, value, and liquidity factors in smart beta strategies reflected the outperformance compared to the market-cap-weighted benchmark index. In addition, the factors that focused on high risk and size had a tendency to underperform compared to the index. The data set in this particular research was from 2008 to 2018. Moreover, Savolainen (2018) researched fundamental indexation in the Finnish stock market, and the research pointed that every fundamental index used in the research, with the exception of cash flow, outperformed the market capitalization-weighted benchmark index. However, the author pointed out in the research that no excess return was statistically significant. The data set in this research consisted of the period from 2005 to 2018.

1.4. Transaction costs

The concept of transaction costs consists of expenses that incur when an investor buys or sells an investment product or service. These costs represent the labor required to bring a good product or service to the market. In the financial world, these costs include brokers' commissions and spreads, which are the differences between the price the seller paid for a security and the price the buyer pays. Depending on the investment product and service, the transaction costs may vary by quite a lot, but as this study is focusing on the Finnish stock market, the transaction costs in equities are the costs this study focuses on. For the perspective of the individual investor, in the Finnish market, the transaction costs will greatly depend on the broker as the transaction costs are differentiated differently between each broker and thus, the overall size of the portfolio as well as the number of trades, and the size of each trade will determine how low or high the transaction costs will be.

Table 1. Comparison between different brokers in the Finnish market

	The cheapest brokerage with a normal pricing system			
Brokers	**Passive**	**Active**	**ETF**	**Median**
1. Degiro	1	1	1	1,0
2. Lynx	-	3	2	2,5
3. Mandatum Trader	3	2	4	3,0
4. Nordea	2	6	2	3,3
5. Nordnet	4	4	6	4,7

Source: Sijoittaja.fi (2019), Brokerage comparison

In the table above, all the different portfolio sections are simulated with four different portfolios. The passive portfolios are constructed as follows, the first portfolio has a size of 5 000€, the size of the trades is 500€, and the number of trades per year is 4. The second has the same portfolio size and size of trades, but the amount of trades is 12 per year. The two remaining simulations' portfolio size is 100 000€, the size of trades is 2 500€ in both simulations, but once again, the trades per year differ, the first having four trades and the second having 12 trades per year. All investments are made into Finnish equities. Thus, in the Helsinki stock exchange, for a passive portfolio, the best brokerage would be Degiro as they charge 2€ + 0,038% per trade, therefore if the individual investor is making just a few trades per year, as long as the amount of each trade surpasses 208€, Degiro will remain the best option for a passive investor.

The active portfolios in the table once again have four different simulated portfolios, where two are investing in Finnish equities, and two are investing in ETFs listed in Germany. Here, the portfolio sizes are 50 000€ and 300 000€, respectively. The amount of trades is 50 trades per year in all the portfolios, and the size of the trades is 3 000€ and 10 000€, respectively, where the smaller trades are made with the smaller portfolio and vice versa. For these four simulations, Degiro once again remains the best option for individual investors. Finally, the ETF portfolio simulations follow the same principles as the passive portfolios in terms of portfolio size, amount of trades per year, as well as size per trades, but they only invest in ETFs that are listed in Germany. Here Degiro is once again the best option in terms of transaction costs. Therefore, Degiro, as a brokerage, has the top spot in Table 2 above, having scored the top spot in each simulation. In addition, the median section of the table above shows how well each brokerage

firm performed in each section combined in the simulation, in terms of transaction costs. Moreover, for an individual investor, it is possible to further reduce transaction costs in certain brokerage firms in Finland by belonging to Osakesäästäjien Keskusliitto (OSKL) or Akava, which offers membership benefits for certain brokerages. These are trade unions or labor unions that operate in Finland and require membership fees each year from their members while offering miscellaneous benefits to their members.

While factor investing, fundamental indexation, or smart beta strategies have received quite extensive coverage in terms of research in finance, transaction costs remain an ongoing argument as the quantitative theories seldom include transaction costs or taxation in the calculations. Furthermore, while transaction costs are a well-documented entity in the financial markets, it is rarely adjusted for calculations, especially in factor investing research or in the research focusing on the Finnish stock market. However, Westerholm (2003) researched the impact of transaction costs on turnover, asset prices, and volatility in the Finnish and Swedish markets and how the Finnish security transaction tax reduction affected this. The author concluded that transaction costs have remained higher compared to Sweden in the Finnish markets and stated that, by lowering the transaction costs of the Finnish markets would increase the efficiency of the market.

Tomberg (2019) researched the performance of smart-beta strategies in the Baltic stock market and found that the transaction costs affected the price-to-book strategy the most, where the returns the strategy generated were reduced by 23,4% in the long term when adjusted with transaction costs. While Rantapuska (2008) examined that investors participate in overnight trading around ex-dividend day, if the relationship between transaction cost and dividend yields is beneficial, in other words, if the transaction costs are low enough and the dividend yield is high enough, investors are willing to participate in trading on ex-dividends day. According to Jones (2002), a high turnover rate will incrementally increase the transaction costs investors are required to pay, thus making them require higher returns to compensate with the rising costs.

2. METHODOLOGY AND DATA

2.1. Data Collection

The research was done by using the data of companies that are listed on the Finnish stock market; in other words, the study used data from publicly listed companies that were listed on Nasdaq Helsinki in November 2019. The author used Thomson Reuters Eikon and Yahoo finance to retrieve the data for the listed companies. Altogether there were 130 companies in the dataset, and companies that were delisted during the research period or lacked the sufficient data to be excluded in the research were removed from the research as the data was not possible to obtain.

After cleaning the data, there were 70 companies remaining. The companies that were left out of the dataset consisted of companies that were either listed after 2006 or delisted at some point during the research period or lacked necessary data regarding the research. This included, but was not limited to, having negative total revenues and missing key ratios. The chosen research period for the dataset is 13 years from 2006 to 2019, resulting in 55 quarters in total.

The dataset contained such fundamental information as historical market capitalization, enterprise value to EBITDA ratio (EV/EBITDA), Total revenue. Price information included daily open, close, high, and low prices, which allowed us to calculate overnight gaps. As the data was processed in Excel, the author decided to upload the Excel file to Google Drive, which can be retrieved from *https://drive.google.com/open?id=1ruSXWiuFn8xXDLy16ZSXztAAhz_XAHDN*

2.2. Stock portfolio construction

The author decided to construct a single benchmark index from the data set by weighting the benchmark index by market capitalization from the sample so the smart beta portfolios can be compared to an index. The index consisted of 20 largest companies by market capitalization. The benchmark index was created in order to more accurately compare the transaction costs related to investing as well as having an index that is constructed in a similar manner compared to the strategies used in the study.

Furthermore, the intention was to create portfolios consisting of 20 stocks by applying the smart beta strategies that would provide higher returns than the benchmark. Thus, stocks that had the most robust characteristics per each fundamental were chosen to the portfolios. The weight of the portfolios was determined with the fundamentals; the best fundamentals were assigned the largest weight of the total portfolio. In addition, with the given data, the fundamentals were assigned to following single-factor strategies. The factors used in the research are size, value, momentum, and market capitalization, which was used as the benchmark index.

To account for the transaction costs, overnight gaps were used to estimate a possible loss associated with the existence of bid-ask spreads (explained in more detail in Section 3.2), and a percentage rate of 0,25% was used as the buy and sell fee. This number was selected because most Finnish brokerages have a similar fee ratio for the Finnish stock market. The dataset from available stocks was extracted to Excel, and all the calculations done in this study were done via excel.

The Size factor essentially presumes to give larger exposure to smaller firms with higher risk. For this factor, the revenues of the companies were used to demonstrate the factor. This was done by ranking the companies from smallest to largest and then selecting the 20 companies with the smallest figures in terms of revenue to the portfolio. Thus companies with the smallest total revenue, *i.e.*, the highest risk, were selected to the portfolio, as according to Fama & French (1993), companies with smaller sizes tend to have increased profits over time relative to larger companies. Rebalancing was done every quarter, and thus, the companies with the lowest revenues were selected every quarter.

For the value factor, enterprise value to EBITDA (EV/EBITDA) was used. Typically, this metric is used to compare the value of a company, including all debt the company has, to the company's cash earnings minus non-cash related expenses. In this particular fundamental, the idea is that the smaller the value ratio, the more weight should be assigned to the company as the companies with smaller EV/EBITDA ratios are considered to be cheaper in terms of valuation. Twenty companies with the smallest EV/EBITDA ratio were selected every quarter.

Momentum factor can be defined as the velocity of price changes in stock, or any other tradable instrument. This essentially assumes that when the price changes, they tend to create a snowball-effect where the change in the price keeps increasing. With the momentum factor, rebalancing was done quarterly as with other fundamental selected in this study. Furthermore, with the momentum

factor, the allocation of the portfolio was limited to five percent per each individual stock selected to the portfolio. This was done in order to have better risk management for the momentum strategy portfolio (Miffre, & Rallis, 2008) and (Fuertes *et al*. 2010). According to Cooper *et al*. (2004), during an expansionary period, the momentum strategy often generates profits but suffers outside the expansionary period.

All of the factors described previously were constructed as single-factor strategies in this research, based on their respective financial valuation metrics that were described in the respective sections of each fundamental. These were combined with weighting the stocks based on the respective performance of the financial valuation metrics, and fundamental-weighting was executed in order to avoid market mispricing, market capitalization was used to create benchmark indices to further compare the performance of the different weighting methods. The rebalancing for the portfolios was done quarterly in order to avoid poor allocation in each particular portfolio.

2.3. Market environment

As the dataset began in 2004, it is important to take into account the financial crisis of 2008-2009 as it affected the global economy and certainly the Finnish market as well. This is important to note in this research as this will play a role in the results of the research; more specifically, the recession itself is quite a large anomaly in the market data, and this will likely affect the different single-factor fundamentals in terms of the results.

For example, the momentum factor tends to underperform during a bear market or market downturn. Cooper *et al*. (2004). In Finland, the recession came a bit later compared to the United States of America, which is generally viewed as the starting point for the financial crisis of 2008, as the gross domestic product (GDP) of Finland grew 4,9% in 2007. However, in the year 2008, it declined by 0,2%, and in 2009 it fell 8,8%. The unemployment rate in Finland shifted from 6,9% in 2007 to 6,4% in 2008 and increased to 8,2% in 2009. According to Laitamäki and Järvinen (2013), the OMX Helsinki stock market index declined from 11627 to 5365 between December 2007 and December 2008, and the index was at its lowest rate ever in March 2009 which was 4914. The globalization and freedom of trade had an impact on the Finnish economy as the portion of foreign trade in production has grown remarkably, and a lot of general production is directed towards foreign trade. Before the crisis, the Finnish export structure was focusing on information

technology-related goods and services as the global economic boom raised the demand for such types of products and services. (Bank of Finland, 2011).

Thus when the global demand declined due to the recession, it affected the Finnish economy quite badly. According to Kaitila (2015), the decline of the Finnish GDP was more severe than the decline of the Swedish GDP, where Sweden managed to rise 7% above its 2007 GDP during 2012, Finland was unable to climb to pre-recession levels in terms of GDP. One definite reason for Finland dragging behind compared to Sweden is the fact that Sweden uses its own currency, while Finland belongs to the euro area.

3. RESULTS

3.1. Performance of the selected strategies

In the research, the benchmark index, which is weighted by free-float market capitalization, ended the whole data period of 55 quarters with just +3,25%. The benchmark index used in this research differs from OMX Helsinki 25 in the sense that the benchmark index is a free-float market capitalization index, whereas the OMX Helsinki 25 is a restricted market capitalization index. The explanation for the performance of the benchmark index is the fact that as the largest company by market capitalization in the Finnish stock exchange is Nokia. The company essentially lost its leading market share as a mobile phone manufacturer during the aftermath of the financial crisis and was reconstructed as a telecommunications and network company Alcacer, *et al*. (2014).

Table 2 shows the performance of smart beta strategies compared to the benchmark. The size factor, where the small-cap companies were selected for the portfolio, was the worst performer out of all the factors used in the study, including the benchmark index. It fell -76,12% compared to the benchmark index. The best performer of the selected strategies was clearly EV/EBITDA.

Table 2. Performance of smart beta strategies without costs compared to the benchmark index and OMXH25 (2006-2019).

Strategy	Metrics	Return	Performance compared to the benchmark index
Benchmark	Market Capitalization	+3,25%	-
Size	Revenue	-75,35%	-78,60%
Value	EV/EBITDA	+573%	+569,75%
Momentum	Top Performers	+133,33%	+130,08%
OMXH25 (nasdaq)	10% Limited Market Cap	+65,50%	+62,25%

Source: Compiled based on authors' calculations.

Considering the table above, during the selected research period of 2006 to 2019, if an individual investor would have invested into the benchmark index, that investment would have given a return of just +3,25% to the investor. Thus, if an investor had been investing in the benchmark at the beginning of the data period, assuming no transaction costs, this investment would have grown by 3,25% in a period of 13 years. However, selecting either the value or momentum strategy, this individual investor would have significantly beaten the OMXH25 Index that is the major index of the Finnish stock market. For comparison, if the same individual investor would have invested the same amount at the beginning of the same period of 2006 to 2019 to the OMXH25 index, this would have profited the investor with +65.50%. (Nasdaq Helsinki). Then again, if an investor would have invested in the Value strategy, that investment would have grown to +573% in a period of 13 years, assuming no transaction costs.

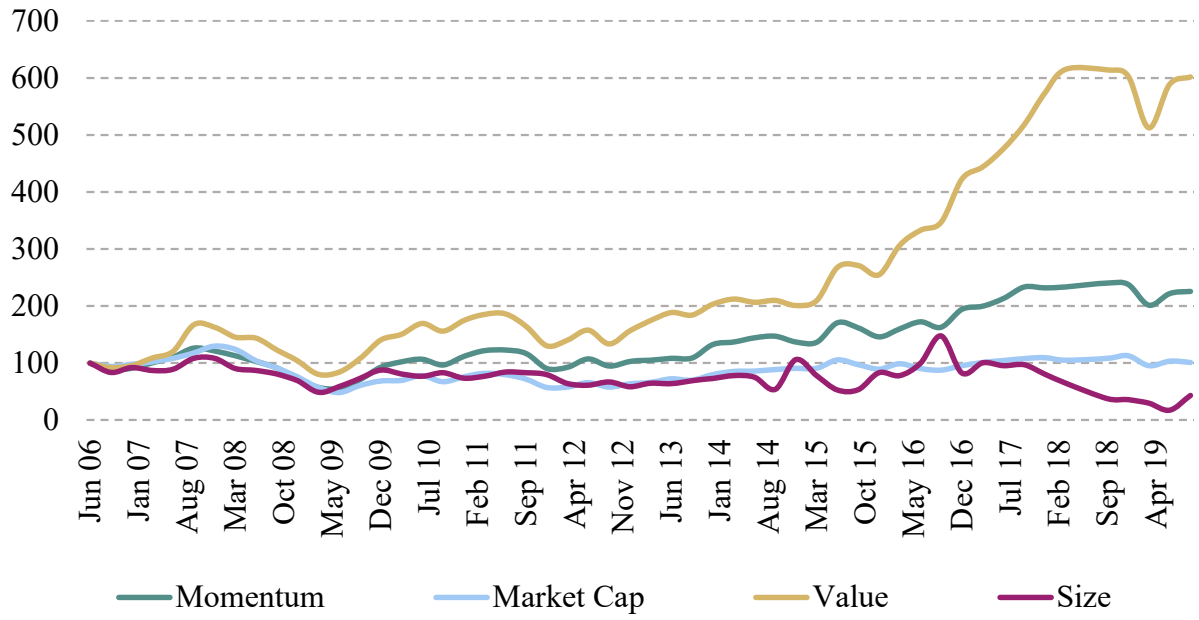

Figure 3. Performance of the indices without transaction costs (2006-2019).
Source: Compiled based on authors' calculations.

Figure 3 above allows for further comparison between the strategies. This figure focuses on the indexation of each selected strategy by forming a points-based system to capture performance. From this chart, it is clearly visible that the Value strategy was the best performer. Furthermore, the results of the financial crisis of 2008 are visible at the very beginning of the timeline. This is the section of the figure, where all selected strategies decline in value.

Table 3 represents how much the individual investor would have gained in terms of percentages as a return when using the selected strategies, where the average returns are available as average yearly as well as quarterly returns. Furthermore, the table also shows the standard deviation (volatility) of returns, which essentially measures how much price change there is; that is how much the stocks' returns are deviating from the average measure of returns. Finally, the Sharpe ratio was calculated in order to calculate the risk-adjusted return of the selected smart beta strategies.

Table 3. Quarterly and yearly average returns, volatility, and Sharpe ratio (2006-2019).

Strategy Index	**Average quarterly returns (%)**	**Volatility (%)**	**Sharpe ratio**	**Average yearly returns (%)**	**Volatility (%)**	**Sharpe ratio**
Benchmark	0,60%	10,34%	0,06	2,31%	25,58%	0,09
Size	1,36%	32,24%	0,04	5,24%	41,43%	0,13
Value	4,36%	12,76%	0,34	16,82%	32,05%	0,52
Momentum	2,23%	11,57%	0,19	8,58%	28,95%	0,30

Source: Compiled based on authors' calculations.

As stated in the table above, the highest average return from the selected strategies is the Value strategy, which had average quarterly returns of 4,36% as well as average yearly returns of 16,82%. The benchmark of the study that is market capitalization-weighted was the worst performer in terms of average quarterly and yearly returns, with average quarterly returns of 0,60% and average yearly returns of 2,31%.

Considering the volatility of the strategies, the Size strategy had the highest average quarterly and yearly volatility. The aforementioned strategy had 32,24% quarterly volatility and 41,43% yearly volatility. This means that from all of the strategies, this is the worst strategy to use (as the increased risk was not compensated by corresponding return). This is because the higher the volatility, the higher the price swings of the strategy, which translates to an increased or unnecessarily high risk. From the strategies used in this study, the benchmark index had the lowest quarterly and yearly volatility. However, the Momentum strategy only had slightly higher quarterly and yearly volatility, compared to the benchmark, the quarterly volatility of the

momentum strategy was only 1,23% higher, and the yearly volatility was 3,37% higher compared to the benchmark.

Finally, the Sharpe ratio is used to measure the risk-return relationship of the investment. The way the Sharpe ratio is interpreted is that a higher ratio translates to a better performance in relation to the risk of the investment. Results in Table 3 show that the Value strategy had the best Sharpe ratio as the quarterly ratio was 0,34, whereas the yearly was 0,52. The benchmark had the lowest Sharpe ratio of all the selected strategies, which was 0,06 and 0,09, respectively.

3.2. Transaction costs of the selected strategies

Transaction costs are costs that are related to trading in financial markets. They usually consist of fees such as brokerage charges, taxes, spreads, and the overall cost of investing. For instance, Ng *et al*. (2008) estimated yearly transaction costs as the sum of commission costs and spread costs to be around 3% per year, depending on the investment strategy used.

As this study focused on smart beta strategies that were rebalanced quarterly, transaction costs are highly likely to occur. In the study, taxes were excluded, but brokerage charges were used as a buy and sell fee, the amount of the buy and sell fees were taken from the average buy and sell fee of Finnish brokerages, the average brokerage percentage charge amounted to 0,25% per transaction at the time of this study. However, this study excluded the minimum fee, which is often a euro-based amount, for example, 9€, rather than a percentage. The fee structure is often depicted as the minimum flat euro-based amount plus the percentage fee. Some brokerages in Finland offer different fee levels, which can be based on the monetary amount of the investment or the number of trades a customer executes in each month.

In this study, spreads were estimated by using overnight gaps as the proxy for the buy and sell spreads. Furthermore, the author decided to use a multiplier for the quarterly overnight gap percentages in order to simulate the spreads more accurately as some of the stocks had quarterly overnight gaps in excess of five percent. As this study had different strategies using different stocks, it makes sense to assume a different overnight gap multiplier per individual strategy. Following this chain of logic, the size factor was assigned the highest multiplier ratio of 0,3 as

small-cap stocks are often less liquid in the market, compared to large market capitalization stocks, so it makes sense that the buy and sell spread differences are also higher when the trading volume is lower. Whereas the market capitalization benchmark, as well as the value strategy, assumed a multiplier ratio of 0,1 as these stocks are extremely likely to be very liquid, compared to the small-cap stocks. Finally, the momentum strategy was assumed a multiplier ratio of 0,2 as due to the nature of the strategy as the momentum-based strategies do not rely on fundamentals, like the other strategies constructed in this study, it can be assumed a higher multiplier because the momentum strategy itself is picking the best performers each quarter. Thus the author expects to see fewer liquid stocks picked during certain quarters and vice versa.

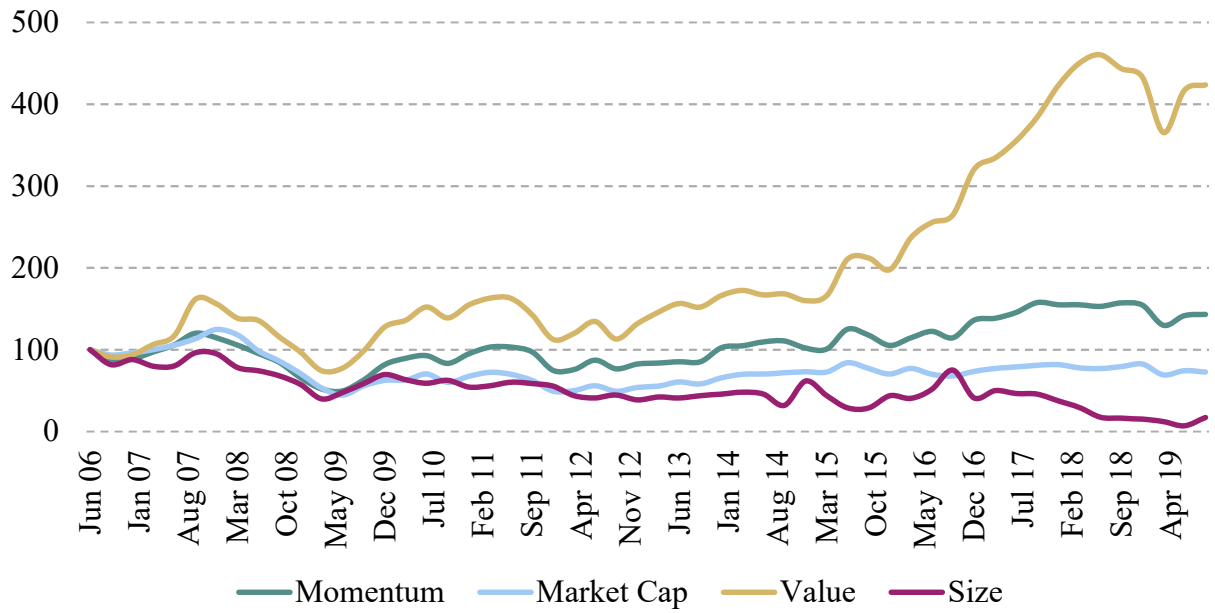

Figure 4. Performance of the indices with transaction costs accounted for (2006-2019).
Source: Compiled based on authors' calculations.

Figure 4 shows the performance of the selected strategies with transaction costs added to the method of construction. The method of construction for these indices is the same as in Figure 3. Comparing Figure 3 (of section 3.1) and Figure 4, the indices behave quite similarly, with the major difference being in the end results. For example, Figure 3 Value index ended at 673,00, whereas Figure 4 Value index ended at 470,75, meaning that when taking transaction costs into account, the difference between performance is 202,25 points. This is the largest difference in terms of index points as the Value strategy was the best performer, and therefore, it was also the most vulnerable strategy to transaction costs. On the other hand, if the lowest performer, which was the Size factor, is compared between these two figures, the difference is not significant. In

Figure 3 (of section 3.1), the ending value for the Size index is 24,65 as compared to 9,79 in Figure 4. From these results, we can conclude that transaction costs correlate with profits in the sense that the more profitable a strategy is, the more the transaction costs affect the profitability.

Table 4. The return of selected strategies with and without transaction costs (2006-2019).

Strategy Index	**No transaction costs**	**Transaction costs**	**Average quarterly returns**	**Average quarterly returns (with costs)**	**Average yearly returns**	**Average yearly returns (with costs)**
Benchmark	+3,25%	-26,29%	+0,60%	-0,02%	+2,31%	-0,09%
Size	-75,35%	-90,21%	+1,36%	-0,34%	+5,24%	-1,33%
Value	+573%	+370,75%	+4,36%	+3,70%	+16,82%	+14,27%
Momentum	+133,33%	+46,83%	+2,23%	+1,37%	+8,58%	+5,28%

Source: Compiled based on authors' calculations.

In the table above, the author compiled data on how the transaction costs of each individual strategy affected the total returns as well as the average quarterly and average yearly returns. From this data, one can conduct that the highest fluctuations relative to total return are present in the strategies which were the top performers of the study. For example, the Value strategy suffered the largest drop in total returns when taking transaction costs into account. However, when considering the average returns, both quarterly and yearly, it is quite clear that there is not any significant change on how the averages performed during the time period of the data set, with the exception of the Size strategy where the average yearly returns changed 6,57% when the transaction costs were added to the calculations.

In addition, the Benchmark and Size factors dropped to negative values on both quarterly and yearly average returns when the costs were considered. This phenomenon can be explained, at least partly, with the fact that the profits of these strategies were not that profitable without the costs, to begin with. When taking a closer inspection into the Benchmark strategy, the lackluster performance can be accredited to a single company, the largest one in the Finnish stock market by market capitalization, as explained at the beginning of section 3.1. This information, combined with the nature of the strategy, which is that it is free-floated, the poor performance of the largest

company tends to drag the whole index down. Finally, the Size factor, which is a small capitalization strategy, tends to suffer from increased volatility, which can be interpreted as the higher the volatility, the higher the risk. The fact that this is a highly risky strategy, to begin with, incorporated into the fundamentals of the strategy, a single factor, free-float strategy, and thus the story is relatively similar to both of the strategies. The only essential exception is the two different stocks that are responsible for dragging their respective indices to the ground.

3.3. Overview of the individual strategies

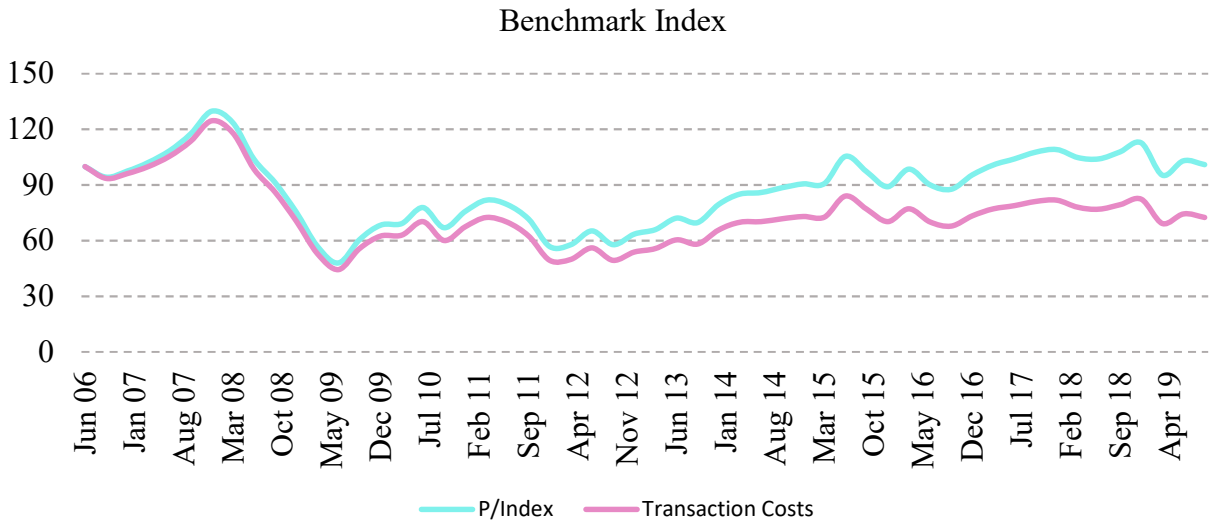

Figure 5. Benchmark index with and without transaction costs (2006-2019).
Source: Compiled based on authors' calculations.

The market capitalization-weighted benchmark index performed poorly due to over selecting a company that has had hard times after the financial crisis of 2008, as explained in section 3.1. Thus, risk management remains a crucial component of fundamental indexation. Figure 5 shows that after the financial crisis, the benchmark index adjusted with costs did not recover very well after the initial spike that occurred directly after the recession. The index without costs ended the data period with minimal returns, but Figure 5 demonstrates that the transaction costs ended up diminishing the profits in the end. However, the transaction costs cannot be offered as the only explanation for the ending results as the ask and bid spread estimate for the benchmark strategy

was the lowest compared to the other strategies due to the assumption that large-capitalization stocks have better liquidity and thus smaller spreads.

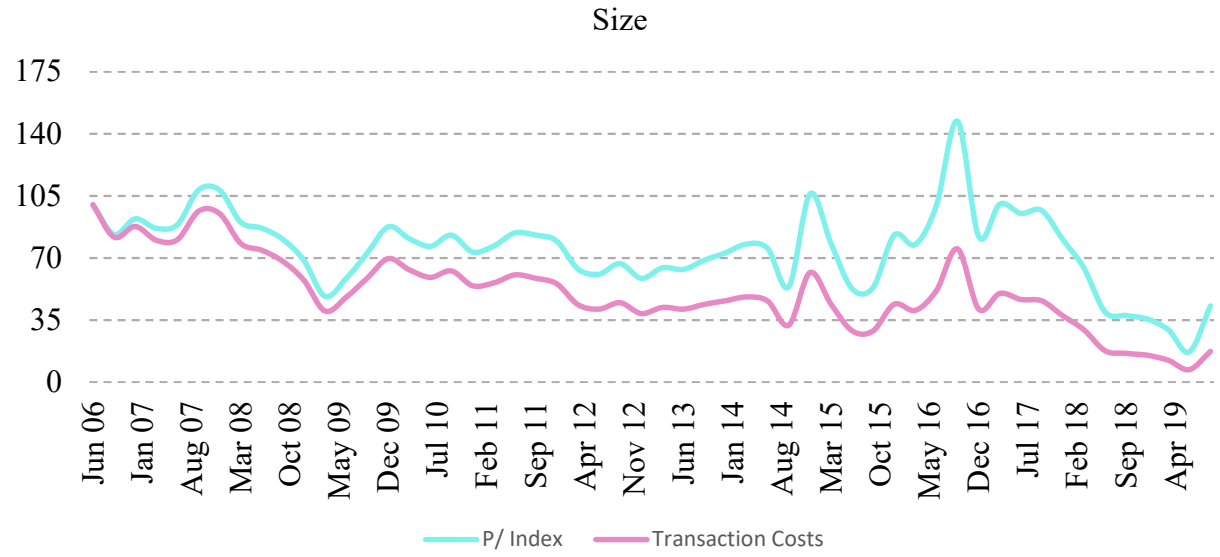

Figure 6. Size strategy with and without transaction costs (2006-2019).
Source: Compiled based on authors' calculations.

The Size strategy had the highest volatility out of all the strategies used in the study. It was also the worst performer out of all the selected strategies. Figure 6 demonstrates the volatility as the chart contains multiple peaks and bottoms. Furthermore, due to the combination of extreme volatility and the financial crisis of 2008 the Figure 6 shows how the transaction costs can affect a strategy, essentially rendering it unable to recover from the crisis, due to the transaction costs preventing profits. This weakening of profitability is demonstrated by the fact that the cyan line, which represents the strategy without costs, has three peaks where it generates profits after the economic downturn. In contrast, the pink line, which is adjusted for the transaction costs, never proceeds to rise above the starting value of 100. Therefore, after an economic downturn, a high-risk high-reward strategy can have increased risk due to the transaction costs. In addition, a good risk management model is required as the poor performance of the strategy cannot be solely attributed to the transaction costs.

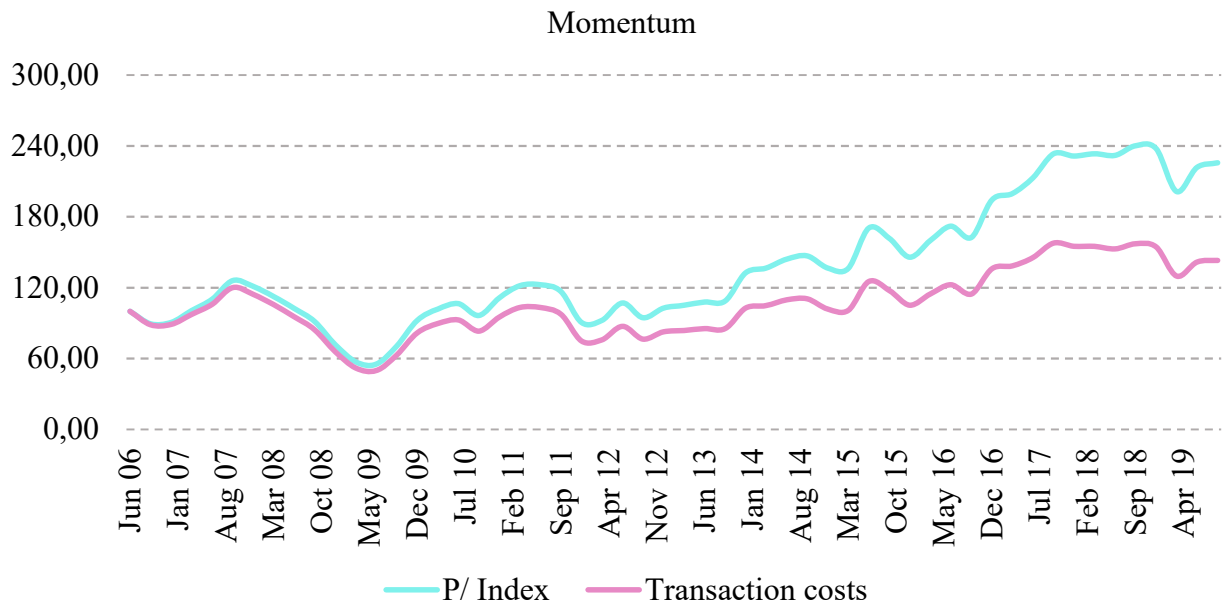

Figure 7. Momentum strategy with and without transaction costs (2006-2019).
Source: Compiled based on authors' calculations.

The Momentum strategy was one of two strategies constructed in this study that performed relatively well in the sense that it managed to accrue a significant amount of profit during the data period. Figure 7 shows that the Momentum strategy did not perform significantly worse compared to other strategies used in this study during the financial crisis of 2008. Albeit this is most likely explained with the fact that the particular strategy at hand had better risk management because of the restrictions set to the momentum strategy, as explained in section 2.2. In addition, Figure 7 demonstrates how the transaction costs decrease profit over time as the ending results differ significantly between the cyan line, which has no costs, and the pink line, which represents the cost adjusted strategy.

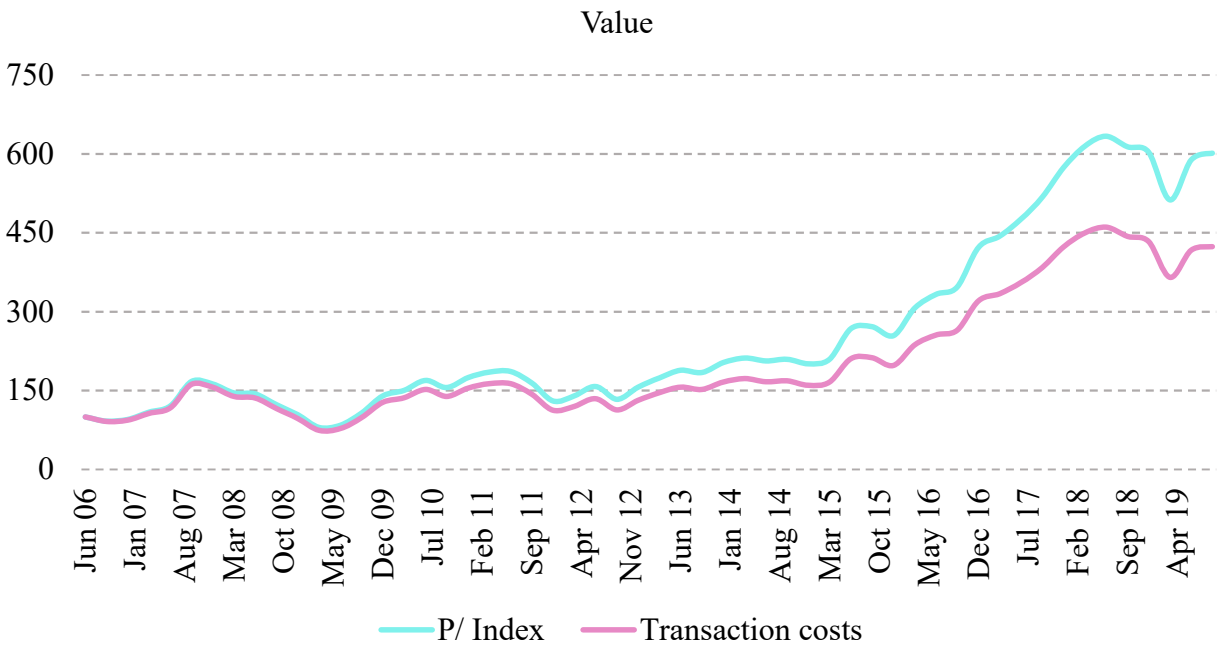

Figure 8. Value strategy with and without transaction costs (2006-2019).

Source: Compiled based on authors' calculations.

Figure 8 shows the Value strategy, which was the best performer out of all the strategies constructed in this research. The figure shows that the transaction costs caused the ending value difference of 202,25 points. Furthermore, the strategy had the fastest recovery in terms of profitability after the financial crisis of 2008, which was included in the data period. The Value strategy had one of the lowest multipliers for the overnight gaps, which, in essence, means that the strategy had smaller transaction costs compared to the other strategies used in the study. Therefore, the post-crisis recovery effects of a value-based strategy seem to be better compared to size, market capitalization, and momentum.

CONCLUSION

In this research, the focus of the study was to look over how three single-factor smart beta strategies perform (value, momentum, and size) with transaction costs accounted for. The data used in the thesis was from the Finnish stock market from 2006 to 2019. In addition, the thesis asks the question if accounting transaction costs to the performance of fundamental indexation strategies, does the existence of transaction costs nullify the results on the aforementioned strategies reported in previous studies. The transaction costs used in the study consisted of a regular brokerage fee based on data reported by multiple different Finnish brokerages as well as estimating potential losses due to bid-ask spread based on stocks overnight gaps.

The study found out that smart beta strategies that generate large profits tend to suffer the most from the associated costs of investing. This is due to the compounding nature of all investments. The best performing strategy from the study was the Value strategy when adjusted for costs. It gained +370,75% in 13 years. The worst performer of the tested strategies was the Size strategy; it decreased 90,21% during the data period. Additionally, if a smart beta strategy has high volatility and the operating period of the strategy includes an economic downturn, the strategy is heavily affected by the downturn. Furthermore, the liquidity of the stock or the market itself is an important factor in the inability of post-crisis recovery. In this study, the Size strategy was assumed the lowest liquidity as the Finnish market is relatively small and due to the assumption that small companies that are listed in the Finnish stock market have low trading volumes. The low liquidity increases the buy and ask spreads of the stocks, further increasing the overall cost of investing. Consequently, the special circumstances of the market can render a high-risk high-reward strategy suboptimal.

The strategy that is often used as the benchmark of smart beta investing, market capitalization, can suffer the same fate as the high-risk strategy due to special circumstances. In this study, the benchmark index failed because the company that was assumed the largest weight essentially had to reinvent themselves in order to survive as a company. This further enhances the argument that market capitalization based smart beta strategy is not necessarily optimal or capable of high returns.

The results indicate that when constructing an investment strategy, specifically a smart beta investing strategy, the transaction cost should be taken into consideration as the costs have a direct

effect on the performance of the strategy. For future research, the author suggests that a longer time period for the data set should be implemented, as 13 years is a relatively short period for investing, and the results from a longer period of data would further highlight the question of transaction costs in investing. Furthermore, considering investing from an individual investor's perspective future research should take taxation into consideration to get more accurate evidence from the relationship of the returns and cost of investing. Finally, performing Monte Carlo simulation for smart beta strategies would enhance the risk management of the strategies itself and could help further to determine the performance of cost-adjusted smart beta strategies.

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APPENDICES

Appendix 1. Figures combining all the strategies

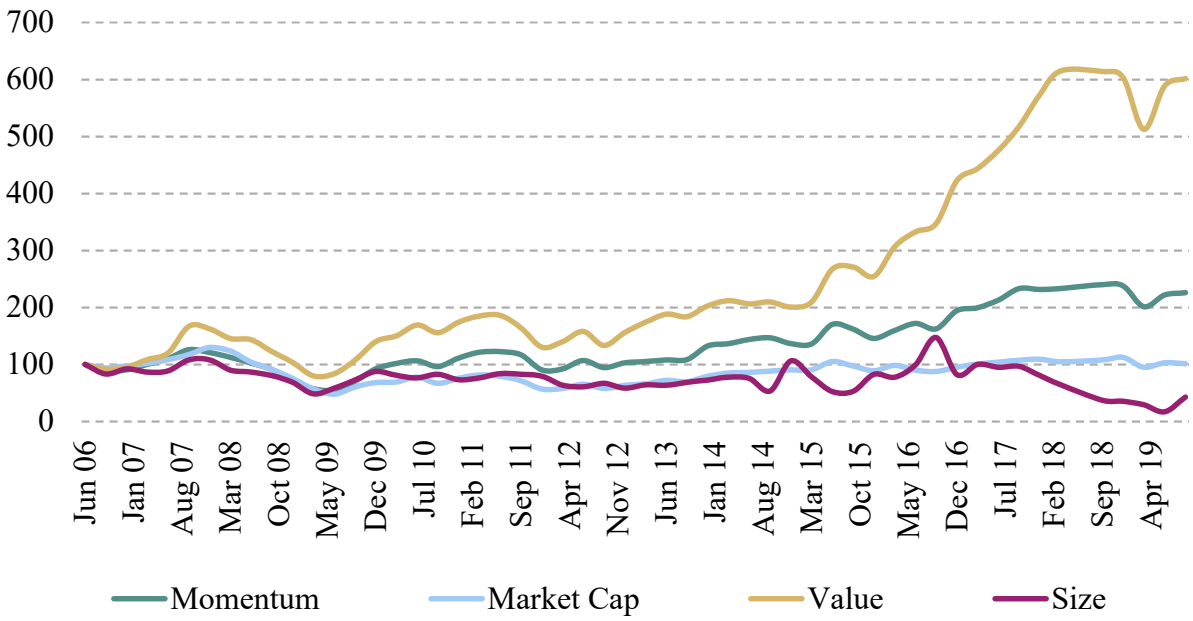

Figure 3. Performance of the indices without transaction costs (2006-2019).

Source: Compiled based on authors' calculations.

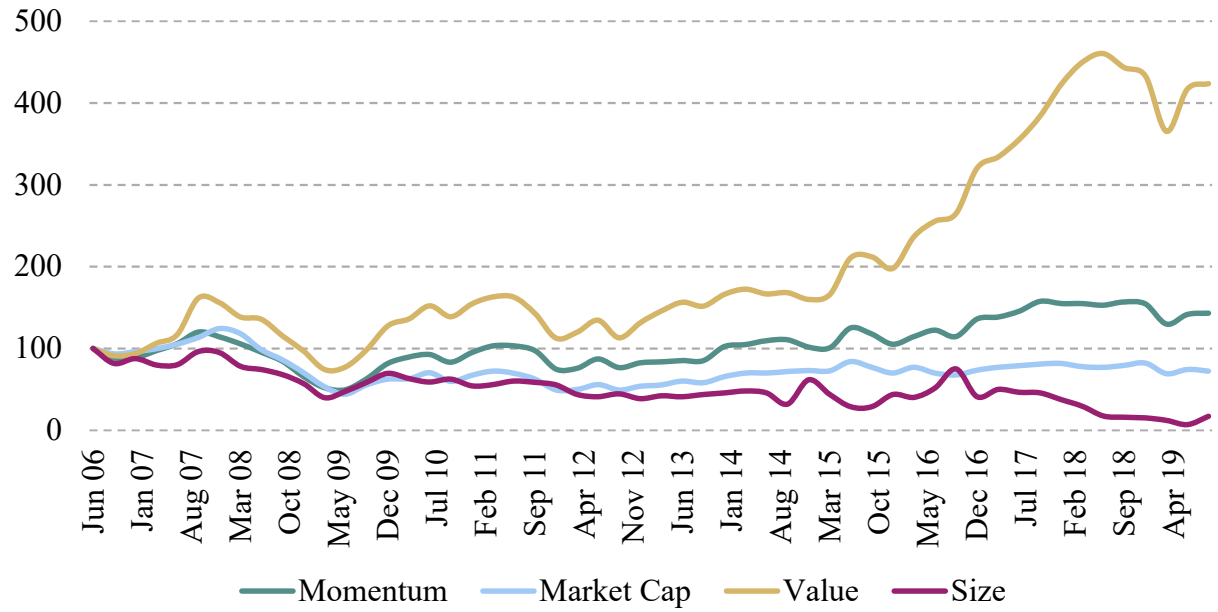

Figure 4. Performance of the indices with transaction costs accounted for (2006-2019).

Source: Compiled based on authors' calculations.

Appendix 2. Figures of the individual strategies

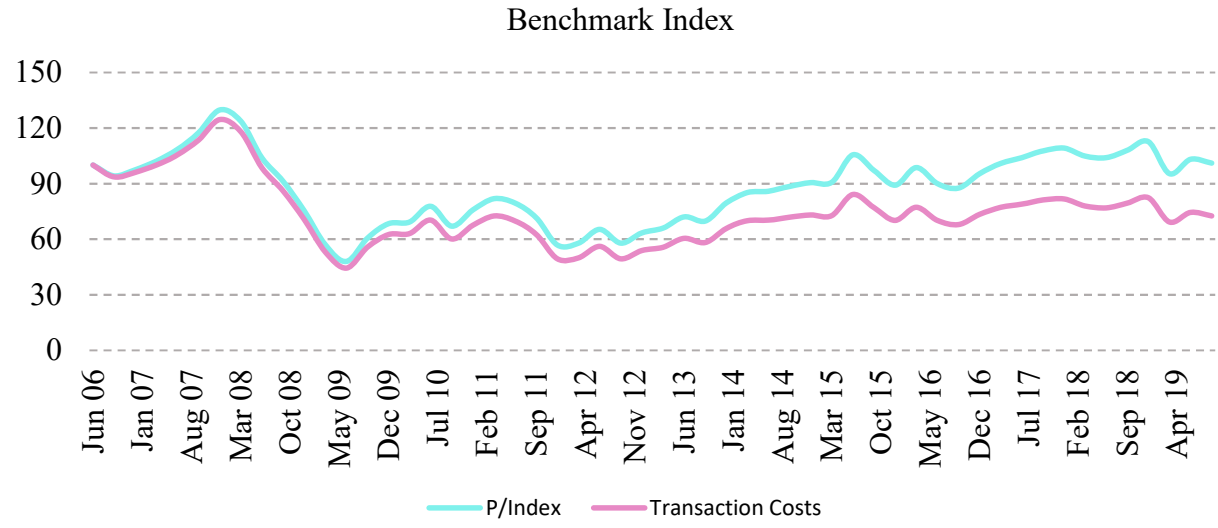

Figure 5. Benchmark index with and without transaction costs (2006-2019).

Source: Compiled based on authors' calculations.

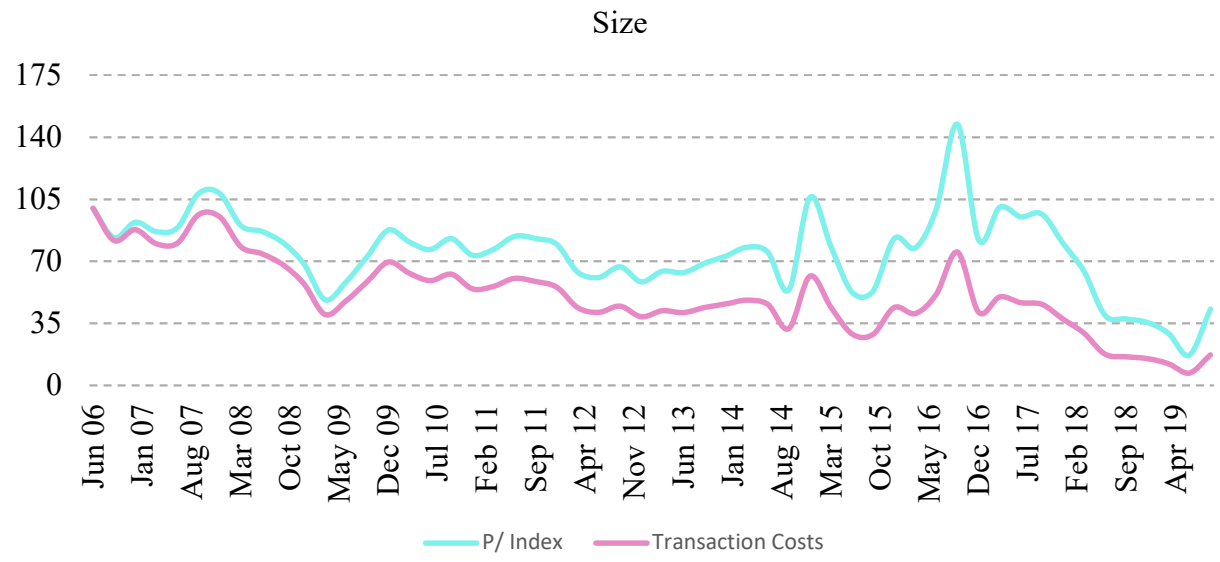

Figure 6. Size strategy with and without transaction costs (2006-2019).

Source: Compiled based on authors' calculations.

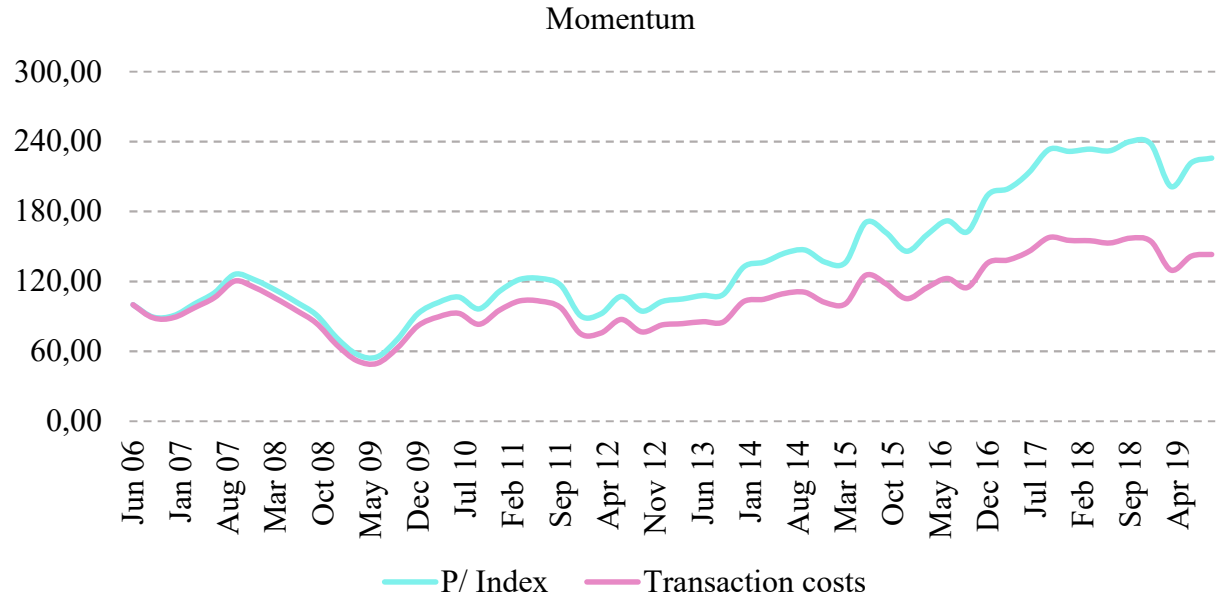

Figure 7. Momentum strategy with and without transaction costs (2006-2019).

Source: Compiled based on authors' calculations.

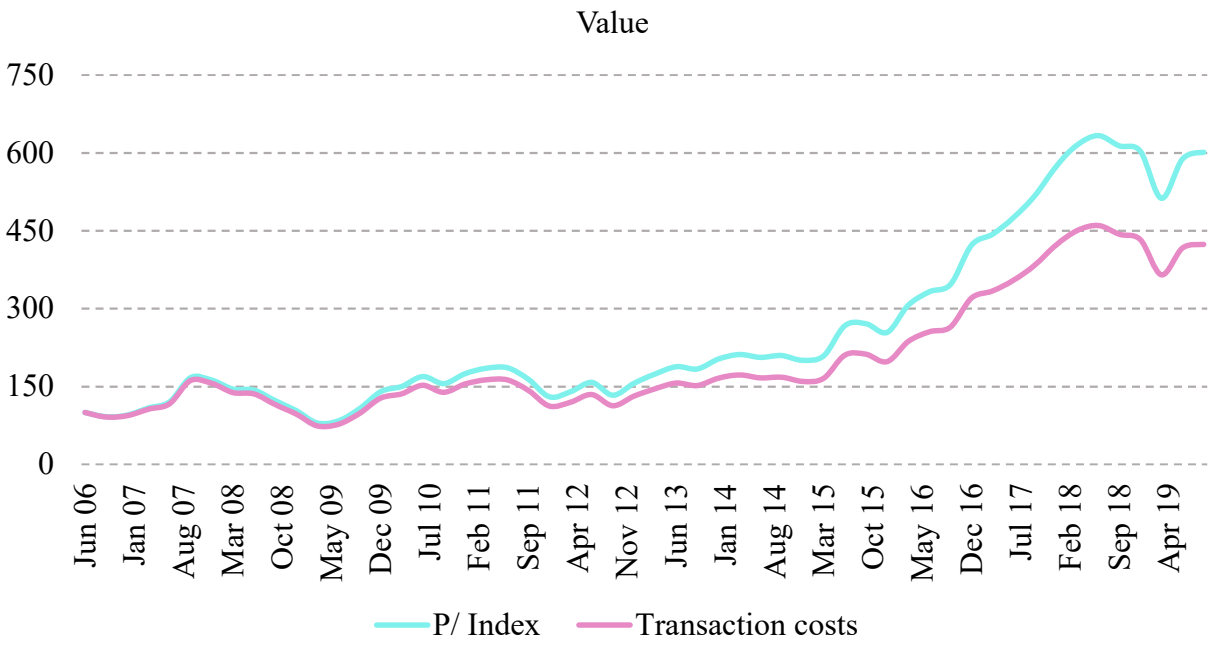

Figure 8. Value strategy with and without transaction costs (2006-2019).

Source: Compiled based on authors' calculations.

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