Preliminary Master Thesis Report

Fundamental Indexation: A Norwegian Investigation

Supervisor:

Samuli Knüpfer

Study Programme:

Master of Science in Business

Major in Finance

Contents

1. Introduction

The main goal of this master thesis is to develop a fundamental index and assess its performance on the Oslo Stock Exchange. Our aim is to carefully consider if the fundamental indexation method creates excess returns compared to the traditional capitalized-weighted indexation method.

Fundamental indexation is a relatively new idea suggesting a different way of asset composition compared to the traditional cap-weighted index form. The concept has attracted interest among several reputable researchers, and there has been published numerous related articles in recent years. That being said, there are no universal agreements regarding the economic theory the fundamental index is built upon, resulting in both praises and heavy critique. Some praises its superiority while others claim that the outperformance is just a result of its value tilt, compared to cap-weighted, which converges more towards a growth-tilt. The fact that the return on value stocks have experienced decades with abnormal returns certainly raise questions whether its outperformance only is sheer luck due to historical features or if it is likely to persist in the future.

We first encountered the phenomenon "Fundamental Indexation" in one of our courses (Investments) during the first year of the MSc in Business and we were both intrigued by it. One of us also participated in the course "Behavioral Finance", with Samuli Knüpfer as a lecturer, at bachelor level, which definitely triggered a general interest towards market inefficiencies and irrational behavior in capital markets.

In our search for a topic conforming our interests, we discovered the work of Arnott, Hsu & Moore (2005) and we quickly decided that we wanted to conduct similar research. They question the validity of the market efficiency and CAPM's arguably inaccurate assumptions. Hence, questioning the mean-variance efficient market portfolio claiming that inefficiency in capital markets would lead to suboptimal performance of capital-weighted indices. This is in opposition to previous consensus as it is said that a passive investor cannot yield a better return from any other portfolio than holding the market portfolio.

An essential pillar in their research is the financial theory stating that stock prices should converge towards fair price in the long-run. Hence, a cap-weighted index will create an inefficient return drag as it will rebalance itself in accordance with market values. The return drag is caused by an overweight in overpriced stocks and an underweight in underpriced stocks, creating an imbalance between stocks which are expected to over-/underperform according to the theory. In order to disentangle from such inefficiency, they created new indices composed of "market-value-indifferent-measures" focusing on firm-specific fundamentals instead, such as; Cash flow, sales, revenues, book value and number of employees. According to Arnott et al. (2008), weighting by these measures will reflect the economic state rather than the market state, distancing the fundamental index from market opinions and reducing its exposure towards mispricing and irrational behavior in "hyped low-tangible asset" stocks and so forth.

Another motivation for this field of study is the fact that several of academic papers worldwide has rejected the concept that a capitalized-weighted index is a good proxy for the market, consequently also rejecting the cap-weighted index to be mean-variance optimal. Further on, consensus is that it should be possible to create even more efficient portfolios. This certainly triggers our motivation to test innovative ideas which can perform better than the traditional indices. Arnott, Hsu & Moore (2005) finds that their portfolios outperform the S&P500 over the 43 year testing period after adjusting for risk (risk-adjusted return). This implies that fundamental indexation in general has the features to be more mean-variance efficient than standard cap-weighted indices.

The study by Arnott et al. (2005) was conducted in the U.S stock market. As of this, we believe that it would be interesting to conduct an equivalent test on the Norwegian stock market to see whether we find similar patterns. Such an outcome could make their conclusion more generalizable across countries whereas the opposite outcome would make us question its validity as a general "rule".

In the following we will describe previous conducted research on the topic, how they did it and critique they faced. We will then describe how we are going to create indices based on key characteristics and then use these characteristics to create fundamental indices, a benchmark index, which is cap-weighted and an equally

weighted index for comparable purposes. Furthermore, we will describe the empirical framework we are going to use to check for excess return for the mentioned indices. Lastly we will present the data we are going to use and how we are going to obtain it.

"*Most of the time common stocks are subject to irrational and excessive price fluctuations in both directions as a consequence of the ingrained tendency of most people to speculate or gamble...to give way to hope, fear and greed.*" - Benjamin Graham

Research question

Our main target with this master thesis is to answer the following research question:

- Does fundamental indexation create superior return for the passive investor compared to a traditional capitalized-weighted index portfolio?

In addition, as a sub-question, we want to assess the following:

- How does index composition affect the returns/losses in bull- and bear markets?

2. Literature review

2.1 Market efficiency and the mean-variance efficient portfolio

A commonly established theory states that under the efficient market hypothesis and Capital Asset Pricing Model (CAPM) framework, the portfolios would be the mean-variance efficient portfolios due to the fact that investors are assumed to be risk-averse (Fama, French, 2004). As of this, all investors are expected to choose the portfolio, which maximizes returns while minimizing the risk (standard deviation). When investors fully agree upon distribution of returns according to CAPM, the portfolio consisting of risky assets would then be equal across all investors, and hence being the mean-variance optimal market portfolio. The weight of each asset in the portfolio would then conform with the total market value of the asset divided by the market value of all risky assets (Fama, French, 2004), hence a capitalization-weighted portfolio.

Although, the credibility of CAPM has been questioned for the last four decades, recent empirical studies reveal that much of the variety in expected returns are not captured by the market beta. Hence, it seems to be unrelated to it, meaning that a large proportion of assets yields deviating returns compared to the suggested as of CAPM. There is evidence from a range of research papers that there are other significant measures to determine returns, such as P/E-ratio, debt/equity-ratio, excess return from small stocks and book-to-market ratio. Furthermore, if beta does not explain expected returns in a sufficient manner, CAPM fails to hold.

Also, constructing the true market portfolio is infeasible in real life due to the fact that it is theoretically unclear which assets that can be excluded from the market portfolio, such as human capital. As of this, one cannot actually test the CAPM as the real life market portfolio would only be a proxy for the true market portfolio. So, an explanation for the lacking relation between expected returns and estimated betas might be that the market portfolio proxies are mean-variance inefficient (Roll and Ross. 1994). According to their research, the market portfolio proxy is 22 basis points below the efficient frontier (Roll and Ross. 1994), which paves the way for questioning whether cap-weighted indices are optimal and if fundamental indices are superior.

2.2 Fundamental Indexation

Fundamental indexation is an idea which can be traced back to the "dot-com bubble" at the end of the 1990s. It can be considered an alternative way to form indexes and it deviates from the traditional market capitalized indexation method. The market capitalized indexation is based on the market value of companies, whereas the fundamental indexation method is a so-called non-price-based indexation method (Arnott, Hsu, West, 2008). The fundamental values which are considered to be non-price-based are for example; dividends, sales, net income, number of employees etc (Arnott, Hsu, Moore, 2005). As we mentioned previously it is believed that the market cannot be considered fully efficient, which in turn can lead to an overweight of overpriced shares and an underweight of underpriced shares when using market capitalization (Mar, Bird, Casavecchia, Yeung, 2009). It can therefore be possible to construct a portfolio with a higher mean return with comparable risk to the market (Chen, Chen and Bassett, 2007).

Even though the fathers of fundamental indexation, Robert D. Arnott, Jason C. Hsu and Philip Moore, points out flaws with the market capitalized indexation, they also point out the many benefits a passive investor can achieve in tracking these indices. The most important aspect they mention is the cost aspect. They emphasize that net of costs it is extremely hard for active funds to outperform the market consistently, which makes an investment in a passive fund tracking the market a better investment for the average investor (Arnott, Hsu, West, 2008, p.49-50). Other benefits which contributes to the attractiveness of index funds are; liquidity and capacity, built-in diversification, low turnover and taxes, and that it is easy to use (Arnott, Hsu, West, 2008). These factors revolve around the fact that the firms in the index are large firms with a high trading volume and a high liquidity. It is also automatically rebalanced which reduces the transactions costs and manager fees. The capital weighted indexes also let the investors participate in a broad equity market which increases the diversification. Lastly, the market capitalized indexes rarely realize gains, and if it does it is often tiny, which makes the taxes lower relative to the active managers, whom are trying to buy low and sell high.

The fundamental indexes are as the market capitalized indexes based on a company's size, but not on the market prices as mentioned. Through the fundamental values, Arnott, Hsu and Moore constructed an index where the resulting portfolios outperformed the S&P 500 with an average of 197 basis points over a 43-year time period (Arnott, Hsu, Moore, 2005). The results were robust through time, business cycles, bull- and bear markets and through different interest rate regimes (Arnott, Hsu, Moore, 2005, p 97). They believed that it could be several reasons for the outperformance, such as better portfolio construction, inefficiency in the stock prices, that their portfolios had additional exposure to distress risk or a combination (Arnott, Hsu, Moore, 2005).

2.3 Performance measures

In order to compute the excess returns provided by the fundamental index relative to the benchmark, Arnott et al (2005) calculated the average CAPM betas to obtain the alpha. Alpha is the abnormal excess returns of the actual portfolio compared to the expected return given by CAPM using the risk-free rate and the expected return

on the market portfolio. This performance measure is known as the Jensen's Alpha, and it was initially used to assess mutual fund performance in the context of managerial skills (Jensen, 1968). Hence, it aims to test the ability to predict excess returns compared to the market expectations adjusted for the systematic risk (beta), which they undertake. Then, if a portfolio manager has an ability to forecast, alpha would be positive (Jensen, 1968).

As Jensen's alpha is based on CAPM, it indicates in accordance to theory that investors are risk-averse, wealth-maximizing with the same time horizon, have the same investment opportunities etc., which implies that the market portfolio would be the mean-variance optimal portfolio. Hence, one should not be able to beat the market, meaning that alpha should be smaller than or equal to zero. This is also proven throughout the research paper as mutual funds on average obtains a negative alpha as well as a lack in evidence of significant outperformance, meaning positive alpha.

In their original study Arnott et.al (2005) mentioned, in addition to the use of Jensen's alpha, the Fama & French three-factor model. This model takes into consideration, in addition to the market risk, both the size of the companies and the relationship between the book-value and the market-value of a company's equity. These two factors are believed to be a good proxy for usual risk factors in stock return as well as directly related to economic fundamentals (Fama & French. 1992). When applied to the fundamental index concept in 2008 the portfolio earned an alpha of 30 basis points, net of the mentioned factors, from the period 1979 to 2006 (Arnott, Hsu, West, 2008).

Carhart (1997) added another factor another to the three-factor model; Jegadeesh & Titman's one-year momentum anomaly from 1993 - and thus created a four-factor model. Through tests the four-factor model improves on the average pricing error compared to the standard CAPM and the three-factor model (Carhart 1997). Hence, the four-factor model seems to be a reasonable and more accurate performance measure.

The use of a four-factor model is also backed by (Amenc, Goltz & Le Sourd. 2009). They argue that using the model leads to an incorporation of the investment style

of an equity portfolio. This again led to a significantly reduction in the alpha compared to the single factor model CAPM alpha which will be discussed more thoroughly in section 2.5.

2.4 Other relevant studies

The "noisy market hypothesis" (Siegel, 2006) is supposed to explain size and value anomalies. The hypothesis implies that stocks with a declining price, for no fundamental reason, tends to yield greater than normal returns, and the opposite for stocks whose prices increase for no fundamental reason. In the context of a cap-weighted index, this effect will lead to an overweight in overpriced stocks and an underweight in underpriced stocks in relative terms. This will cause a return drag (Amenc et al, 2009), leaving cap-weighted indexes suboptimal. Amenc et al (2009) concludes that all characteristic-based indices, such as the fundamental index, yielded higher returns than the cap-weighted S&P500 index.

2.5 Possible shortcomings and critique

Even though Amenc et al (2009) finds that characteristic-based indices beat the cap-weighted index in terms of returns, the performance difference is not statistically significant for most of these. Also compared to the equally-weighted index, most other characteristic-based indices have lower returns, hence leaving Amenc et al. critical regarding the superiority of the fundamental index concept as suggested by Arnott et al. (2005). As mentioned previously when adjusting for systematic risk using the Fama/French/Carhart 4-factor model, the abnormal returns are reduced drastically leaving the alpha to be not significantly different from zero in most cases.

It is also argued that the recent outperformance of the fundamental indices over the traditional cap-weighted indices is not a result of the strategy's ability to arbitrage the inefficiency of the cap-weighted market, but rather being rewarded by loading on factor tilts (Jun & Malkiel. 2007). This is done by increasing the exposure in Fama-French's "value" and "size" risk factors. Jun & Malkiel (2007) also points out that during the past decades it has been the "value" stocks which have enjoyed

a significantly larger return than "growth" stocks. It is not certain that this trend will prevail in the future and the tide can easily turn as these types of stocks tends to outperform one another.

Perold (2007) has a critical view on the "Noisy market hypothesis", which is one of the pillars of why fundamental indexation should be able to outperform cap-weighted indices. He argues that cap-weighted indices do not skew investments towards overvalued stocks (and vice versa) and that the likelihood for over-/under valuation is equal when using cap-weighting, hence claiming that the return drag statement is wrong. He also discusses the performance of the fundamental index. Since value stocks in general have yielded documented higher-than-index returns in the last decades, questioning whether this is due to mispricing or simply because they are riskier. In his opinion, the theory seeks to implement an active management form into a passive management framework

Estrada (2008) points out that it is important for investors to consider whether the fundamental indices will outperform the traditional cap-weighted indices in the future. If this is the case it is important that investors do not bid up the value of companies with high fundamental values even though indices with an overweight of these kind of companies, today, deliver higher returns than normal cap-weighted indices (Estrada. 2008).

3. Methodology

3.1 - Making a proper index

In order to make an index we chose to follow the same key attributes as Arnott, Hsu and West (2008) used to make the "ideal" index. They define a proper index to be an index built on four key characteristics, where non imply cap-weighting. The first is that the index should be *representative* meaning that it should include a large number of stocks which represent the market as a whole. The second attribute revolves around *replicability* which means that it should be possible to buy the desired weights of different stocks easily. *Transparency and rule-based* is the third factor which makes the index historically replicable. Finally, an index which is designed for passive investing should have *low turnover.*

Based on the mentioned criterion we want to construct indices which can be considered non-priced based resulting in the construction of a composite of the different indices. The reason for the combination of single indices is that this approach will lead to a better and more robust index construction as well as it removes some of the biases any single index may experience (Arnott, Hsu, West. 2008). The non-price based fundamentals we intend to use are; book value, dividends, cash flows and sales which are the same fundamentals, as Arnott, Hsu and Moore used in their original study from 2005. These fundamentals represent objective measures which can be used to measure economic size and they are easily obtainable implying that the composite index can be used globally (Arnott, Hsu, West, 2008).

To construct the indices, we will use the Oslo Stock Exchange All Share Index (OSEAX) in order to obtain a large enough sample of data. We will then pick a sufficient number of large companies which reflect the Norwegian economy for the mentioned metrics. There are different reasons that we are not just simply re-weighting the Oslo Stock Exchange Benchmark Index (OSEBX). We might end up with a portfolio that is heavily concentrated in stocks that are large in both book value and in cap-value and we might face the risk of excluding stocks with low

market value which are heavyweights in terms of fundamental assets. (Arnott, Hsu & Moore. 2005).

For comparison reasons we also choose to construct our own reference portfolio on the same sample of stocks. We will therefore use the same framework as we use for our fundamental indices, choosing an equal amount of companies which represent the Norwegian economy based on market value using the same population sample. By doing this we can directly compare the two indices uncomplicated by questions of float, market impact, subjective selections etc. (Arnott, Hsu & Moore. 2005. p.86).

To create the separate fundamental indices, we use trailing five-year averages for all the metrics except the book value. We do this because using a single-year metric might lead to substantial volatility in the indices and hence high turnover (Arnott, Hsu & Moore. 2005. p.85). We will, as previously mentioned, rank the companies by the size of their fundamental values and use the following formula to give them their respective weights in the different indices:

$$w_i = \frac{FV_i}{\sum_{i=1}^{N} FV_i}$$

Where:

w_i = the weight of the single firm, i in the index

FV_i = the fundamental value of the single firm, i

To create the fundamental indices, we use the following formula:

$$I_i = \sum_{i=1}^{N} w_i * p_i$$

Where:

p_i = the price per share for the single firm, i

I_i = single fundamental index value, i

The rebalance of the indices happens at the last trading day of December to adjust the weights due to the fact that they will change since fundamental values are not constant. As of now we are going to assume a transaction cost based on the work

of Lesmond, Ogden and Trzcinka (1999) where they argue that transaction costs for large firms are close to 1.2%.

We will then merge the individual fundamental indices into a composite for the reasons mentioned previously. This is done simply by equally weighting the four individual indices. However, some companies do not pay out dividends, which have to be taken into account. In order to adjust for the companies that do not pay dividends we rely on an equally weighted three-metric average for companies that have not paid dividends in the past five years, as Arnott, Hsu & West (2008) did.

Finally, we want to construct an equally weighted index using the same framework as our other constructed indices. We will give all the different companies in our population sample an equal weight. Hence, the name "equally weighted index". The reason for constructing an additional index is that we want to check the performance of the fundamental indexation against another, much studied, alternative way of indexation. If the fundamental indexation method is to be the closest to mean-variance optimal of the two, the risk adjusted return have to be superior to the equally weighted index's risk adjusted return.

3.2 - Outline of empirical study

In order to evaluate the significance of our result, we need to conduct different empirical tests.

An important aspect when measuring performance between portfolio types would be to adjust the returns for the risk involved due to its composition. Hence, when comparing the performance difference between fundamental-weighted against the cap-weighted- and equally weighted portfolios, we want to calculate their Sharpe ratios as follows:

$$Sharpe\ Ratio = \frac{R_p - R_f}{\sigma_p}$$

Outperformance would in this manner be shown as a higher Sharpe-ratio, meaning that the risk-to-reward ratio is better. Because the majority of investors are short-

term in general, a majority of research sources suggest that a short-term T-bill rate would be an appropriate proxy for the risk-free rate in the Sharpe ratio. However, as the Nibor might be more volatile during recessions and booms as it reflects the average lending rate for unsecured loans between Nibor-banks, it is reasonable to assume that Nibor is a better proxy for reflecting the time-varying risk-aversion in general.

Furthermore, we want to conduct tests to gain insight into the potential abnormal returns generated by the fundamental index. Using the Jensen's Alpha (Jensen, 1968) we can compare the portfolios actual return against what is implied in terms of CAPM, meaning expected returns, as a function of the portfolio beta, risk-free rate and market portfolio return. The alpha-term would then indicate whether there are signs of outperformance compared to the market portfolio, which is supposed to be the mean-variance efficient portfolio as long as the Efficient Market Hypothesis and CAPM holds.

The formula is as follows:

$$\alpha = R_p - \left[R_f + (R_m - R_f)\beta \right]$$

To determine the significance of alpha, we will conduct the following t-test:

$H_0: \alpha_i = 0$

$H_A: \alpha_i \neq 0$

As a fundamental index typically will gain a value-tilt compared to cap-weighted indices, it will also be relevant to implement an "extended" version of CAPM, namely Fama French three factor model, who's capturing more of the effects from such value tilts. Here we will also implement the fourth factor, Momentum, as suggested by Carhart. The difference between actual and expected returns will generate an alpha, which will be tested in the same manner as Jensen's Alpha.

The four-factor model is written as follows:

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_{M,t}(R_{M,t} - R_{f,t}) + \beta_{SMB,t}SMB + \beta_{HML,t}HML$$
$$+ \beta_{MOM,t}MOM + \varepsilon_{i,t}$$

Where MOM refers to momentum, also known as WML (winners minus losers), using the difference between the 10% top-and bottom return averages.

To determine the significance of alpha, we will conduct the following t-test:

$H_0: \alpha_i = 0$

$H_A: \alpha_i \neq 0$

In addition to testing the fundamental index towards the market and the cap-weighted reference index, we will also test it against an equal-weighted index. This is done in order to easier assess the credibility of the fundamental index as a potential outperforming concept; Is it superior, or is it just the fact that cap-weighted indices are highly inefficient and that there are even greater ways to weight a passive portfolio(?). This comparison will be tested using the differences in returns and risk-adjusted returns using Sharpe ratio.

4. Data

Arnott, Hsu & Moore (2005) gathered several additional fundamental data than what they ended up using in their composite index, such as for example "number of employees". We however, choose not to collect additional fundamental data other than we are going to use in our composite. The reason for this is that we believe it will be difficult to obtain adequate data on for example number of employees. As we mentioned previously we also consider the four metrics; book value, sales, cash flows, and dividends to be sufficient to determine the economic strength of companies. Hence, we will gather these types of fundamental data.

The timeframe of the data will hopefully be monthly, quarterly, semi-annually and annually as Arnott, Hsu & Moore (2005) used. Their findings however suggest that rebalancing monthly, quarterly and semi-annually only generate a higher index-turnover but do not have a significant positive impact on the annual returns (Arnott,

Hsu & Moore. 2005). We therefore consider the possibility of using only annual data if the collection process from shorter time intervals proves difficult.

We will use Datastream (Thompson Reuters) for our collection of fundamental data which will be for a 30-year time period (1986-2016). In order to construct the indices, we will also need the respective share prices of the companies to be used in the indices. Additionally, we need the risk-free rate in the Norwegian market and as mentioned we deem the Nibor valid to be considered as the risk-free rate. BI also have access to the database "Oslo Børs Informasjon" (OBI) which consists of various information regarding Oslo Stock Exchange from 1980 until present time. If Datastream proves to be insufficient in certain areas, we will try to extract the missing information from OBI.

Plan

January	• Writing the preliminary • Start the process of collecting data
February	• Continue collecting data • Develop models in excel
March	• Extract data from Excel and conduct empirical testing in Stata/Excel • Start writing first draft
April	• Continue writing thesis alongside exam prep in elective course
May	• Hand in first draft by the end of May
June	• Correct first draft in accordance with comments • Hand in final draft by 20.06.2018

Bibliography

- Arnott D. Robert, Hsu, Jason and Moore, Philip. "Fundamental Indexation". 2005. Financial Analysts Journal

- Hsu. Jason and Campollo. Carmen. "New Frontiers in Index Investing". 2006. Journal of Indexes.

- J. Hemminki, and V. Puttonen. "Fundamental indexation in Europe". 2008. Journal of Asset Management.

- J. Mar, R. Bird, L. Casavecchia and D. Yeung. "Fundamental Indexation: An Australian Investigation". 2009. Australian Journal of Management.

- Hsu Jason. "Cap-Weighted Portfolios are Sub-Optimal Portfolios". 2005. Journal of Investment Management. Vol 4. No. 3

- Partha. S. Mohanram. "Separating Winners from Losers among Low Book-to-Market Stocks using Financial Statement Analysis". 2005. Review of Accounting Studies. Volume 10. Issue 2.

- Hsu. J., Kalensnik. V., Little, B. "A Survey of Alternative Equity Index Strategies". 2011. Financial Analysts Journal. Vol 67. Number 5.

- Bodie, Z., Kane, A., Marcus, A. "Investments". 2014. 10th edition. McGraw- Hill Education.

- David Blitz and Laurens Swinkels. "Fundamental Indexation: An active value strategy in disguise". 2008. Journal of Asset Management. Vol 9. p. 264-269.

- Amenc Noël, Goltz Felix and Le Sourd Veronique. "The performance of characteristics-based indices". 2009. European Financial Management. Vol 15.

- Carhart M. Mark. "On persistence in mutual fund performance". 1997. The Journal of Finance. Vol 52.

- Fama Eugene F., French Kenneth R. "Common risk factors in the returns on stocks and bonds". 1992. The Journal of Financial Economics.

- Jun Derek and Malkiel G. Burton. "New paradigms in stock market indexing". 2007. European Financial Management. Vol 14.

- Arnott D. Robert, Hsu C. Jason and West M. John. "The fundamental index - a better way to invest". 2008. John Wiley & Sons, Inc.

- Estrada Javier. "Fundamental indexation and international diversification". 2008. Journal of Portfolio Management.

- Fama Eugene F., French Kenneth R. "The Capital Asset Pricing Model: Theory and Evidence". 2004. Journal of Economic Perspectives.

- Chen Chen, Chen Rong, Bassett Gilbert W. "Fundamental indexation via smoothed cap weights.". 2007. Journal of Banking and Finance.

- Roll, Richard, Ross Stephen A. "On the cross-sectional relation between expected returns and betas". 1994. The journal of Finance.

- Siegel, Jeremy J. "The noisy market hypothesis". 2006. The Wall Street Journal.

- Jensen, Michael. "THE PERFORMANCE OF MUTUAL FUNDS IN THE PERIOD 1945–1964". 1968. The journal of Finance.

- Malkiel, Burton G. "The efficient market hypothesis and its critics". 2003. Journal of Economic Perspectives.

- Perold, André F. "Fundamentally flawed indexing". 2007. Financial Analyst Journal.

- Lesmond A. David, Ogden P. Joseph and Trzcinka A. Charles. "A New Estimate of Transaction Costs". 1999. The Review of Financial Studies. Vol 12.