Performance Evaluation of Fundamental Indexation Strategies on the NASDAQ OMX Baltic Stock Exchange

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Abstract

This paper studies the fundamental indexing approach to the Baltic Stock market. Using sales, EBITDA, EBIT, net income, book equity and composite metrics as a basis for re-weighting the capitalisation-weighted OMX Baltic Benchmark Gross Index makes it apparent that fundamental indices outperformed the benchmark index throughout the period 2006–2016. As for applications to fundamentally indexing in bigger markets, the Fama-French four-factor analysis confirms the active exposure of the fundamental indices to the value factor, and to a lesser extent to the size factor. After adjustment for these risk exposures, four of the six fundamental indices here analysed still significantly outperform the benchmark index, confirming that these smart beta indices are more rewarding when applied to smaller, less covered markets. The outperformance is significant both economically and statistically.

JEL classification codes: G11, G15, G17
Key words: fundamental indexation, alternative weighting schemes, performance evaluation, stock market indices, Fama-French factor model, Baltic Stock Exchanges, value investing

1. Introduction

Fundamental indexation has become the latest key trend in the world of investment strategies. The main idea behind the concept is that indices weighted by market capitalisation are inefficient and can be outperformed by alternatively-weighted indices, as the market cap-weighted indices tend to be overweight in overpriced assets and underweight in undervalued assets. Although fundamental indexing is a fairly new phenomenon, interest in it has grown rapidly and the underlying idea has evolved into other alternative weighting strategies such as smart beta weighting, optimisation based weighting and others. This development has occurred partly because these strategies provide low-cost passive index tracking, and partly because they promise excess returns over the benchmark market index. Although fundamental indices are widespread in bigger and more liquid markets, they are still little known in the Baltic States.

Our study mainly draws on the pioneering study "Fundamental Indexation", published by Arnott, Hsu and Moore in 2005, which demonstrated that fundamentally-weighted indices, meaning those which assign weights using firm-specific accounting measures rather than market capitalisation, strongly outperformed the capitalisation-weighted S&P500 index. Subsequent papers have similarly confirmed this superior performance of fundamentally-weighted indices in other stock markets. However, studies have also revealed that the outstanding performance of fundamentally-weighted indexation is due not to its systematic ability to take advantage of market mispricing, but rather to the excess returns coming from the increased risk exposure to stocks with low price-to-book values and small capitalisations, which have historically shown superior performance.

In this paper we contribute to the existing literature in two ways. First, we seek to explore the validity of fundamental indexation in the Baltic market, which has been overlooked in the literature. The Baltic market is an interesting case for two reasons; first, Baltic countries are "in between" developed markets (with which they share many characteristics, the first being a common currency) and with other CEE countries; second, these markets are considered to be more inefficient than bigger markets (to which fundamental indexing has been mainly applied and tested). This is because the coverage by financial analysts and investors is not broad as in more liquid markets, and, at least in theory, this gives a higher probability to discover over or undervalued stocks (where fair valuation is measured by fundamental factors). Fundamental indexing is built, in essence, to discover unfairly priced stocks and, in a small ("under the radar") market, this should be more rewarding than in larger, widely analysed, markets.

We also want to explore how far the performance of fundamentally-weighted indices is driven by exposure to Fama-French factors, revealing how much the returns of these indices are driven by systematic risk. Usually, the literature is focused on big markets, where the small and book effects are well documented. This is not necessarily the case for smaller and less liquid markets.

The rest of the paper is organised as follows. Section 2 briefly introduces the concept of fundamental indexation and discusses previous studies and findings on the fundamental indexation technique. Section 3 presents the methodology and data used in the paper. In Section 4, the results of the empirical analysis are presented and discussed. Section 5 proceeds with the discussion of the results and a comparison with previous studies. Section 6 summarises the results of the research and concludes.

2. Literature review

The literature review in this section starts looking at CAPM and the optimality of the capitalisation-weighted market portfolio. Given the mixed empirical results on the optimality of the capitalisation-weighted market portfolio, a review of alternative methods for building portfolios is presented in the second part of the this section.

To understand the central role of the capitalisation-weighted index in today's investment world, it is necessary to look at the capital asset pricing model (CAPM), which is the intellectual foundation of market-cap-weighted indexing. The theory was built on Markowitz's (1959) mean-variance model.

Sharpe used CAPM theory to develop the idea of portfolio selection: assuming a risk-free asset can be borrowed and lent, all investors face the same opportunity set and choose the same "optimal" portfolio. Because all investors then hold the same portfolio of risky assets, the market portfolio must be the value-weight market portfolio of risky assets, in which the weight of each asset is the total market value of all the outstanding units of that asset divided by the total market value of all risky assets. Therefore the market portfolio is capitalisation-weighted (Fama and French, 2004).

There is plenty of past empirical evidence both to support and to reject the efficiency of the market portfolio. The majority of more recent studies, however, tend to reject the CAPM and the hypothesis of optimality of the capitalisation-weighted portfolio. This suggests that alternative weighting schemes could be more efficient. An example is found in Haugen and Baker (1991), who constructed low-volatility portfolios with no short selling and cap restrictions based on the constituents of the Wilshire 500 index, and concluded that for 1972–1989 there were equity portfolios with equal or greater return and lower risk level than the market index. Research papers by Zhou (1991) and Gibbons et al. (1989) used likelihood-based tests to show that the market value-weighted NYSE stock portfolios are inefficient. Furthermore, Basak et al. (2002) introduced a new geometric test as a way to approach the optimality of the market portfolio. They evaluated the horizontal distance between the value-weighted index of stocks traded on the US stock exchanges and the efficient frontier and found that the market portfolio is well within the frontier, thus rejecting the CAPM. Brière et al. (2013) developed a new vertical distance test for evaluating the mean-variance efficiency of the market portfolio, and their calculations resulted in the finding that US equity capitalisation-weighted portfolios were inefficient.

Although it seems that the consensus tends towards a rejection of the efficiency of the market portfolio, there are some positive points to be found in capitalisation based weighting (Arnott et al., 2005), like the simplicity of having no, or only a little, active management and therefore no active management fee; the automatic rebalancing of the index; and the high liquidity of the portfolio, since the greatest weights are assigned to the largest companies. Moreover, Tabner (2012) provides evidence that the biggest index constituents have lower covariance than the average when extreme negative shocks strike, which in turn reduces index volatility and leads to a better risk adjusted return. Furthermore, Philips (2011) argues that market indices are intended to gauge the overall state of the market and therefore should be capitalisation-weighted.

On top of the lack of support for the CAPM comes the main claim against the capitalisation weighting approach, which is that it inevitably invests more in overvalued stocks and less in undervalued stocks. It is essential to highlight that the capitalisation approach intrinsically assumes that markets are not efficient and that the price of a security does not necessarily reflect its fair value at a given point in time, as expected by the EMH, but rather that prices are mean reverting and over time overvalued stocks depreciate and undervalued stocks appreciate. Shiller (1981) already confronted the efficient market pricing theory by showing that stock price movements were many times larger than could have been justified following changes in the expectations of dividend payments, meaning the stock prices overreacted more than the changes in fundamental values suggested they should. Also, Brainard et al. (1980) determined that stock price movements are more sporadic than the underlying changes in expectations for future cash flows or interest rates would predict.

Treynor (2005) and Hsu (2006) showed that market capitalisation weighting is a sub-optimal solution when there are mean-reverting random pricing errors, meaning when stock prices are inefficient and thus do not fully reflect companies' fair value and prices are noisy as presented by Shiller (1981) and Brainard et al. (1980). As overvalued stocks will have a higher market capitalisation than their fair equity value and undervalued stocks will have smaller capitalisations than their fair equity value, a capitalisation-weighted portfolio allocates more weights into overvalued stocks while shifting weights away from undervalued stocks, on average. Given that these pricing errors are not infinitely persistent, stock prices will eventually move towards fair value over time and a capitalisation-weighted portfolio would show a greater decline in its value than non-cap-weighted portfolios would, due to its large exposure to stocks with positive pricing errors (Hsu, 2006). Hsu's model is challenged by Perold (2007), who proves that capitalisation-weighting does not actually create a drag, since it does not change the likelihood of a stock being either over or undervalued.

Given the multiple criticisms directed at market-capitalisation indices, most importantly the lack of mean-variance efficiency and the bias towards overvalued stocks, alternatively constructed indices have been widely analysed. A review of recent studies on the subject is presented below. We will first present a review of the fundamental indexing idea and some relevant empirical tests. While the empirical results tend to support the claim that fundamentally-weighted indices outperform the capitalisation-weighted indices, we will also review more critical researches on fundamentally-weighted indices.

As a starting point on fundamentally-weighted indexing, Arnott et al. (2005) show that non-capitalisation-weighted indices built on the fundamental factors of companies, such as their revenue, equity, dividends, cash flow and employees, provided a better return and lower risk than the market capitalisation-weighted index in the US market over a 40-year period. Fundamental indexation assigns the weights of the companies in the index using a specific measure like sales, EBITDA, book value or earnings for each company, instead of conventional market-capitalisation, which is mathematically expressed as:

$$X_{Accounting\ Size,i} = \frac{Accounting\ Size_i}{\sum_{i=1}^{N} Accounting\ Size_i} \tag{1}$$

Arnott, Hsu and Moore (2005) constructed index portfolios weighted for the metrics for six alternative company size variables (book value, trailing five-year cash flow, trailing five-year average revenue, trailing five-year average sales, trailing five-year gross dividends and employment) and back-tested[1] the hypothetical return against the S&P 500 for the period

[1] It was assumed there were no trading costs.

1962–2004. They found that on average the annual return of the alternatively-weighted indices was 1.97% over the S&P500 index. The lowest outperformance was recorded for the dividend-weighted index, which had an average return of 1.66% over the market, while the highest outperformance was for the reference portfolio-weighted with sales, which yielded on average 2.56% more per year than the market capitalisation-weighted index did. What is more, the Sharpe ratio of 0.44 and the information ratio of 0.47 for the fundamental indices were significantly higher than the respective 0.32 and 0.12 recorded for the overall market portfolio (Arnott et al., 2005).

Arnott, Hsu and Moore concluded that the excess return of the fundamental index portfolios over the S&P 500 could have arisen from: 1) a superior portfolio construction methodology, 2) price inefficiency, 3) additional exposure to distress risk, or 4) a mixture of all three. Whatever the cause, the fundamental indices were essentially more mean-variance efficient than the standard cap-weighted index and the exact choice of weighting metrics and the number of financial metrics chosen did not result in statistically different performances in the long-run.

Back-testing analysis using historical stock market data has also indicated the superiority of fundamental indexation in both Europe and Asia. Hypothetical return statistics from 1987 through to 2005 have shown that fundamentally-weighted indices would have outperformed capitalisation-weighted indices in Greece, Ireland, France, Switzerland, Germany and Denmark by over 200 basis points per year, and the outperformance in Japan would have been more than 300 basis points per year (Jun and Malkiel, 2008). Additionally, Hemminki and Puttonen (2008) found that the fundamental indexation strategies in Europe outperformed the DJ Euro Stoxx 50 Total Market index by 2% annually, with all strategies showing better risk-adjusted return. The researchers concluded that the best indexation strategy was book value and dividend-weighting, or a composite metric. Furthermore, Houwer and Plantinga (2009) expanded the Hemminki and Puttonen (2008) European stock universe research and re-weighted the DJ Stoxx 600 index constituents by fundamental measures. Their analysis demonstrated that for 1993–2007 the performance of fundamental indices was superior by 2.4 percentage points per year, when compared to the broad-based DJ Stoxx 600 index.

The main argument used for challenging the superiority of fundamentally-weighted indices has been the exposure to risk factors. A number of studies have also shown that the better performance of fundamental indexation than of capitalisation-weighted indices is fully explained by positive biases towards value and size factor (also called factor tilts) – for example, Jun and Malkiel (2008) and Blitz and Swinkels (2008) for the US market and Estrada (2008) for international markets. Furthermore, research by Amenc et al.,(2011) showed that fundamental indices in the US and global markets experienced positive value tilt, but, interestingly, the US fundamental index experienced negative small cap exposure. It was explained that this was because the Fama-French factors were calculated for the whole US stock universe, whereas the study was done in the S&P500 universe, which inevitably has big cap bias compared to the whole US stock universe. However, in their later research Arnott et al., (2010) concluded that even after they adjusted for the four-factor model, fundamentally-weighted global stock index strategies showed statistically significant alpha at the 5% confidence level. The statistically significant positive Fama-French alpha was also confirmed a year earlier by Houwer and Plantinga (2009), who also found the excess return to be present in the European market and concluded that fundamental indices added value.

Chow et al. (2011), along with Hsu, also acknowledged in their later studies that the superior performance of alternative indices is due to the additional significant exposure to value and size variables. Like Arnott et al. (2005), they found that fundamentally-weighted index models for the US stock market yielded a 2.14% annual outperformance, with slightly higher standard deviation than the market index. What is more, global stocks outperformed the MSCI World Index annually by 3.5% over the period 1987–2009, while showing slightly lower volatility than the market index. Nevertheless, the adjusted four-factor return decomposition model showed that neither the US nor the global fundamental indexation strategy displayed a statistically significant alpha compared to the market index, whereas they both experienced statistically significant positive value and size factor tilt. Chow et al. (2011) argue that the absence of four-factor alpha is not surprising though, as the alternative strategies are not meant to seek excess return from proprietary portfolio construction or knowingly to pursue exposure to other factors or anomalies. The authors add that even without the alpha, alternative indices provide exposure to value and size factors, which investors could benefit from. Blitz and Swinkels (2008) on the other hand claim that, as fundamental indices are mainly designed for simplicity and appeal, using fundamental indexation to capture the value premium is unlikely to be the most efficient way of doing it. Estrada (2008) also concluded that investors should prefer value indices over fundamental indices, as they provide a better way of capturing the value factor. Interestingly, Hsu et al. (2010) proved that the most popular factor indices were actually sub-optimal, due to their capitalisation weighting methodology, and thus the alternative weighting gives an excess return over pure factor exposure.

Perold (2007) argued that every fundamental indexing method is likely to overweight "value stocks" and small capitalisation stocks. This is for the simple reason that, during sector market bubbles, the growth in the market value of companies exceeds any growth in their fundamental measures. In this case, those stocks tend to have a bigger share in the capitalisation based index, but are represented much less in fundamental indices. Consequently, fundamental weighting assigns more weight to companies with smaller capitalisation and better value characteristics, such as a low P/E ratio, a high dividend yield or low P/B values[2]. Thus, fundamental indexing usually performs well in periods when value and small-cap stocks outperform (Perold, 2007).

Besides the exposure to risk factors, some studies have pointed to other possible weaknesses of fundamentally-weighted indices. The high frequency of rebalancing (and the associated costs) is one of the arguments against fundamentally-weighted indices. Chow et al. (2011) showed that the turnover of alternative weighting methods is considerably greater than that of market portfolios. Although the high turnover led to elevated transaction costs however, the researchers still estimated that the transaction costs would not fully erode the extra return against the benchmark. From another perspective, Houwer and Plantinga (2009) concluded from the turnover characteristics of the fundamental indices in their study that fundamental indexation is neither a passive nor an active strategy.

The return characteristics of fundamentally-weighted indices in different time periods has been also analysed. Although Jun and Malkiel (2008) found that fundamental indexing outperformed the market, they cautioned investors not to anticipate that fundamental

[2] The past superiority of theses value characteristics in the US market can, for example, be found in the studies conducted by Lakonishok et al. (1994), Loughran and Wellman (2011), and Gray and Vogel (2012)

indices will outperform the market all the time. They also provided evidence that the strategies based on value and size advantage tend to revert towards the mean in the long-run. There have been periods in history when growth stocks have performed better, and other periods when value stocks have shown better performance than growth stocks (Jun and Malkiel, 2008). Moreover, Clare et al. (2013) demonstrated that there are periods when a market capitalisation-weighted index can outperform alternatively-weighted indices over a long period of time, as the US market-cap-weighted index outperformed fundamental indexation models in 1990-2000, but lagged behind during the 1970s, 1980s and 2000s.

Finally, it is also worth noting that research conducted by Clare et al. (2013) showed that even randomly constructed portfolios outperformed the US market in 1969-2011. This discovery, to some extent, confirms that in a mean-reverting pricing error economy, weighting schemes that are uncorrelated with pricing errors provide a better return than cap-weighting, irrespective of the weighting scheme. It is important to note that there were also periods when the market portfolio outperformed the randomly constructed portfolios, but altogether random portfolios outperformed the market cap index 60% of the time over a three-year period. In addition to this, random portfolios outperformed several fundamental-based methods, namely the dividend, composite and sales methods (Clare et al., 2013).

Summarising the research so far on fundamental indexation, some main highlights can be stressed. First, fundamental indices usually have exposure to value and size risk factors. This gives rise to some complications. Investors are not fully aware which factor they are exposed to, nor to what extent, and CAPM and Fama-French beta-factors are time-varying (Ang and Kristensen, 2012; Blitz and Swinkels, 2008). Factor exposure could be captured more efficiently, by using factor indices, for example. Fundamental indices can also cause unintended exposures, as a value factor may lead to an exposure to distressed firms for example (Avramov et al., 2013), whereas small cap could tilt towards illiquid stocks. Also, fundamental indices are subject to possible underperformance due to their exposure to factors which may show poor performance at certain times. Finally, there is the risk of diminishing returns: if the number of investments in the fundamental strategies grows, the market inefficiencies which these strategies exploit will ultimately disappear and will, therefore, not provide excess return.

Studies of fundamental indexing for the Baltic markets are very limited, and have a different objective to our research. Lieksnis (2010, 2011) focuses on the multifactor asset pricing analysis in the region, but does not deal specifically with the question of fundamental indexation. Bistrova and Lace (2009, 2010) study the link between fundamental ratios and the subsequent return of stocks in the Baltic equity market, but it is mainly based on correlation analysis. The authors found that there is a link between fundamental ratios and ex-post returns, but indexation based on ratios is not analysed in their contributions. The present paper is mostly based on Tomingas (2016), and it adds to the analysis and interpretation of the results of the cited work.

In conclusion, earlier studies have shown that back-tested fundamental strategies have generally performed considerably better than market capitalisation based indices, but these strategies are exposed to overall market risk, similarly to the cap-weighted market indices. The fundamental indexation strategies usually have a market beta that is close to 1, and their conventional risk-adjusted return is clearly better, but the outperformance comes mainly from taking significant active risks compared to the market index through value, momentum and small cap. In fact, by adjusting for these factors the excess return could be insignificant and can, therefore, actually be attributed to the factor tilting.

3. Methodology and data

This section will present the data and the methods used for this paper, as well as some practical problems and their implications. The paper concentrates on the Baltic Stock Exchange and constructs alternative fundamental indexation strategies against the OMX Baltic Benchmark Gross Index3 (OMX BB GI) index. In order to guarantee that the index is constructed using liquid stocks and at the same time that the different sectors are adequately represented, the index contains a limited number of shares4. Unfortunately, the NASDAQ OMX Group does not disclose the exact historical constituents and weights of the Baltic Benchmark GI index, and it is nearly impossible to replicate the index fully due to methodological changes over time, free float adjustments, and so forth. This practical problem is consistent with the observation by Amenc et al. (2012) that the lack of free access to constituents' data and incomplete information on the precise index construction methodology make it difficult to evaluate the true risk and performance of the alternative indexing strategies.

Nevertheless, the fundamental indices tested here are constructed using the same constituents that the OMX Baltic Benchmark Gross Index used. The actual constituent data was retrieved from the NASDAQ OMX Baltic website from the "New OMX Baltic Benchmark portfolio" market announcements, meaning the changes and new constituents' data for the index were recovered step-by-step for each year and thus the index replicating portfolios hold exactly the same securities as the index did at the time. As also pointed out by Houwer and Plantinga (2009), this "actual constituents" method ought to provide a better understanding of fundamental indexing in practice and limit any apparent bias from stocks that are not present in the benchmark index, giving directly comparable results for evaluating fundamental indexation performance against the capitalisation-weighted OMX Baltic Benchmark Gross Index.

Because the constituent data that was collected has been available from 2006, the observation period of the indices starts from 1 July 2006 and ends on 31 March 2016, with a total of 117 monthly observations included for each index5. Depending on the year, each index covers between 27 and 35 companies. The monthly price data adjusted for dividends and the historical financial figures, both denominated in euros, were obtained from the Bloomberg terminal for 2004–2016. Where data was missing, the NASDAQ OMX Baltic website was used to retrieve the correct numbers from the companies' annual reports.

Like in other research (e.g. Arnott et al., 2005, Jun and Malkiel 2008, and Clare et al., 2013), a back testing method was used to mimic the hypothetical past returns of the fundamental indices. To evaluate the performance of the fundamental indices on the NASDAQ OMX Baltic stock exchange, hypothetical test index-portfolios based on fundamentally-based weighting schemes were constructed and back tested on the period from 1 July 2006 to 31 March 2016. A portfolio was created for each alternative approach using weights so that the portfolio is entirely invested and no short selling is allowed, while no limit is set on the weights of constituents. The portfolio weights form a vector x = (x1, x2, … , xn), where and 0 ≤ xi ≤ 1 for all N stocks.

[3] GI, the Gross Index, includes dividends and reinvests them at the ex-dividend date.

[4] For the exact rules on how the index is constructed, see https://indexes.nasdaqomx.com/docs/Methodology_OMX_BALTIC.pdf.

[5] The GI index of the OMX Baltic Benchmark index is rebalanced twice a year on the first trading days of January and July.

The weights of the stocks in the different indices are assigned by five accounting metrics: sales, EBITDA, EBIT, net income and the book value of equity. The previous three-year average value of the variables is used for each company, so that only information that was known at the time of rebalancing is included. In addition, a combined method is used for these variables, where the weight of each stock in the composite index is the simple average of the five weights calculated according to the five accounting metrics.

After the weight has been assigned to each security, a simulation of the monthly performances of the portfolios is implemented over a one-year period. The monthly returns for each stock are calculated from the daily total return index. Using the new OMX Baltic Benchmark Gross Index constituents, the fundamentally-weighted portfolios are also rebalanced on 1 July in each year in the simulations. The real OMX Baltic Benchmark Gross Index is rebalanced biannually, but, as studies have shown, rebalancing more frequently than annually does not give better results (e.g. Chow et al., 2011). Furthermore, the biannual replacement of constituents is rather minor, and so this should not have a major impact on the overall results. For the dividends, a dividend adjusted return is used, where dividends are reinvested in the same security.

Once the indices have been calculated, we can compare them in three ways, using the Sharpe ratio, the Tracking Error, and the Information Ratio. The Sharpe ratio is defined as:

$$Sharpe\ ratio = \frac{R_p - R_f}{\sigma_p} \tag{2}$$

where $R_p - R_f$ is the excess return of the portfolio over the risk free rate and σ_p is the standard deviation of the portfolio.

The Tracking Error (TE) is a measure of the quality of the replication:

$$TE_{(p-b)} = \sigma_{(R_p - R_b)} \tag{3}$$

where $R_p - R_b$ is the excess return of the portfolio over the benchmark, $\sigma_{(R_p - R_b)}$ is the standard deviation of the excess return and $TE_{(p-b)}$ is the Tracking Error.

Finally, the Information Ratio is a gauge of the portfolio's performance against risk and return relative to a benchmark. In this study, the market portfolio is used as the benchmark reference. The Information Ratio (IR) can be calculated by dividing the excess returns by the risk, or the standard deviation, of the excess returns.

$$IR = \frac{R_p - R_b}{TE_{(p-b)}} \tag{4}$$

To assess how much the performance of the fundamentally-weighted indices depends on the exposure to the factors, the four-factor model by Carhart (1997) is used (equation 5):

$$Rp - Rm = \alpha + \beta_1(R_m - R_f) + \beta_2(HML) + \beta_3(SMB) + \beta_4 MOM + \varepsilon \tag{5}$$

The average monthly EONIA (Euro OverNight Index Average) rate is used as a proxy for a risk-free rate and the OMX Baltic Benchmark Gross Index is used as the market index. The same variables were used by Lieksnis (2010, 2011) in his studies on the Fama-French factor models in the Baltic stock market. The general idea of Fama and French (1992) is followed for the factor loadings, with differentiation between the returns of portfolios consisting of small and large companies, and between high and low book-to-market value companies. The test universe for a given year is limited to the 30 most traded stocks on the Baltic Stock Exchange in the previous 12 months, plus any constituent present in the real Baltic Benchmark index. Only pure value-weighted factor portfolios are used so as to mimic the returns of size or value factors; in July of each year, eligible stocks are ranked by their size or a B/M measure and then divided into portfolios. The same approach is used by Lieksnis (2010). For value premium (HML), the sample is ranked by B/M value and divided into two groups by the median B/M value (High B/M and Low B/M), after which the monthly return of the two portfolios is calculated and for each month the return of the high B/M portfolio is deducted from the low B/M portfolio. Calculation of the size factor (SMB) follows the same logic, but the sample is ranked by market capitalisation and divided into two groups by median market-cap. Consequently, the size factor SMB is the difference between the monthly small-cap portfolio and the large-cap portfolio. For the momentum factor, the methodology of Carhart (1997) is used, where stocks are ranked by their return of the previous year and then returns of the lowest 30% of performers are subtracted from those of the best 30% of performers, leaving 40% of the stocks neutral.

4. Empirical results

A brief overview of the results of the alternative strategies is given first to introduce the main findings, followed by a deeper period-by-period analysis, factor modelling, risk evaluation and an interpretation of the results.

A back test was carried out on the period from 1 July 2006 to 31 March 2016 to evaluate the performance of the hypothetical fundamental indices on the OMX Baltic Stock Exchange. Table 1 presents the main performance results of the back test. The results of the back test analysis show that during the sample period all of the fundamentally-weighted indices substantially outperformed the market index OMX Baltic Benchmark Gross Index. The average annual return of the fundamental indices was 4.4%, which was 2.1 percentage points higher than the return of the market index. Consequently, the cumulative return of the fundamentally-weighted indices ranged between 37.4% and 66.3%, as opposed to the 24.3% returned by the benchmark index. The highest return was registered by the EBITDA-weighted index and the lowest by the net income-weighted index.

Table 1. Return and risk characteristics of market and fundamental indices 01.07.2006 – 31.03.2016

	Return for the full period	Annual geo-metric return	Volatility	Sharpe ratio	Excess return vs. OMX BB GI	Tracking Error vs. Index	Information Ratio
OMX BB GI	24.3%	2.3%	25.4%	0.03	-	-	-
SALES	44.5%	3.8%	25.6%	0.09	1.59%	1.37%	1.16
EBITDA	66.3%	5.4%	24.1%	0.16	3.09%	1.53%	2.02
EBIT	56.2%	4.7%	24.2%	0.13	2.42%	1.36%	1.78
Net income	37.4%	3.3%	23.4%	0.08	1.06%	1.57%	0.67
Equity	55.3%	4.6%	24.1%	0.13	2.36%	2.05%	1.15
Composite	52.7%	4.4%	24.2%	0.12	2.18%	1.43%	1.59

The results also show that all of the alternative indices, other than the sales-weighted index, had lower annualised volatility than the market index. The net income-weighted index had the lowest volatility, as it was as much as two percentage points lower than the volatility of the market index. The standard deviation of the other indices is more than one percentage point lower than that of the OMX Baltic Benchmark Gross Index. Furthermore, the risk adjusted return expressed by the Sharpe ratio is also considerably higher for all of the fundamental indices than the figure for the comparable benchmark index. We can conclude that the OMX Baltic Benchmark Gross Index has performed relatively poorly in the sample analysed here and has been an inferior investment choice.

Regarding other risk metrics, the Tracking Errors of the fundamental indices range between 1.37% and 2.05%. The measure is the lowest for the sales-weighted index and the highest for the equity-weighted index. The Information Ratio, which is directly related to the Tracking Error, is the highest for sales-weighted and lowest for net income. With the exception of that for the net income index, all the Information Ratios are well above one, a level that can be considered extremely high in the context of active management.

Concerning the dynamics of the fundamental indices over time, the overall movement is in line with the benchmark market index. We show this by running a traditional CAPM regression, meaning we run regressions of the extra return generated by each fundamentally-weighted portfolio against the extra return produced by the market capitalisation index:

$$(R_p - R_f)_t = R_{f,t} + \beta(R_m - R_f)_t + \varepsilon_t \qquad (6)$$

where is the return of the fundamentally-weighted portfolio and is the return of the market capitalisation-weighted portfolio, is the risk-free rate, is the error term and subscript t represents the time.

The betas of the regressions range between 0.90 and 0.99 (Table 2). Furthermore, as the estimated betas are below 1, the volatilities of the fundamentally-weighted portfolios are lower than the volatility of the market index. Additionally, the excess return in the CAPM sense (alpha) is positive for all of the fundamental indices, but is statistically significant at the 10% level only for the EBITDA-weighted model.

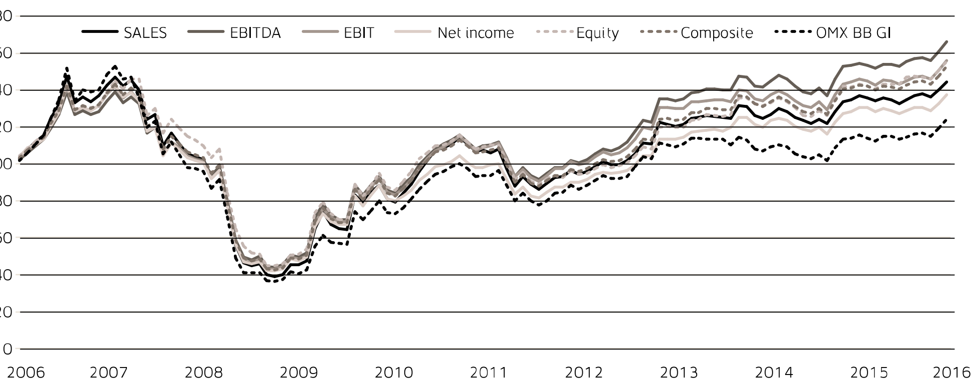
Table 2. CAPM alpha and beta for fundamental indices, monthly observations

	α	β
OMX Baltic Benchmark Gross Index	0	1
SALES	0.001 (1.02)	0.990 (0.31)
EBITDA	0.002* (1.79)	0.927*** (16.05)
EBIT	0.002 (1.58)	0.935*** (15.99)
Net income	0.001 (0.59)	0.901*** (31.56)
Equity	0.002 (1.03)	0.911*** (13.08)
Composite	0.002 (1.34)	0.933*** (15.58)

Note: t-statistics reported for α. For β, the F statistic of the Wald test is reported for the test of β =1. Confidence levels: 1%***, 5%**, 10%*.

Figure 1 shows the cumulative return of the fundamentally-weighted indices and of the market-capped index. It confirms that the fundamentally weighed indices trace the market capped index fairly closely and shows that the market index performed well before the 2008-2009 crisis, but also fell the most during the crisis.

Figure 1. The performance of alternative indices throughout the period 01.07.2006 – 31.03.2016



Breaking down the returns by year, it is possible to see a more detailed picture than that provided in Table 1 and Table 2. Even though the total returns, and the annual average returns, of the alternative indices were better than the return of the market index OMX Baltic Benchmark Gross Index, it follows from Table 3 that during four annual periods (2006-2007, 2009-2010, 2011-2012 and 2015-2016) the OMX Baltic Benchmark Gross Index was actually the best performing index. On the other hand, it was also the worst performer of all the indices in three periods (2007-2008, 2008-2009, and 2013-2014). The equity-weighted portfolio was the best performing index during three annual observation periods, but was lagging in two of the periods. The portfolio weighting based on net income was the worst performer for three annual periods, but it did not show the best return in any year. The EBIT and composite indices stand out from their peer group for not having any best or worst yearly performance.

Table 3. The annual return of the indices, from 1 July to the subsequent 30 June

	Sales	EBITDA	EBIT	Net income	Equity	Composite	OMX BB GI
2006–2007	42.9%	34.0%	37.7%	38.5%	39.0%	38.4%	48.6%
2007–2008	-28.6%	-24.2%	-26.6%	-27.4%	-20.9%	-25.5%	-35.4%
2008–2009	-55.9%	-51.2%	-52.1%	-52.8%	-53.4%	-53.1%	-57.6%
2009–2010	76.5%	70.0%	71.2%	68.0%	67.5%	70.6%	79.1%
2010–2011	33.1%	31.0%	32.4%	24.9%	28.6%	30.0%	28.5%
2011–2012	-9.2%	-7.3%	-8.2%	-8.1%	-14.0%	-9.4%	-5.2%
2012–2013	26.3%	32.1%	29.0%	24.9%	26.5%	27.7%	25.1%
2013–2014	7.0%	9.6%	7.4%	9.2%	13.1%	9.3%	-0.8%
2014–2015	3.6%	2.3%	2.3%	2.7%	3.6%	2.9%	2.3%
2015–2016	7.5%	9.7%	9.3%	7.2%	10.5%	8.8%	10.5%
Average geometrical annual return	3.8%	5.4%	4.7%	3.3%	4.6%	4.4%	2.3%

Note: For the period 2015–2016, the return is calculated up to 30 March 2016.

The excess return of the fundamental indices is dependent on the test period chosen. For example, the average excess return of the fundamental indices in 2006-2016 was 2.1%, whereas in 2009-2013, the OMX Baltic Benchmark Gross Index had a better total return, and a better annualised return, than the alternative indices, meaning the fundamental indices underperformed for four years: the benchmark index showed an annualised return of 28.5%, whereas the average return of the fundamental indices was 26.6%, meaning there was a 1.9 percentage point underperformance. This is in line with the findings of earlier research that market capitalisation indices usually perform better than fundamentally-weighted indices during equity market rallies because they are overweight with companies with an increasing market capitalisation and increasing prices.

It is important to note that the main cause of the lower performance of the benchmark index was the considerably inferior return during the extreme market downturn in 2007-2009, which is partly compensated for by the superior return in the years of strong growth. This again results in higher volatility and thus in lower risk adjusted returns. It also confirms the valuation critique of indices based on market capitalisation, in that overweighting in overvalued stocks results in deeper price falls during phases of correction. This could be seen from the market downturn in 2007-2009, when the market capitalisation index was arguably the worst performer, but also from the maximum drawdown (peak-to-trough decline of the index) figure, which is led by the same cap-weighted market index (Table 4). It also shows inferior performance when the worst one-month, three-month and trailing twelve-months returns are compared. Furthermore, all of the fundamental indices show lower downside risk, with the highest downside deviation in the OMX Baltic Benchmark Gross Index.

Table 4. Outlier and downside risk characteristics of the indices

Index	Maximum drawdown	Worst month	Best month	Worst trailing 3-months	Best trailing 3-months	Worst trailing 12-months	Best trailing 12- months	Semi-deviation (B=0)
OMX BB GI	-76.2%	-31.0%	31.1%	-55.0%	50.5%	-67.2%	114.0%	17.5%
Sales	-73.6%	-29.0%	37.0%	-52.7%	64.4%	-65.7%	119.3%	16.7%
EBITDA	-68.4%	-26.1%	37.0%	-49.6%	57.7%	-60.4%	104.7%	15.4%
EBIT	-70.2%	-27.6%	35.4%	-51.1%	56.4%	-61.3%	108.2%	16.0%
Net income	-71.0%	-26.5%	34.3%	-51.1%	53.7%	-62.0%	103.9%	15.9%
Equity	-69.3%	-23.1%	37.0%	-48.9%	54.6%	-63.8%	106.4%	15.5%
Composite	-70.5%	-26.5%	36.1%	-50.6%	57.4%	-62.7%	108.4%	15.8%

One important characteristic in the index returns is the factor exposures. Table 5 summarises the exposure of the fundamental indices tested to market, value, size, and momentum variables, and the running regression (5) obtained for each index. The market factor exposure is statistically significant for every alternative index-weighting scheme, and is less than 1, implying lower market risk exposure. The lowest market loading is shown by the indices-weighted by net income and equity, while the sales-weighted index has the highest market loading. Moreover, all fundamental indices have a positive value tilt (HML), but only the sales, EBITDA, equity and composite indices have statistically significant value tilt. The highest loading of stocks with a high B/M factor is present for the equity weighting index, whereas no statistically significant bias is seen for the EBIT and net income indices.

Table 5. Multi-factor return analysis of the fundamental indices tested for 2006–2016

	Alpha	$R_m - R_f$	HML	SMB	MOM	R^2
OMX BB GI	0	1	-	-	-	
Sales	0.0158 (1.33)	0.963*** (51.88)	0.101*** (2.99)	0.131*** (3.58)	-0.007 -(0.32)	0.972
EBITDA	0.0028** (2.19)	0.917*** (44.97)	0.108*** (2.91)	-0.007 -(0.17)	-0.008 -(0.31)	0.961
EBIT	0.0020* (1.71)	0.926*** (49.41)	0.036 (1.05)	0.002 (0.06)	-0.018 -(0.80)	0.968
Net income	0.0009 (0.71)	0.895*** (43.79)	0.029 (0.78)	-0.017 -(0.42)	-0.019 -(0.76)	0.959
Equity	0.0030* (1.94)	0.904*** (36.79)	0.282*** (6.28)	-0.064 -(1.32)	0.021 (0.69)	0.905
Composite	0.0021* (1.76)	0.921*** (48.63)	0.112*** (3.25)	0.009 (0.25)	-0.006 -(0.24)	0.922

Note: Confidence levels: 1%***, 5%**, 10%*. For β, the statistic of the Wald test is reported for the test of β =1

Three of the fundamentally-weighted indices (sales, EBIT and composite) have small-cap bias, while the other three (EBITDA, net income and equity) are tilted towards large cap stocks, although the SMB loading is only statistically significant for the sales-weighted index.

Momentum does not have statistically significant effects on the index return for any of the fundamental indices and is negative for all the indices, with the exception of the equity-weighted index, for which the value is positive.

Furthermore, all the alternative indices show a positive alpha after adjustment for the factor returns, though only the EBITDA-based index has a statistically significant alpha at the 5% confidence level. Moreover, the EBIT, equity and composite indices have a positive alpha at the 10% confidence level. Therefore, for these four weighting schemes the source of excess return cannot be explained by the chosen value, size and momentum factors and, so they provided value added performance for investors.

An additional check on the robustness of the multi-factor return analysis has been performed using rolling windows regressions of equation (5). The regressions have been conducted with different rolling window's width, and the results are not affected by the choice of the width. For this reason, Table 6 reports the average and standard deviation of each coefficient for the five independent variables, only for the 36-month window. In the Appendix, the figures of the evolution of the five coefficients for the six different regressions are reported.

Some interesting observations can be drawn. First, the market factor Rm-Rf for all the regressions seems to be close to one before the crisis, but when the crisis' months enter the rolling window sample, the slopes of the market factor fall below one for all the fundamentally-weighted indices, indicating that the ability of the indices to track the market slightly decreased (the slope is still between 0.7 and 0.9). The second observation is that the HML factor is positive and stays consistently positive for most of the fundamentally-weighted indices, indicating that bias of the indices towards the growth/value factor is persistent across different cycles.

Finally, alpha, the return of the alternative indices adjusted for the factor exposure, tend to be positive at the beginning and at the end of the sample, while becoming slightly negative when 2010 and 2011 are included in the rolling window. These two years are the years of the recovery of the Baltic equity market. This confirms a common empirical finding on fundamentally-weighted indices: they tend to underperform in very positive cycles (when the capitalisation-weighted indices grow strongly), but perform better in more volatile market conditions.

Table 6. A multi-factor return analysis of the fundamental indices (rolling regressions)

	Alpha		$R_m - R_f$		HML		SMB		MOM	
	average	st dev	average	st dev	average	st dev	average	st dev	average	st dev
Sales	0.0012	0.0024	0.9624	0.0556	0.1098	0.0603	0.1244	0.0515	-0.0041	0.0508
EBIDA	0.0036	0.0023	0.9241	0.0612	0.1379	0.0764	-0.0213	0.0531	0.0189	0.0490
EBIT	0.0025	0.0019	0.9244	0.0546	0.0763	0.0801	-0.0134	0.0499	0.0057	0.0527
Net Income	0.0022	0.0020	0.8653	0.0772	0.0596	0.0736	0.0406	0.1299	-0.0371	0.0790
Equity	0.0033	0.0024	0.8828	0.0914	0.2970	0.0742	-0.0336	0.1106	0.0118	0.0955
Composite	0.0026	0.0022	0.9104	0.0669	0.1395	0.0664	0.0188	0.0649	0.0016	0.0581

Note: Rolling window's width: 36 months

In conclusion, the multifactor analysis confirms a standard result of fundamentally-weighted indices, which is that some of the Fama-French factors explain the extra return of these indices over the market cap index. In our case, the value factor seems to be the most relevant. At the same time, contrary to what has been found for other markets, the momentum and small-cap factors are not relevant in the Baltic market, and, more importantly, all the other indices – apart from the net income index – outperforming the capitalisation-weighted index even after the factor exposures are accounted for.

5. Discussion

The results of the back-testing showed that indices based on fundamental measures outperformed the market capitalisation-weighted OMX Baltic Benchmark Gross Index over the observed time period irrespective of the measure used for the alternative weighting. The average excess return was 2.1 percentage points per annum[6]. This is consistent with previous studies conducted on fundamental indexation, such as Arnott et al. (2005), who found that the fundamental indexation outperformed its capital-weighted peer the S&P500 index by 1.97 percentage points, on average; Hemminki and Puttonen (2008), who found from their back-test an average excess return of 1.76 percentage points for the fundamental index peers of the Euro Stoxx 50; and Houwer and Plantinga (2009), whose findings show that fundamentally-weighted portfolios outperformed the DJ Stoxx 600 annually by 1.8 percentage points. The reason for the slightly higher outperformance than in the other studies could be that fundamental indices have the greatest advantage in less developed stock markets, where the market is most likely to be the least efficient, as suggested by Hsu et al. (2007).

The volatilities of the fundamental indices were also lower than the volatility for the benchmark index. Some of the studies covered in the literature review report that fundamental indices tended to be exposed to more mature companies, or value companies, which are less risky in terms of price volatility. This is also partially suggested by Arnott et

[6] Although this study does not consider fees and trading costs, it is worth noting that even were they as much as one percentage point higher for the fundamental indices, those indices would still have shown a better annual performance by more than one percentage point over the observation period.

al., (2005) when they explain the low volatility of the dividend-weighting method. The sales-weighted index had slightly higher volatility than the market index, but this could be explained by the statistically significant positive small cap bias, which is more volatile.

Even though fundamental indices showed better absolute and relative returns for the period observed, there were periods where the benchmark index return was higher than those of any of the fundamental indices. This problem has been emphasised in previous studies by Jun and Malkiel (2008) and Clare et al. (2013). It is worth noting that the alternative indices cannot really be expected to outperform the benchmark every year. Even so, our results suggest that the fundamental indices still do outperform in the long-term.

The results of the back-testing also revealed that fundamental indices exhibited less severe price falls during the market downturn than the market capitalisation based benchmark index did, had lower semi-deviation than it (Table 4) and also lower maximum drawdown. This is consistent with the argument that market capitalisation-weighted approaches overweight overvalued stocks, which tend to fall more during market corrections, whereas fundamental indices are less volatile and invest inherently in stocks with better valuation, thus smoothing the market cycle. This feature of fundamental indices was also noted by Arnott et al. (2005).

On the contrary, other studies find that fundamental indices carry more risk than market-weighted indices. Clare et al. (2013) found that fundamental indices had a maximum drawdown that was seven percentage points higher, and therefore they bore a higher tail risk. However, they also concluded, from the Sharpe and Sortino ratio measures for the annualised return, that investors were eventually rewarded for this higher maximum drawdown risk. The difference in results may have been driven by the lack of exposure to small caps, as the fundamental indices tested in this study did not have statistically significant small cap bias, except for the sales-weighted index, which also had the second lowest maximum drawdown at a level comparable to that of the cap-weighted index. On the other hand, it can be argued that the less severe drawdown of fundamental indices may also arise from exposure to more mature companies, which are more resilient to price declines, as also proposed by Tabner (2012), although his argument was in defence of capitalisation-weighting.

Interestingly, the tracking error of fundamental indices in this study is considerably lower than in other comparable studies carried out on fundamental indexation. For example, the study by Arnott et al., (2005) found the average tracking error to be 4.57% and Hemminki and Puttonen (2008) found an average tracking error of 3.7%, whereas the comparable figure in this study was as low as 1.55%. This might be because the index constituents where chosen to be exactly the same as in the benchmark index, which eliminated any bias for other stocks and gave a fully equivalent market exposure. Moreover, the information ratio, which is directly related to tracking error, was materially higher than in those reference studies.

The Fama-French multifactor analysis demonstrated that all the fundamental indices exhibited a positive value tilt, although it should be noted that it was not statistically significant for the indices based on EBIT and net income. This positive value tilt aligns with previous findings by Jun and Malkiel (2008), Blitz and Swinkles (2008), and Clare et al. (2013), who claim fundamental indexation is a "value strategy in disguise". Furthermore, the construction mechanism behind fundamental indices favours value tilting, as stated by Perold (2007). For example, it is easy to recognise that the equity-weighted index, which had the highest value tilt bias in this study, puts inherently more weight on value stocks than the market capitalisation-weighting does, as the market value and fair equity value differentiation diverges.

Regarding the small cap exposure, half of the indices experienced negative small cap exposure, whereas the other half were positive, though this was statistically significant only for the sales-weighted method. This elusive result might be explained by the construction methodology of the SMB factor, as was also pointed out earlier in this study regarding the negative small cap exposure of fundamental indices in the study by Amenc et al. (2011). The positive small cap tilt confirms the earlier findings of, for example, Jun and Malkiel (2008) and Houwer and Plantinga (2009). Overall, we can conclude that the fundamentally-weighted indices do not exhibit any relevant small cap tilt in our sample.

No momentum factor exposure was detected for the fundamental indices tested in this study either. It is statistically insignificant for all the fundamental indices tested, which is, to some extent, in line with the research conducted by Lieksnis (2011), in which he found that the book-to-market ratio (HML factor) can partially explain the momentum effect in the Baltic Stock Exchange, and therefore the momentum variable may be inapplicable for the model used in this work. Nevertheless, the negative exposure to momentum stocks confirms the fundamental-weighting method's indifference to market capitalisation-weighting and, therefore, does not favour recent winner stocks, but rather losers (as shown by Clare et al., 2013).

After adjusting for the value, size and momentum factors, the EBITDA-weighted index showed a positive alpha at the 5% confidence level and the EBIT, equity and composite methods did so at the 10% confidence level. It seems that fundamental weighting did add positive extra value, compared to the benchmark index. This statistically positive outperformance is supported by previous studies by Houwer and Plantinga (2009) and Arnott et al. (2010), whereas other studies, such as Jun and Malkiel (2008), Estrada (2008) and Clare et al. (2013), have resulted in a statistically insignificant Fama-French alpha, as is the case with the sales and net income-weighted indices in this study.

6. Conclusion

There is no ex-ante reason why the OMX Baltic Benchmark Gross Index should be mean-variance efficient and thus located on the efficient frontier. This study showed that fundamental indices provided better risk adjusted returns (Sharpe ratio) and were, therefore, more efficient in a Pareto sense than the market index. This was achieved by both higher return and lower volatility than the benchmark index. Furthermore, fundamental indices demonstrated lower CAPM beta, also implying lower market risk.

Fundamental indices were exposed to the value and, to a smaller extent, size biases, as shown by the Fama-French four-factor model analysis, with value tilting being the most important driver of the excess return. Four out of the six indices had statistically significant positive value bias, which was rewarded over the observation period. Nevertheless, it can be argued that the superior performance of the fundamental indices derives from the market pricing inefficiency and rebalancing effects, whereby value and size tilt is a by-product of the methodology used to construct fundamental indices. Further support for this is that after adjusting for value, size and momentum factors, four fundamental index-weighting schemes in the Baltic market showed a statistically significant alpha. This is different from what is usually found in fundamental indexing which is applied to bigger markets, where performance over market-cap indices, when adjusted for the four Fama-French factors, tends to be close to zero. This result stresses that fundamental indexing can generate a higher extra return (versus the market cap index) in smaller, less liquid and less analysed markets than in liquid markets. The robustness check conducted using rolling windows of the Fama-French model also highlighted that the extra performance of fundamentally-weighted indices is stronger in volatile market conditions, and is lower in positive and stable market conditions. Investors should bear in mind that there might be some hidden risk factors that have not been taken into account in this thesis, but over the period observed even these hidden risks were rewarded.

The results of this paper can be expanded upon in a number of different directions. Further studies should concentrate on the liquidity and turnover characteristics of the fundamental indices compared to the market index, as the liquidity of the Baltic market is a major outstanding issue. Additionally, studies could use a longer time period observation to provide more definite conclusions about long-term performance. Furthermore, future studies could extend the universe of alternative weighting strategies and also test other alternative weighting schemes in the Baltic stock market. Finally, a similar analysis could be conducted for the same time period and other markets (other Eastern European markets, Scandinavian markets) in order to understand if the results shown by the Baltic stock exchange apply to other medium to small markets in the same region.

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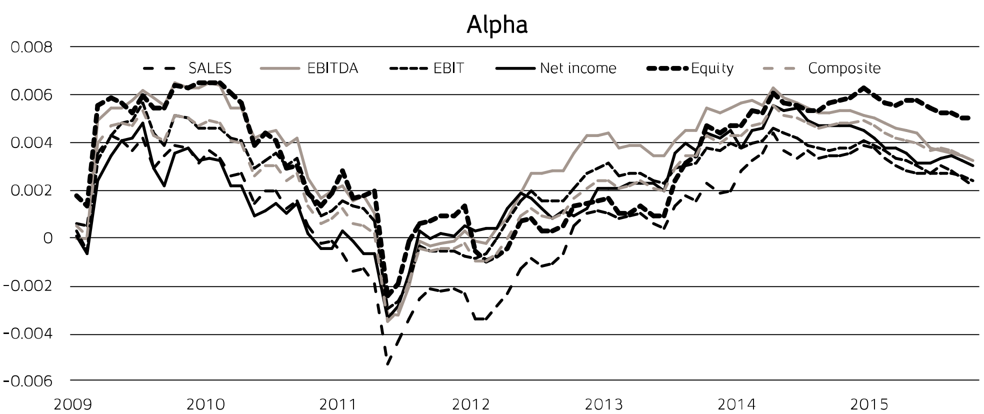
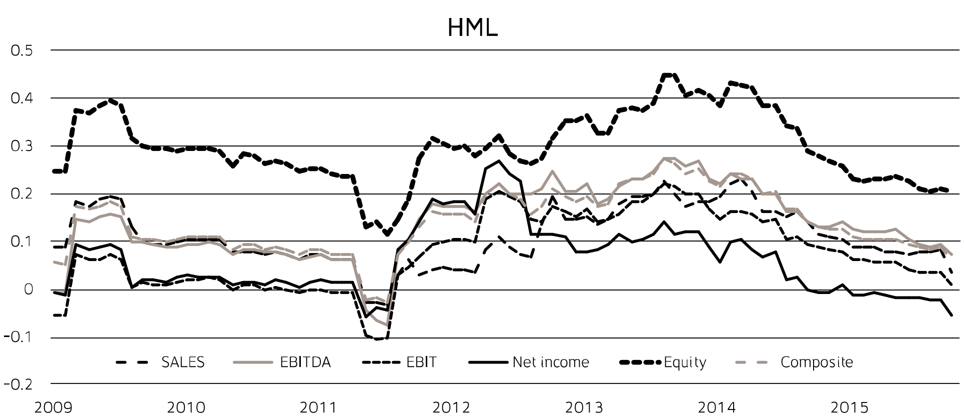
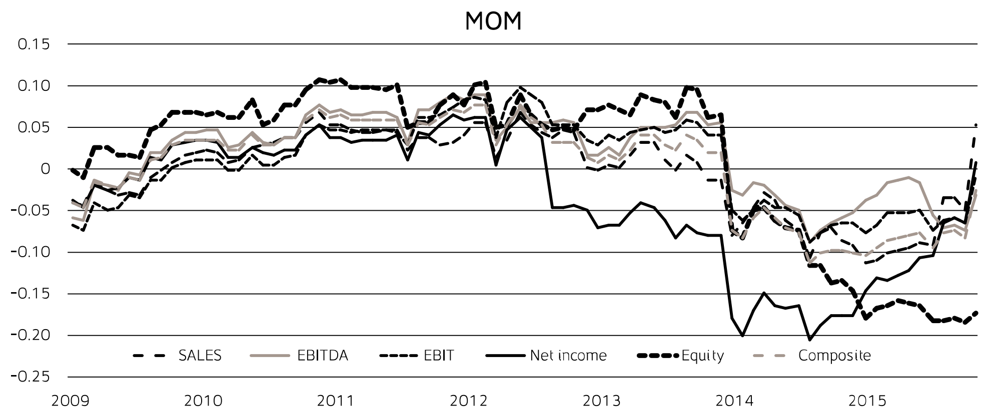
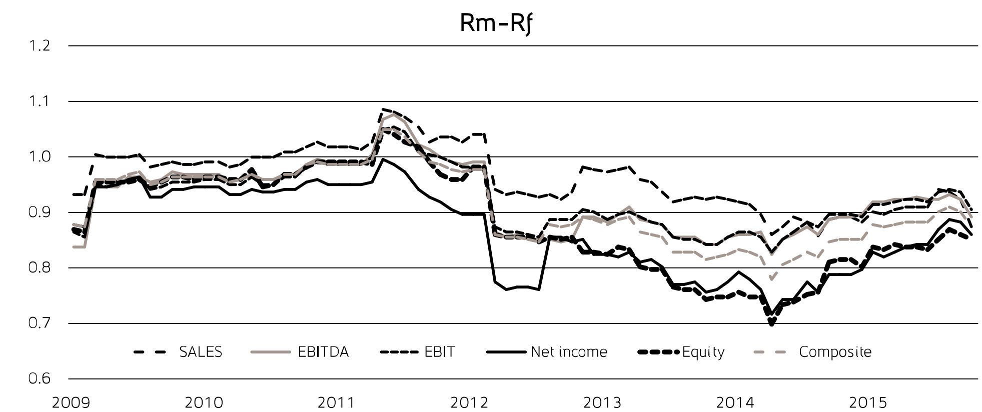
Appendix

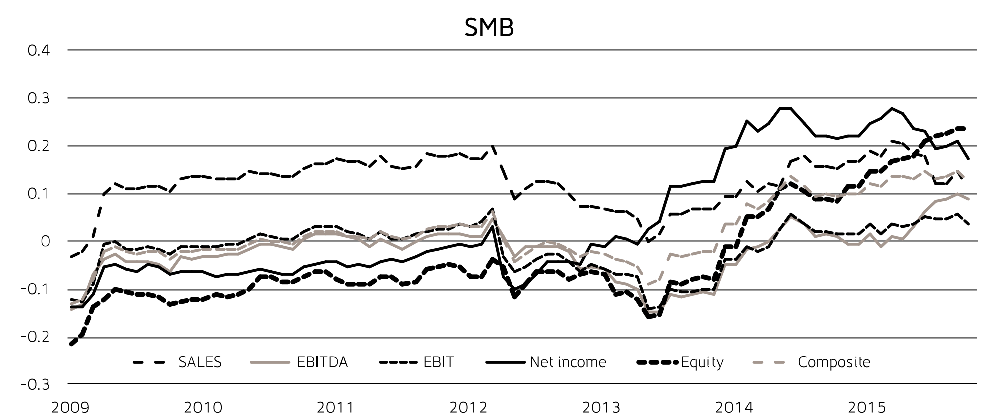
Coefficients from equation (5) estimated with rolling windows of width 36 months.






MOM
0.15
0.10
0.05
0
-0.05
-0.10
-0.15
-0.20
-0.25
SALES
EBITDA
EBIT
Net income
Equity
Composite
2009
2010
2011
2012
2013
2014
2015


Rm-Rf
1.2
1.1
1.0
0.9
0.8
0.7
0.6
SALES
EBITDA
EBIT
Net income
Equity
Composite
2009
2010
2011
2012
2013
2014
2015


SMB
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
SALES
EBITDA
EBIT
Net income
Equity
Composite
2009
2010
2011
2012
2013
2014
2015