

Irrational Indexation

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ABSTRACT

I show for the first time by using the most comprehensive handcrafted Swedish fundamental database spanning 11,600** annual fundamentals and 29 years that Swedish fundamental indices are by design expected to generate abnormal returns. All fundamental indices are markedly tilted toward small caps and value stocks. Since small caps and value stock generate abnormal return in Sweden during the last 29 years there is no surprise I also find a statistical significant abnormal return among fundamental indices. This premium exists even after having adjusted for the systematic CAPM risk because CAPM fails to capture the small cap and value premiums. From a rational market perspective, fundamental indexation is a high-risk-high-return strategy. For those irrational market believers who believe small caps and value stocks carry no or little extra risk fundamental indexation is simply a high return strategy. Since fundamental indexation is based on Robert Arnott's irrational rationale and since it relies on a very irrational stock market view among investors I have decided to rename it *Irrational Indexation*TM.

Keywords: fundamental indexation, value stocks, small cap effect, CAPM anomalies, efficient market hypothesis.

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** 100 stocks × 4 fundamentals × 29 years

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DEFINITION OF FUNDAMENTAL INDEXATION

This thesis examines the *fundamental indexation* index fund method of investing. The method is very similar to the traditional capitalization indexation index fund method that involves investing in companies in line with their relative market value weights. Instead of market values, a fundamental index fund invests in companies in line with their relative fundamental value weights. Fundamental index managers commonly apply the following fundamentals: sales, earnings before interest and tax (ebit), earnings, book equity, cash flow, and dividends. Employees have only been used in research so far. Most index fund managers apply the fundamentals separately and thus manage e.g. one separate fundamental earnings index fund and one separate fundamental dividend index fund such as for example Wisdom Tree associated with Jeremy Siegel, a Wharton professor. The fundamentals are also used jointly in so-called composite fundamental index funds. For example Robert Arnott, a pioneer of the fundamental indexation concept, manages composite fundamental index funds based on equal weights of four fundamentals: sales, book equity, cash flow, and dividends. A potential benefit with composite fundamental indices is that they might average out specific sector exposures. A fundamental index just based on book equity may favor sectors which tend to have a relatively large book equity values and disfavor sectors with relatively low book equity values. It must be noted that the rationale and theory behind fundamental indexation has so far been far from crystal clear and that there is a fundamental indexation hype in the investment community because of its claimed ability in beating the market.

PREREQUISITE

Before reading this research paper, it is highly recommended for non-experts on fundamental indexation to read Robert Arnott's article "Fundamental Indexation" published in *Financial Analysts Journal* in Mar-Apr, 2005, page 83-99. It is available on the Internet via the website of Research Affiliates.

I. INTRODUCTION

“In Sweden, fundamental-weighted index funds have shown to generate 10.5% annual excess return says Dag Tjernsmo, CEO of XACT Fonder”

(XACT press release as of March 26, 2007)

The statement above is a Swedish version of the controversial superiority claim of fundamental indexation. It was issued in order to market Swedish fundamental index funds, pioneered in Sweden by XACT of Handelsbanken in 2006/07. This thesis investigates the claimed superiority of fundamental indices and the reasons behind this superiority. This research is novel and adds to past research on fundamental indexation in several ways.

First, this is the first study examining the characteristics of Swedish fundamental indices — not just the performance per se — which is a key reason why this thesis adds more understanding of the performance generated by fundamental indices. Second, it is the first study that applies econometrics and statistics in examining Swedish fundamental index data. Third, it is based on a handcrafted Swedish fundamental index database, which is the most comprehensive fundamental index database ever created in Sweden. It comprises key annual fundamentals — earnings (*EARN*), book equity (*BOOK*), employees (*EMPL*), sales (*SALE*) — and annual return on stocks including re-invested dividend of 335 different firms (132 listed + 203 de-listed stocks) during the past 29 years, which is the maximum time span available via the SIX trust database used for collecting return time series. This unique Swedish fundamental database could be used for further research into fundamental indexation — especially since Sweden lacks a public fundamental index database — and the Swedish stock market and is available upon request to the author.

Fundamental indexation was first presented by Robert Arnott, *et al.*, in 2005 in the article “Fundamental Indexation” published by *Financial Analysts Journal* (2005a). The article makes the claim that a fundamental index is probably to beat the S&P500 cap-weighted benchmark index by 2.13% per annum in risk-adjusted terms. This is why fundamental indexing has attracted a lot of attention from asset managers and investors. The global assets under management under fundamental indexing strategies have expanded swiftly to a multibillion-dollar industry. Fundamental indexing is one of the most successful investment products launched in recent ten years. During its first two full years since birth, 2006 thru 2008, fundamental indexing attracted over USD10billion in investments from both institutional and retail investors in the US. In September 2006, Handelsbanken, one of the largest Swedish banks, established the first fundamental index fund in Sweden, *XACT FTSE RAFI Fundamental Euro*. In October 2006, AP3, a major Swedish state pension fund, initiated a fundamental index strategy of managing

their assets. Because of its increased popularity fundamental indexation is important to study and it is likely to impact the pension wealth of most Swedish people. It must however be noted that it is somewhat unclear how to define the fundamental index industry. Some might define it narrowly as only the funds managed by Robert Arnott and his competitors since 2006 but others might also define it more broadly as all funds which apply the same characteristics biases similar to these fundamental index funds. According to Robert Arnott +USD30 billion is currently invested globally in line with fundamental indexation strategies. Compared to the USD3 trillion currently invested in capitalization-weighted index investment funds, fundamental indexation is only a marginal strategy. However, fundamental indexation is only an important investment strategy as long as it is a relatively marginal strategy since it is then it has potential to provide abnormal return. If fundamental indexation would supersede capitalization indexing as the new index paradigm its performance would turn into and thus be equal with the capitalization-weighted index.

Note that my study is not a direct Swedish replication of the research performed by Robert Arnott which spans more stocks, 1000, and a longer time period, 43 years, and partly other fundamental metrics. I exclude an examination of fundamental cash flow and dividend indices which belong to the most popular set of fundamental metrics examined and used by fundamental index managers besides the four examined by me. These two are excluded since I simply could not find the relevant data for these two metrics in an easy manner. I also picked a sample of Top-100 stocks by market capitalization annually because the pioneering Swedish fundamental index fund *XACT FTSE RAFI Fundamental Euro* is based on the 100 most liquid stocks in Europe and since there is a strong positive correlation between size and liquidity. It must be noted that *XACT FTSE RAFI Fundamental Euro* is based also on cash flow and dividends excluded in my study.

Fundamental indexation has sparked a fierce debate among academics and their opposing opinions rely heavily on opposing assumptions. Proponents claiming a new revolutionary paradigm in index fund investing such as for example Robert Arnott, Jeremy Siegel and Jack Treynor — all affiliated with fundamental index funds — assume somewhat irrational markets whereas opponents such as for example Burton G. Malkiel, Johan C. Bogle, and William Sharpe — some affiliated with conventional index funds — assume more rational and efficient markets.

The remainder of the paper is organized as follows. Section II introduces the relevant theoretical framework of fundamental indexation. Section III presents the hypotheses. Section IV presents data and methodology. Section V presents results. Section VI presents a discussion of the results. Section VII concludes.

II. THEORETICAL FRAMEWORK

In this section I present the theoretical framework of fundamental indexing. It must be noted that this study is targeted at a sophisticated finance audience such as scholars and fund managers. It is taken for granted that readers know about classic financial economics concepts such as for example market efficiency (Fama, 1970, 1991), Modern Portfolio Theory (Markowitz 1952), CAPM (Sharpe 1964, Lintner 1965) and value stocks (Fama and French, 1992). *Irrational Indexation* by Robert Arnott, *et al.*, (2005a) is also essential reading before reading any further.

The first four parts review the rationale and theories supporting and opposing fundamental indexation. In the first part I present Robert Arnott's rationale of fundamental indexing. In the second part I present the flaws in his rationale. In the third part I present the theoretical support of fundamental indexation. In the fourth part I present the theoretical critique of fundamental indexation. Note that I have excluded theories pertaining to cash flow, dividends and momentum in sales and return since my study does not examine these fundamentals. The fifth part reviews the empirical findings on fundamental indexation with a focus on studies of fundamental indexation from a Swedish perspective.

Part I: Robert Arnott's Rationale

Since stock markets are not 100% rational CAPM cannot hold and stock prices are assumed to irrationally deviate from intrinsic fair value. A cap index comprising over- and undervalued stocks will by definition overweight overvalued stocks and underweight undervalued stocks and according to Robert Arnott (2005a) experience a performance drag. The idea originates from for example Robert C. Jones with Goldman Sachs Investment Management and is explicitly stated in the 6th August 1990 issue of *Pensions&Investments*. Index fund managers who typically allocate in line to cap weighting will similarly overweight in overvalued stocks and underweight in undervalued stocks and also experience a performance drag. The implications of this argument, if true, is profound since more than USD3 trillion (Bogle & Malkiel, 2006) is currently being invested in capitalization-weighted index investment funds.

Further, the market cap portfolio includes both large cap stocks and growth stocks. However, financial research shows that in the long run small cap stocks tend to beat large-cap stocks and low price-to-fundamental stocks tend to beat large price-to-fundamental stocks. If one assumes market irrationality as Robert Arnott, small caps and low price-to-fundamental stocks provides a free lunch. They are constantly undervalued in a capitalization-weighted stock market. Robert Arnott assumes that small caps and low price-to-fundamentals do not carry any extra risk besides the risk measured by volatility.

About Two thirds of the small-cap premium is due to that low-cap stocks also tend to have low price-to-fundamentals according to Arnott. The low price-to-fundamental premium is thus the core value driver of fundamental indexation. Nevertheless, investing money directly based on low price-to-fundamentals produce abnormal return but is also produce more volatile because of volatile stock prices. That is why Arnott has chosen to create low price-to-fundamental indices indirectly by picking large fundamentals instead of doing a carbon copy of Dimensional Fund Advisor's approach launched in 2004 of picking low price-to-fundamental stocks directly

Arnott's solution is to allocate investment capital to stocks with large fundamentals with no regard to stock prices. This he calls valuation indifferent indexing. The allocation to specific stocks is smoothed by using five-year trailing averages of fundamentals. This minimizes volatility of the investment portfolio. By allocating investment capital without taking stock prices into regard, fundamental indexing does not suffer from the performance drag of overinvesting in overvalued stocks and underinvesting in undervalued stocks.

An often stated rationale of fundamental indexing is also that fundamental such as accounting measures are more objective measures of value and thus closer to the intrinsic values of companies than subjective market values. At least the goal with accounting measures such as earnings is to make it a measure of the true value according to Black (1980). If fundamentals are proxies for intrinsic values and if markets were rational all companies would sell at the same price-to-fundamental ratios. However, markets are irrational according to Robert Arnott so companies sell at different price-to-fundamental ratios. The rational thing to do then is to focus on buying underpriced stocks in terms of their fundamentals: stocks with relatively low price-to-fundamentals. This is likely achieved in a direct way by buying large fundamental stocks as will be examined in this thesis.

Today Robert Arnott is a fulltime fundamental index asset manager and runs his firm Research Affiliates. There are at least four other asset managers and consultants who exclusively focus on fundamental indices and which sell proprietary fundamental index licenses to other asset managers: Wisdom Tree, Global Wealth Allocators, VTL Associates, and Mergent. It is interesting to note that most, if not all, research claiming strict superiority of fundamental indexation springs from people linked to these asset managers and who profit from these claims.

Robert Arnott's key rationale is summarized in two bullets below:

- A cap index overweight overvalued stocks
- Small cap and value stocks will provide abnormal risk-adjusted return

Part II: The Flaws of Robert Arnott's Rationale

Robert Arnott's rationale of fundamental indexation is fundamentally flawed according to Perold (2007). For example, one key implicit assumption is a presupposition of systematic reversals in stock prices toward their fair value. This contradicts the explicit assumption of irrational markets that price usually differ from their fair value. Further, if this implicit assumption were in line with reality, the return of low price-to-fundamental portfolios would be strictly superior to the return of large fundamental portfolios (i.e., fundamental index portfolios), exposing a performance drag in fundamental indices. In other words, if market cap (i.e. price) indexation is relatively bad and fundamental indexation is relatively good, then an arbitrage return could be generated by going long in the small bad-to-good (i.e. small price-to-fundamental) stocks rather than just going long in the large good (i.e. large fundamental) stocks.

Further, the stated key rationale is a claim of a performance drag among cap-weighted indices is due to the truism that a stock market index overweight overvalued stocks and underweight undervalued stocks. Perold shows that albeit the key assumption of the fundamental index theory is unknown fair values of stocks among stock investors, fundamental index theorists include the fair values in the information set in formulating the theoretical expected return of market-cap-weighted portfolios. In other words, they implicitly, assume that investors know the fair values of stocks. When Perold formulated expected returns without knowledge of the fair prices, by using Bayesian analysis, the claimed drag disappeared.

Kaplan (2008) shows that Arnott's fundamental indexation concept assumes the fundamental weights are unbiased estimators of fair value weights and that the fundamentals are statistically independent of market values. He demonstrates that this assumption is internally inconsistent because the sources of the errors are also determinants of market values. In this way he dismisses the notion that fundamental indexing *must* work. He also shows that a fundamental index *might* work because fundamental indices tend to be value biased, and value stocks have outperformed growth stocks during the most recent years. However, Malkiel (2003) shows that US value stocks tended to outperform growth stocks during the last +30 years but that they underperformed value stocks between 1937 and 1969. So even if a fundamental index *might* work, there is no guarantee it *will* work.

The key flaws of Arnott's rationale are summarized in two bullets below:

- A cap index do not overweight overvalued stocks
- Small cap and value stocks may not provide abnormal risk-adjusted return

Since the fundamental index "theory" of Arnott is flawed the motivation behind and against it must be found in other financial research. This other financial research is presented below.

Part III: Irrational Markets Support of Fundamental Indexation

Robert Arnott assumes at least semi-strong market irrationality, i.e. that stock markets are not efficient in the semi-strong form. He admits this in his first circulated version of the Fundamental Indexation article: “This is a stronger form of price inefficiency since the pattern of price deviation is systematic and there are obvious strategies to profit from the inefficiency.” (Arnott, *et al.*, 2004). If information of fundamentals adjusted for non-recurring items of all stocks on a stock market were accessible to all investors at zero information cost there would be no premium in this public information. This would be a perfectly competitive equilibrium in a perfectly rational market. However, if in line with Robert Arnott assume irrational markets there is no perfectly competitive equilibrium and no zero profit limits. Then, information of the top companies by fundamentals in an economy, which is assumed superior valuation information, is only available at an information cost. As long as not all investors incur this cost the ones who do are informed and could profit from this asymmetric information and this profit could be larger than the cost of obtaining it. Thus, if fundamental indexation delivers abnormal return it is generated by a wealth transfer from uninformed investors to informed fundamental index investors.

The information about which stocks that have large fundamentals might also be a good indicator of which stocks that are small cap stocks and value stocks and thus tend to generate abnormal return due to the well-documented small cap and value premiums in the financial markets. Below are the irrational markets explanations of the small cap premium and the two most well documented low price-to-fundamental premiums: the market-to-book and price-to-earnings.

The small cap premium was first documented by Banz (1981). Its result is that at various holding horizons small firms on average outperform large firms. Since 1936 small company stocks in the US have produced 1.5 percentage points larger return than large company stocks. Specifically, low market cap firms have higher sample mean returns in average than it is estimated by CAPM if the market portfolio was mean-variance efficient. Albeit the small cap effect is usually portrayed as a premium it is not always the case. For example Dimson and Marsh (1998) report evidence that the size premium was -5.6% in the U.K. over the period 1989-1997.

Irrational markets proponents tend to argue that the size effect indicates a persistent mispricing of small cap stocks. One irrational explanation is that investors consistently underestimate the relative growth rate of small cap stocks vis-à-vis large cap stocks. This underestimation causes small cap stocks to be underpriced and thus generate abnormal return vis-à-vis large cap stocks. This could be shown in algebraic form by applying the so-called Gordon’s (Gordon and Shapiro, 1956) growth formula.

$$P_{t=0} = \frac{DIV_{t=1}}{r_{WACC} - g} \Rightarrow g \downarrow \Rightarrow P_{t=0} \downarrow \Rightarrow r(0,1) \uparrow \quad (1)$$

As seen in equation (1) above, if growth rate g is consistently underestimated it will cause the stock prices to be persistently underpriced. The initial value $P(0)$ will go down (i.e. is lower) if g is lower in period 0. Then in the next period when the actual higher growth rate is known, the price will appreciate. The reason why investors underestimate the relative growth g rate of small cap stocks could be that there is more estimation risk for small firms since far less information is available on these stocks. Since investors are far less certain of the growth rate of small caps, they are not willing to pay for this growth rate at the same extent they are willing to pay for the more certain growth rate of large cap stocks. However, on the whole, this non-willingness to pay for uncertain growth rate of individual small cap stocks causes the return of the collective group of small cap stocks to outperform the group of large cap stocks.

The second effect reviewed here is the most well documented low price-to-fundamental premium: the market-to-book premium. This is the well studied effect that low market-to-book stocks generate abnormal return in relation to large market-to-book stocks and in relation to return expected by the CAPM. Daniel and Titman (1997) argue the market-to-book effect is not due to systematic risk but due to certain value characteristics, for example that investors prefer value stocks. They argue that same size market-to-book stocks simply move together because they are impacted by similar factors, not because they possess certain level of systematic risk. Lakonishok, *et al.*, (1994) claim that the value stock premium is not a risk premium. Instead, they propose the premium is due to investors' systematic naïve extrapolation of future performance. They argue that investors seem "to extrapolate past performance too far in the future" leading to a constant overestimation of the future growth prospects of growth stocks and an underestimation of the growth prospects value stocks. The persistent relative underestimation of value stocks could be shown in algebraic form by applying the Gordon's growth formula to the market-to-book ratio.

$$P_{t=0} = M_{t=0} = \frac{DIV_{t=1}}{r_{WACC} - g} \Rightarrow \frac{M_{t=0}}{B_{t=0}} = \frac{\frac{DIV_{t=1}}{r_{WACC} - g}}{B_{t=0}} \Rightarrow g \downarrow \Rightarrow \frac{M_{t=0}}{B_{t=0}} \downarrow \Rightarrow r(0,1) \uparrow \quad (2)$$

The relative underestimation of the growth g rate of value stocks causes them to have low market-to-book ratios, and subsequently an abnormal return.

The third effect reviewed here is the second most well documented low price-to-fundamental premium: the low price-to-earnings premium. One of the pioneers of the price-to-earnings premium was Nicolson (1960), who showed that companies with low price-to-earnings ratios on average subsequently yield higher returns than large price-to-earnings companies. The

return differential is the value premium. This result was later confirmed by Basu (1975, 1977) in his more extensive studies. Basu (1975) even states that investors could beat the market by acquiring low price-to-earnings stocks and thus that “a market inefficiency seems to have existed.” Irrational markets-believing economists often interpret the low price-to-earnings premium as a systematic mispricing. One explanation is in line with the claim of Lakonishok, *et al.* (1994) presented above that investors relatively and irrationally underestimate the growth rate g of value stocks vis-à-vis growth stocks. This is shown in algebraic form by applying the Gordon’s growth formula to the P/E ratio below.

$$P_{t=0} = \frac{DIV_{t=1}}{r_{WACC} - g} \Rightarrow \frac{P_{t=0}}{E_{t=1}} = \frac{\frac{DIV_{t=1}}{r_{WACC} - g}}{E_{t=1}} \Rightarrow g \downarrow \Rightarrow \frac{P_{t=0}}{E_{t=1}} \downarrow \Rightarrow r(0,1) \uparrow \quad (3)$$

The relative underestimation of the growth rate g of value stocks causes them to have low price-to-earnings ratios, and subsequently an abnormal return.

All the three irrational premiums described above — small cap, low price-to-earnings, and low market-to-book — provide opportunities for investors to earn higher rates of return than those predicted by a benchmark, usually the CAPM. These are likely key performance determinants of fundamental index performance along with any other low price-to-fundamental effects in relation to the specific fundamental chosen as metric in a fundamental index. All the effects interpreted here are related to an underestimation of growth. In other words, “proponents of fundamental indexing assert that investors are overpaying for growth” (Sharpe, 2007)

A central difficulty in interpreting the three effects presented above is the so-called joint hypothesis problem as explained by for example Campbell, *et al.* (1997). Either they produce abnormal return because stock markets are irrational, or they produce abnormal return because the chosen benchmark market model, especially CAPM, is irrational, or perhaps because both stock markets and the market model are irrational. The problem is to determine which. The solution by Robert Arnott is to claim that both CAPM and the cap-weighted stock market are likely irrational (2005b) although it is not really possible to know. Further, he also uses CAPM in claiming that fundamental indexation generates abnormal return (2005a). It must involve some flawed logic in claiming superiority over an expected performance calculated according to a flawed model. The section below presents the alternative rational explanations of the three effects presented.

Part IV: Rational Markets Critique of Fundamental Indexation

There are also perfectly rational explanations to the abnormal return generated by fundamental indexation. Even Robert Arnott admits this possibility by saying that “the excess return of the

Fundamental Index over the S&P500 can arise from (1) superior market portfolio construction, (2) price inefficiency, (3) additional exposure to distress risk, or (4) a mixture of the three” (Arnott, *et al.*, 2004). Mr. Arnott argues strongly in favor of the first two alternatives although he in another article states that “Most small companies are fundamentally riskier than most large companies” (2005b). Here are the rational markets explanations of the small cap premium and the two most well documented low price-to-fundamental premiums: market-to-book and price-to-earnings.

The small cap premium reflects according to Chan, Chen, and Hsieh (1985) default risk. Smaller firms are less diversified and have a higher systematic risk to default and therefore it is natural to under price these securities because investors demand a higher return for holding these stocks. The rational explanation to the size effect — high risk high return — could be shown in algebraic form by applying Gordon’s growth formula.

$$P_{t=0} = \frac{DIV_{t=1}}{r_{WACC} - g} \Rightarrow r_{WACC} \uparrow \Rightarrow P_{t=0} \downarrow \Rightarrow r(0,1) \uparrow \quad (4)$$

For example small companies with small resources tend to have higher borrowing costs than large diversified firms because of their high risk of default. This increases the weighted average cost of capital of these firms (r_{WACC}) as seen above. Also, the size effect found in some studies could be at least partly due to survivorship bias in currently available computer tapes of past returns (Malkiel, 2003). Rather than indicating market inefficiency, the size effect could thus rather indicate model (CAPM) inefficiency. That is why CAPM popularly is extended with two additional factors, SMB (small minus big) and HML (high minus low). This is the Fama French three factor pricing model, and it thus takes the size effect (SMB) into account in calculating expected returns. SMB equals the return differential between portfolios of small and large stocks. The small cap premium is closely related to the value stock premium since especially small cap stocks tend to have a value premium.

The low market-to-book premium is well-documented by Fama and French (1992, 1993, 1996, 1998). Specifically, they show that the CAPM beta cannot explain the difference in return between portfolios formed on the basis of the ratio of market-to-book. However, rather than indicating market inefficiency, they argue that the market-to-book effect indicate CAPM model inefficiency. Fama and French (1998) claim that the market-to-book effect represents a compensation for systematic risk not captured by the CAPM beta. For example companies in financial distress have often low market-to-book ratios. The rational explanation to low market-to-book ratios could be shown in algebraic form by applying the Gordon’s growth formula to the market-to-book ratio.

$$P_{t=0} = M_{t=0} = \frac{DIV_{t=1}}{r_{WACC} - g} \Rightarrow \frac{M_{t=0}}{B_{t=0}} = \frac{\frac{DIV_{t=1}}{r_{WACC} - g}}{B_{t=0}} \Rightarrow r_{WACC} \uparrow \Rightarrow \frac{M_{t=0}}{B_{t=0}} \downarrow \Rightarrow r(0,1) \uparrow \quad (5)$$

Thus, if certain stocks' systematic risk is higher than others, investors will rationally demand a higher return on these stocks. The higher required return decreases the current stock price and decreases their current market-to-book ratios. Thus, low market-to-book stocks outperform high market-to-book stocks, and vice versa. The firm's market-to-book ratio is correlated with its excess capital capacity and could therefore serve as a proxy for the firm's systematic risk. Since the CAPM cannot explain the abnormal return of low market-to-book stocks it is usually extended into the Fama French three factor pricing model, which takes the market-to-book effect into account with its HML factor.

The price-to-earnings premium was first extensively researched by Basu (1977). Efficient market proponents tend to argue that the price-to-earnings premium is a compensation for higher systematic risk. This could be shown in algebraic form by applying the Gordon's growth formula to the price-to-earnings ratio.

$$P_{t=0} = \frac{DIV_{t=1}}{r_{WACC} - g} \Rightarrow \frac{P_{t=0}}{E_{t=1}} = \frac{\frac{DIV_{t=1}}{r_{WACC} - g}}{E_{t=1}} \Rightarrow r_{WACC} \uparrow \Rightarrow \frac{P_{t=0}}{E_{t=1}} \downarrow \Rightarrow r(0,1) \uparrow \quad (6)$$

Thus, if certain stocks' systematic risk is higher than others, investors will rationally demand higher return (r_{WACC}) on these stocks. The higher required future return, depresses the current stock price as well as their current price-to-earnings ratios. Thus, low price-to-earnings stocks outperform large price-to-earnings stocks, and vice versa. Campbell and Shiller (1988) report that over 40% of the variability in long-horizon returns can be predicted on the basis of the initial market price-to-earnings. Buying low price-to-earnings stocks could however be a folly since, instead of indicating value stocks, it could indicate that these companies have more lax accounting policies overstating their earnings. Price-to-earnings is in line with market-to-book also a value stock effect. The key take away from the efficient market hypothesis about price-to-fundamental ratios such as price-to-earnings is that low and high such values cannot indicate whether the stock is over- and undervalued. The distribution of over- and undervalued stocks is completely random according to the efficient market hypothesis and there is no way to design a strategy to beat the market after adjusting for the extra costs and risks involved of implementing this strategy.

In rational markets, the three effects described above provide no opportunity for investors to earn higher rates of return than those predicted by a rational benchmark. CAPM could be a best estimate, but it fails to fully capture and explain the small cap, the market-to-book, and the price-

to-earnings effects. If fundamental indexation performance is generated by any of these three effects, it is deemed to generate abnormal return vs. the CAPM benchmark. This abnormal return may however not indicate that fundamental indexation is superior but merely that high fundamental stocks carry extra risk, which produce this extra return. The problem lies in measuring and adjusting for the extra risk involved.

According to the theoretical reviews above, Robert Arnott presents his rationale for fundamental indexing. However, I show that his rationale is flawed. Also, I have shown that there are both theoretical arguments in support of fundamental indexation and in opposition of it depending on how rational we deem financial markets to be. In the next section I will review the more basic and specific empirical findings on fundamental indexing from a Swedish perspective.

Part V: Basic Empirical Fundamental Index Findings

Robert Arnott is the founding father of the fundamental indexing academic literature launched in 2005. The most important pre-2005 literature is presented above in its broader and more theoretical context. The more focused literature on the fundamental indexation subject post-2005 is primarily focused on empirical performance evaluation of different fundamental indices and is presented in this section. The focus here is on the empirical Swedish fundamental index research so I will shortly review the four relevant Swedish research papers examining this topic.

First, Grufman and Sjölund (2008) study a fundamental earnings index for 250 European stocks during a 28-year period (1979-2006). Note that this study is based on European-wide data and not exclusively Swedish data. They show a 2.7% abnormal return of the fundamental index versus its relevant benchmark. However, they are only able to reject one of their six null hypotheses: that a growth adjusted fundamental index will not create abnormal return above the expected return according to CAPM as well as according to the Fama French three factor model. This might thus indicate that the growth adjusted fundamental index is superior. However, they fail to discuss the potential association between trends in fundamentals and trends in stock prices and the failure of the CAPM and the Fama French models in capturing the trend aspects in stock prices which have caused many researchers, even Fama and French themselves, to add a fourth momentum factor to the original Fama French model. Thus, their only statistical significant abnormal return of a fundamental index could also be explained by a failure in the CAPM and the Fama French models in capturing the momentum effect. They also apply a commonly non-robust way in comparing different Sharpe ratios (Ledoit and Wolf, 2008) and offer no robustness test to show that their sample is not producing non-robust results. Despite these limitations, there is one key conclusion from the many tests performed: fundamental indices based on a European-wide sample of stocks do not tend to generate statistical significant excess risk-adjusted return.

Second, Holm and Moberg (2006) study a composite (sales, dividend, earnings) fundamental index of 28 stocks during a 10-year period (1996-2005). They show that average annual abnormal return of the composite fundamental index is 6% versus the OMX Stockholm (OMXS) all share index benchmark whereas the annual standard deviation of the composite fundamental index versus the OMX Stockholm all share index is virtually similar. Therefore, the Sharpe ratio of the composite fundamental index is superior to that of the OMXS benchmark. Naturally, they conclude that fundamental indices generate abnormal risk-adjusted returns during the period versus the broad OMXS all share index. This study suffers however from many flaws which puts the conclusion into questioning. The benchmark index used for comparison to the composite fundamental index consisting of 28 stocks is fundamentally different since it comprises all stocks on the Stockholm Stock Exchange. The OMXS index is not a good benchmark since it for example includes bid-ask spread transaction costs in contrast to the composite fundamental index which excludes these costs, giving it an unfair advantage. However, the key flaw in this study is that the data selection for the fundamental indices is made only in the end of the 10-year period under study based on the top 28 stocks by market caps with historical time series so it is clearly biased toward survivors and large cap stocks. This selection bias is the key reason why this study finds the highest annual abnormal return, 6%, among the studies reviewed here.

Third, Falk and Callervik (2005) study a composite (sales, ebit, book equity, dividends) fundamental index of 178 Swedish stocks during a 22-year period (1981-2002). They show that the fundamental index generates abnormal annual return of 2.7% with a lower and thus also superior standard deviation. They conclude that fundamental indices are superior in line with the pioneering research made by Robert Arnott. One drawback with this study is that the annual fundamentals for each year are linked to the returns of the following year even though the fundamentals were not published before the inception of the following year. This is unrealistic and could render biased results. Another drawback is that they have not applied any econometric methodologies so they cannot examine the statistical significance of their results.

Fourth, Martinson, Ramel and Vikström (2005) is the first Swedish study on fundamental indexation and it studies four fundamental indices (sales, ebit, ebt, employees) comprising 30 Swedish stocks each during an 11-year period (1992-2002). They show that three out of four indices (sales, employees, ebt) generate abnormal return of between 0.9-2.1% per annum whereas one (ebit) underperform by 0.3% and they all have lower and thus superior standard deviation than the cap-weighted benchmark index. They show that the fundamental employee index displays the highest implied Sharpe ratio among the four fundamental indices examined. The key flaw in this study is that a broad all-share benchmark is used as comparison to much smaller sample of stocks containing 30 stocks which excludes transaction costs included in the broader index.

There is a fifth Swedish research paper on fundamental indexation: Uhrdin and Walljaeger (2005). I have chosen to exclude a review of this thesis because of its poor quality and since they even fail to arrive at the accurate conclusion interpreting their data. They conclude that their fundamental index is inferior to the benchmark although if they would have adjusted for the lower volatility of the fundamental index they would have arrived at the typical Swedish academic conclusion of a superior fundamental index.

A summary of the key findings in the four Swedish research articles to date on fundamental indexation versus the original findings of Robert Arnott is presented in Table I below.

Table I
Original Findings vs. Swedish Empirical Findings

The Original Findings							
	Annual Return	STDEV	Sharpe	Excess Return	CAPM alpha	Fama French alpha	Data
Arnott, et al. (Mar 2005) Published in <i>Financial Analyst Journal</i> "Fundamental Indexation"							
FI Sample: 1000 US stocks	12,50%	14,7%	0,46	2,2%	2,4%	2,3%	43 years (1962-2004)
Benchmark: 1000 US stocks	10,35%	15,2%	0,30	t-obs: 3.26	t-obs: 2,44	n/a	F-to-T lag: 1 year
Risk Free Interest Rate	5,81%*					n/a	
Statistical Significant Excess Return				"Yes!"	"Yes!"	n/a	
*5.8% is the implied interest derived from the reported Sharpe, composite index return and standard deviation							
Versus the Swedish Findings							
	Annual Return	STDEV	Sharpe	Excess Return	CAPM alpha	Fama French alpha	Data
Sjöholm & Grufman (Feb 2008) Stockholm School of Economics Master Thesis "Are Market Capital Weighted Indices Suboptimal?"							
FI Sample: 250 European stocks	9,1%	18,0%*	0,20*	2,7%	3,70%	2,51%	28 years (1979-2006)
Benchmark: 250 European stocks	6,4%	19,1%*	0,05*	0,0%	t-obs: 1.58	t-obs: 1.46	F-to-T lag: 1 year + 4 months
Risk Free Interest Rate	5,5%						
Statistical Significant Excess Return			"No!"	n/a	"No!"	"No!"	
Holm & Moberg (Dec 2006) Stockholm University Master Thesis: "Fundamentalindex"							
FI Sample: 28 Swedish stocks	18,0%	32%	0,40	6,0%	n/a	n/a	10 years (1996-2005)
Benchmark: OMX Stockholm all-share	12,0%	31%	0,21	0,0%	n/a	n/a	F-to-T lag: 1 year
Risk Free Interest Rate	5,0%				n/a	n/a	
Statistical Significant Excess Return				n/a	n/a	n/a	
Falk & Callervik (Dec 2005) Lund University Master Thesis "Alternativa Index"							
FI Sample: 178 Swedish stocks	22,6%	7,3%	0,13	2,7%	n/a	n/a	22 years (1981-2002)
Benchmark: 178 Swedish stocks	19,9%	8,4%	0,09	0,0%	n/a	n/a	F-to-T lag: 1 year
Risk Free Interest Rate	n/a				n/a	n/a	
Statistical Significant Excess Return				n/a	n/a	n/a	
Martinsson, Ramel & Vikström (Jun 2005) Lund University Bachelor Thesis "Alternativt Viktade Aktieportföljer"							
FI Sample: 30 Swedish stocks	14,6%**	8,7%	Superior	2,1%	n/a	n/a	11 years (1992-2002)
Benchmark: SIXRS Stockholm all-share	12,5%	10,3%	Inferior	0,0%	n/a	n/a	F-to-T lag: 1 year + 2 months
Risk Free Interest Rate	n/a				n/a	n/a	
Statistical Significant Excess Return				n/a	n/a	n/a	
*STDEV and Sharpe are calculated by using the data of Sjöholm & Grufman's Table XIV (page 44)							
**The performance of the best performing index in the study; the fundamental employee index							

As seen in Table I above, the studies of Grufman and Sjöholm and (2008) and Falk and Callervik (2005) are the most robust Swedish studies of fundamental indexation. Both studies use more comparable benchmarks to their fundamental index (FI) samples. Both of these studies cover a large amount of stocks and also a relatively long period of data. All four Swedish studies support Robert Arnott's conclusion that fundamental indices generate abnormal risk-adjusted return measured in absolute terms. This support might however be superficial. This is because only one of the four Swedish studies, Grufman and Sjöholm (2008), applies econometrics and examine the statistical significance of the superiority claim and their conclusion is the opposite of that of

Arnott, *et al.*, (2005a): the higher risk-adjusted return is not statistically significant in terms of Sharpe, the CAPM, and the Fama and French three factor model. Arnott, *et al.*, on the contrary, conclude that the higher risk-adjusted return is statistical significant in terms of abnormal return and CAPM. It must however be noted that the study by Grufman and Sjöholm examines European-wide data. This means that there is currently no single study focusing exclusively on Swedish data that has examined fundamental indexation using econometrics. There is therefore no knowledge if any of the abnormal return generated by Swedish fundamental indices is statistically significant. I will fill this knowledge gap with this study.

Based on the comprehensive theoretical framework presented above, I will now form a set of testable hypotheses.

III. HYPOTHESES

I derive the following research hypotheses from my theoretical framework in the section above. The focus is on examining performance and some of the key performance determinants.

As shown in the theoretical framework above, all past studies examining Swedish fundamental index data conclude that fundamental indices outperform. Although, the study of Grufman and Sjöholm (2008) indicates it might be difficult to establish abnormal return in terms of statistical significance, I put my initial trust in the original research of Robert Arnott, *et al.* (2005a), and their most basic claim that fundamental indices generate abnormal return. This forms basis for my first research hypothesis related to my four fundamental indices ($Z = EARN, BOOK, EMPL, SALE$) and their relevant cap-weighted benchmark index ($MCAP$).

Hypothesis 1: Fundamental index Z generates abnormal return versus the $MCAP$ benchmark

The reason why fundamental indices outperform their relevant cap-weighted benchmark indices in past studies must be due to a different portfolio composition. The prime suspect is that fundamental indices are relatively low-cap biased simple because they probably do not put as much weight into large cap stocks as its capitalization-weighted benchmark index. The “performance drag” of capitalization-weighted indices is the key explicit rationale of fundamental indexing as stated by Arnott (2005a). The reasoning is that a cap-weighted index is inferior since it gives large caps a large metric weight. If that is the logic, then a fundamental index should be superior as long as it gives large caps a lower metric weight and higher weight to small caps. I thus believe that fundamental indices tend to stack up in small cap stocks and that these stocks potentially outperform large cap stocks. This forms the basis for my second research hypothesis related to my four fundamental indices ($Z = EARN, BOOK, EMPL, SALE$) and their relevant benchmark ($MCAP$).

Hypothesis 2: Fundamental index Z is relatively small cap biased vs the $MCAP$ benchmark

If a fundamental index is small cap biased in line with my research hypothesis, the next step is to investigate if this bias is a potential determinant of the fundamental index performance. The small cap premium was first documented by Banz (1981) in the US. Its result is that at various holding horizons small firms on average outperform large firms. Since 1926, small company stocks in the US have produced 1.5-percentage point larger return than large company stocks. Since my hypothesis is that fundamental indices are small-cap biased, my subsequent hypothesis is also that the small cap bias is associated with a small cap premium, which might explain why fundamental indices might outperform. However, this could be very difficult to measure econometrically since the small cap bias is probably just one of the many effects driving any abnormal return of fundamental indices. I might not find any statistical significant abnormal return of fundamental indices in line with Grufman and Sjöholm (2008) and then it will probably be even harder to find statistical significance among one of the many value drivers of this abnormal return. Therefore my subsequent hypothesis is focused on studying the differential in performance between small stocks and large stocks in my sample with no focus on fundamental indices. This focus is not needed since the low-cap bias should already be established above in answering the second hypothesis. My research hypothesis of a small cap premium is as follows.

Hypothesis 3: There is a small cap premium in Sweden

If a fundamental index focuses on stocks with large fundamentals (i.e. $Z\uparrow$), and perhaps also relatively small market capitalization (i.e. $MCAP\downarrow$), it would also imply that such an index would have a low price-to-fundamental ($MCAP\downarrow/Z\uparrow$) stock bias, i.e. a so-called value stock bias. That is, if a fundamental index is weighted by high earnings, I believe it will have a generally low price-to-earnings ratio. Arnott (2005b) has explicitly stated that he would like to focus on stocks with large fundamentals in relation to their prices. Also Kaplan (2008), among many other fundamental index critics, claims that fundamental indices tend to be value stock biased. And Arnott, *et al.*, (2005a) state in their conclusion regarding future avenues of research that “a particularly worthy question is whether the Fundamental Index has a value bias relatively to the cap-weighted indexes”. Since I am examining four fundamental indices based on four different metrics ($Y = EARN, BOOK, EMPL, SALE$) vis-à-vis their relevant benchmark ($MCAP$) my research hypothesis is as follows.

Hypothesis 4: Fundamental index Z is value stock biased versus the $MCAP$ benchmark

If a specific fundamental index has a value stock bias (i.e. low $MCAP/Z$), the next step is to investigate if this bias is associated with a premium. Relating to my four fundamental indices, especially two premiums are well documented: low price-to-earnings and low market-to-book.

First, the low price-to-earnings premium was documented early by Nicolson (1960), who showed that companies with relatively low price-to-earnings ratios generated a premium. The difference, Nicolson demonstrated, represents a value premium. This result was later confirmed by Basu (1975, 1977).

Second, the low market-to-book premium is well-documented by Fama and French (1992, 1993, 1996, 1998) who shows that companies with low market-to-book ratios on average yield higher return than large market-to-book companies. This difference is also called a value premium.

Since my fourth hypothesis is that fundamental indices are low price-to-fundamental biased, my subsequent hypothesis is that this bias causes the fundamental indices to outperform in line with the original findings of for example Nicolson and Fama and French. However, this could be very difficult to measure econometrically since one instance of a low price-to-fundamental bias is probably just one of the many effects driving an abnormal return of the specific fundamental index Z . I might not find any statistical significant abnormal return of fundamental indices in line with Grufman and Sjöholm (2008) and then it will probably be even harder to find statistical significance among one of the many value drivers of this abnormal return. Therefore my subsequent hypothesis is focused on studying the differential in performance between low price-to-fundamental stocks and large price-to-fundamental stocks with no focus on fundamental indices. I do not need to take the characteristic of fundamental indices into account since the low price-to-fundamental characteristic should already be established above in answering the fourth hypothesis. My research hypothesis of a low price-to-fundamental premium is as follows.

Hypothesis 5: There is a value stock premium in Sweden

Although I might establish a low price-to-fundamental bias in line with my fourth hypothesis above and/or that this bias generates a premium in line with my fifth hypothesis above, I cannot be fully convinced that this relationship holds also after having adjusted for the

extra risk a fundamental index involves. This is why I here will re-examine the abnormal return as examined in the first hypothesis adjusting for the systematic CAPM risk as well. I assume here that the CAPM captures all systematic risk. Arnott, *et al.*, (2005a) have shown that their fundamental index generated abnormal return also in a CAPM framework. Past research attempting at replicating the study of Arnott in the European stock markets such as Grufman and Sjöholm (2008) and Amenc, Goltz, and Le Sourd (2008) have not found statistical significant Jensen's alphas. I trust however the original research of Robert Arnott in forming my sixth research hypothesis relating to my four fundamental indices ($Z = EARN, BOOK, EMPL, SALE$) and benchmarks ($MCAP$).

Hypothesis 6: Fundamental index Z generates Jensen's alpha versus the $MCAP$ benchmark

A summary of the full set of hypotheses from above is presented in Table II below.

Table II
Summary of Hypothesis

This table shows all the six research hypotheses presented above. The second and the fourth hypotheses are related to the characteristics of fundamental indices whereas the other are related to the expected out-performance of fundamental indices. Z stands for either $EARN, BOOK, EMPL$, or $SALE$, which are the four different fundamental indices being examined. On the far right is the specific data set used in order to test respective hypothesis: A or B. Basically, *Data A* is a small sample of 29 annual portfolio performance figures and *Data B* is a large sample of 100 individual stock performance figures and individual weights during all 29 years, i.e. a sample of 2900.

H1: Fundamental index Z generates abnormal return versus the $MCAP$ benchmark	Data: A
H2: Fundamental index Z is relatively small cap biased versus the $MCAP$ benchmark	Data: B
H3: There is a Swedish small cap premium	Data: B
H4: Fundamental index Z is value stock biased versus the $MCAP$ benchmark	Data: B
H5: There is a value stock premium in Sweden	Data: B
H6: Fundamental index Z generates Jensen's alpha versus the $MCAP$ benchmark	Data: A

Note that the hypotheses in Table II above are highly interrelated. For example the sixth hypothesis is heavily related to the first hypothesis. The difference is that the sixth hypothesis goes a step further and adds a CAPM risk adjustment in examining abnormal return. Note also that the second hypothesis is related to the third hypothesis. The second hypothesis examines the small cap characteristic whereas the third hypotheses examines if this characteristic is associated with superior performance. Similarly, the fourth hypothesis examines the value stock characteristic whereas the fifth hypothesis examines if this characteristic is associated with superior performance.

My aim is to apply the six testable hypotheses presented in Table II to econometric models in order to generate results and draw conclusions. The data collected for this exercise is presented in Section IV below.

IV. DATA

The data used in this study is a manually constructed sample (n) of the Swedish stock market population (N). This sample is used in order to draw inferences about the performance and characteristics of fundamental indices. There are two levels of the sample: composite (A) and individual (B). First, there is annual portfolio performance data as displayed in Table III below. These 29 years of data is composite of a maximum of 100 individual stocks each year. Second, there is annual fundamental and individual stock performance data for each of the maximum of 100 individual companies during the last 29 years. The A level of the sample is simple a composite of the B level combining a maximum of 100 fundamental weights and 100 performance figures into one annual portfolio performance figure.

In order to form fundamental indices, two kinds of data sets are needed: annual fundamental figures in order to calculate annual portfolio weights and annual share price time series — dividends included and reinvested — in order to calculate performance. First, the fundamental data used comprises annual fundamental metrics for each of the top-100 companies by market cap in Sweden for each year during $t = 29$ years: 1979 – 2007. This means that there are samples (n) of a maximum of 2,900 annual fundamental observations for each metric. The full set of metrics used in this study includes:

- | | |
|--------------------------|-------------|
| 1. Market capitalization | <i>MCAP</i> |
| 2. Earnings before tax | <i>EARN</i> |
| 3. Book equity | <i>BOOK</i> |
| 4. Employees | <i>EMPL</i> |
| 5. Sales | <i>SALE</i> |

Note that employees and sales are only very seldom used to value companies for example among corporate finance professionals; free cash flow, dividends, book equity, and earnings are more common and probably better proxies for corporate value. Also, financial research has shown that price-ratios comprising especially these fundamentals — not employees and sales — are associated with the average returns of common stocks. These are probably the key reasons why sales and employees are very seldom in use among fundamental index managers and why the other fundamentals are so commonly used. I have not included any composite index simple because most fundamental index managers use one sole fundamental metric.

All the metrics are sourced from the annual publication *Börsguiden*, which is published around mid-year every year. Note that *MCAP* has been adjusted so it gives the value at year-end

and not at publication date which is a few months later. For one year, 1990, when information for employees was missing I have taken figures from this from the annual publication *Sveriges Största Företag 1991/92*. The benefit of using these publications as sources is that all values included have been verified, adjusted and normalized. To further ensure that mainly fundamentals adjusted for non-recurring items are being included, whenever available the fundamentals have been replaced by figures from the proprietary database of *SEB Enskilda Securities*. This database contains all the key fundamentals of all the stocks *SEB Enskilda Securities* has ever covered with their equity research team during a 20-year period (1987-2007). A second rationale of using the proprietary data of *SEB Enskilda Securities* is to minimize survivorship bias and include a few stocks that were excluded by *Börsguiden*. Note that my annual fundamental data for the Top-100 companies by market from 1987 until 2007 is sourced from *SEB Enskilda's* database, whereas the fundamental data for the smaller companies post-1987 and all fundamental data pre-1987 are sourced from mainly *Börsguiden*.

Second, the share price data used comprises annual total return data for each of the top-100 companies by market cap in Sweden for each year during the last 29 years: 1980 – 2008. It must be noted that I use a specific definition of return and that I assume it is distributed in a specific manner. The definition of return used in this thesis is the simplest possible:

$$\frac{P_t - P_{t-1}}{P_{t-1}} = \frac{P_t}{P_{t-1}} - 1 = r(0,1) \quad (7)$$

Note that I make the simplifying assumption, in line with Modern Portfolio Theory, that the distribution of stock returns, and therefore also abnormal returns, is normally distributed. Graphical inspection and tests of normality of abnormal returns used are included in Appendix A and B. The analysis and assumptions of the distributions of stock returns plays an important part in financial theory since a distributional assumption is required for example for mean-variance portfolio theory and theoretical models of capital asset prices.

Note that I use a fundamental-to-time series lag of one year in line with Robert Arnott. My full-year fundamentals originate from 1979 – 2007 and these fundamentals are linked to total return time series as of January 1980 – December 2008. The reason for this lag is that fundamental full-year figures regarding e.g. sales and earnings for one year, e.g. 1979 were published in the year-end report. Therefore I buy securities based on these fundamentals in early January 1980 and hold it until end of December 1980, when I do the very same procedure again. The full set of time series data used in this study includes:

1. Share prices of 132 currently listed firms on Stockholm Stock Exchange
2. Share prices of 203 delisted firms
3. Annual dividends for the 335 firms
4. The Swedish benchmark stock index Affärsvärldens Generalindex, *AFGX*
5. The so-called risk free Swedish reference interest rate, *REFR*

The return data used is originally daily closing bid prices from the *SIX Trust* database. Share prices of delisted firms have been included in order to minimize survivorship bias.

Note that the *SIX Trust* database is nowadays a very dysfunctional database. It includes dividends only at a maximum of ten years back and only for the currently listed companies. Further, only the time series for the very largest companies have been adjusted for M&A events and name changes. Because of this, annual dividends for all stocks have been instead been sourced from the annual publication *Börsguiden* and reinvested in the share prices of all stocks as of mid-year (early July). The Swedish market benchmark index included is Affärsvärldens Generalindex (*AFGX*) and it has been sourced from the website of *Affärsvärlden*. Note that this index is not being used as a benchmark in this study since that would not be relevant since it is markedly different from my fundamental indices in several aspects. First, this index does not include reinvested dividends. Second, this index includes the bid-ask-spread transaction cost. Third, it comprises many more stocks. The risk free interest rate used is the so-called Swedish reference rate (*REFR*) and it has been sourced from the website of The Riksbank, the central bank of Sweden.

To create each of the four fundamental indices I have ranked the 100 companies by their respective metric (*EMPL*, *SALE*, *EARN*, *BOOK*) from high to low for each of the 29 years. All companies are included in respective index at its relative annual metric weight to create the fundamental index for that metric. Whenever a metric is missing, for example the number of employees for a specific company and year, the metric weight given is zero. To ensure that the fundamental metrics are known before the share price data used, I match all fundamental metrics for fiscal year $n=0$ (e.g. 1979) with returns for calendar year $n=1$ (e.g. 1980) as described above. The annual metric weight times the annual total return for each stock represents each stock's annual return contribution to the index. The sum of the return contributions of the 100 metrics every year is the annual return of the index.

Below is the descriptive statistics of all total annual returns of the four indices (*EARN*, *BOOK*, *EMPL*, *SALE*), the relevant benchmark index (*MCAP*), *AFGX*, and the government risk-free interest rate (*REFR*).

Table III
Descriptive Statistics of Annual Returns of Fundamental Indices & Benchmarks

This table shows the annual total return for the four fundamental indices *EARN*, *BOOK*, *EMPL*, *SALE* as well as their relevant cap-weighted reference index comprising exactly the same 100 top cap stocks, *MCAP*. Note that the fundamental indices use a 1-year fundamental-to-time series lag (1979 - 2007 annual fundamentals linked to Jan 1980 - Dec 2008 annual total return time series). Table III shows also the annual total return of *AFGX*, the broad cap-weighted index including all listed companies on NASDAQ OMX Stockholm's main market. The Swedish Central Bank's reference interest, *REFR*, is also included.

#	YEAR	R(REFR)	R(AFGX)	R(MCAP)	R(EARN)	R(BOOK)	R(EMPL)	R(SALE)
1	1980	10,0%	22,4%	80,8%	96,2%	110,3%	102,2%	99,2%
2	1981	11,7%	57,0%	86,8%	91,5%	94,5%	88,0%	87,7%
3	1982	10,2%	34,3%	59,9%	80,6%	71,0%	73,6%	82,8%
4	1983	8,7%	67,2%	65,8%	73,8%	82,8%	82,2%	65,3%
5	1984	9,0%	-11,4%	-8,9%	-4,2%	-3,9%	-2,8%	0,2%
6	1985	10,3%	29,0%	34,7%	50,8%	67,2%	45,6%	55,0%
7	1986	8,2%	47,4%	46,3%	41,5%	50,6%	43,8%	50,9%
8	1987	7,5%	-9,5%	-9,3%	-10,3%	-7,4%	-12,8%	-6,4%
9	1988	8,2%	47,3%	26,2%	26,0%	28,8%	37,8%	32,5%
10	1989	9,2%	28,7%	30,9%	36,0%	39,0%	40,7%	32,0%
11	1990	11,1%	-32,9%	-27,0%	-29,0%	-31,0%	-30,8%	-30,2%
12	1991	9,4%	9,3%	7,4%	15,3%	9,6%	26,5%	16,6%
13	1992	8,9%	1,8%	12,9%	11,9%	9,4%	17,0%	9,4%
14	1993	6,8%	53,2%	61,7%	63,4%	102,1%	76,3%	77,9%
15	1994	5,4%	4,3%	18,2%	13,6%	19,0%	24,7%	23,7%
16	1995	7,1%	18,4%	7,4%	5,6%	14,3%	7,9%	6,5%
17	1996	4,9%	34,8%	34,4%	34,9%	31,9%	33,1%	31,1%
18	1997	2,5%	26,9%	35,7%	35,1%	35,0%	45,7%	44,5%
19	1998	2,2%	13,3%	27,2%	22,1%	11,5%	16,4%	12,9%
20	1999	1,3%	62,0%	73,7%	56,4%	41,5%	52,7%	46,1%
21	2000	2,1%	-14,2%	-2,9%	-1,4%	0,7%	-7,8%	-4,9%
22	2001	1,9%	-16,7%	-14,3%	1,7%	-1,4%	-1,7%	-5,1%
23	2002	4,5%	-33,9%	-34,1%	-22,2%	-22,5%	-27,9%	-27,3%
24	2003	3,5%	26,5%	16,3%	18,4%	28,7%	27,2%	25,9%
25	2004	2,5%	17,2%	8,1%	7,4%	16,3%	15,6%	9,5%
26	2005	1,7%	31,6%	38,2%	38,5%	35,3%	39,6%	39,9%
27	2006	2,0%	25,7%	17,9%	23,0%	24,9%	24,3%	21,9%
28	2007	3,3%	-9,2%	0,2%	-1,4%	-3,8%	3,7%	1,0%
29	2008	4,3%	-35,5%	-36,5%	-35,7%	-38,9%	-36,7%	-42,0%
Cumulative 29 year-return:		456%	3645%	12518%	24763%	37462%	37741%	25473%
Cumulative 1980-89 return:		143%	1145%	2309%	3609%	5034%	4036%	4235%
Cumulative 1990-99 return:		78%	343%	633%	525%	540%	737%	553%
Cumulative 2000-08 return:		28,8%	-32,1%	-28,5%	7,2%	14,4%	9,3%	-9,6%
29 year mean cum. (i.e. geometric) return:		6,1%	13,3%	18,2%	20,9%	22,7%	22,7%	21,1%
29 yr. mean cumulative Abnormal Return (AR)*:		n/m	0,0%	0,0%	2,5%	4,6%	4,6%	2,9%
29 year mean cumulative Excess Return (ER)**:		0,0%	7,0%	11,9%	14,7%	16,4%	16,4%	14,8%
29 year arithmetic mean return:		6,1%	17,1%	22,7%	25,5%	28,1%	27,7%	26,1%
Standard deviation:		3,4%	28,8%	33,2%	34,3%	38,2%	35,5%	35,5%
Beta:				1,00	0,98	1,03	1,00	1,00
Treydor:				12,1%	15,2%	16,1%	16,6%	15,0%
Sharpe:				49,9%	56,5%	57,6%	60,7%	56,2%

Gray = Fundamental index Z underperforms benchmark index MCAP
 White = Fundamental index Z outperform benchmark index MCAP

* R(AR) = R(Fundamental index Z) - R(MCAP)
**R(ER) = R(Fundamental index Z) - R(REFR)

As seen in Table III above the 29-year mean returns for all fundamental indices are strictly higher than the relevant cap-weighted benchmark index (*MCAP*). Also the standard deviation is above but less so in relative terms which makes the fundamental indices look more mean-variance

efficient. The Sharpe ratios of the fundamental indices are strictly superior to their *MCAP* benchmark index. According to these metrics the fundamental indices appear superior and the fundamental book equity index and the employee index are the two top performers among the fundamental indices with an annual geometric return of 22.7%. The table also shows that the mean 29-year excess return varies between 14.7%-16.4% which is somewhat above the 10.5% claimed by Dag Tjernsmo of XACT Fonder. I investigate this superior performance and its potential determinants in more detail in the Results section below.

V. RESULTS

In this section I present the results of my econometric examinations of the data presented above. I begin each examination and result by presenting the hypothesis it examines. The first hypothesis is related to each of my four Swedish fundamental indices but it represents the most basic claim by Robert Arnott that fundamental index strategies generate superior return.

Hypothesis 1: Fundamental index *Z* generates abnormal return versus the *MCAP* benchmark

This first hypothesis can be examined by using the composite level (A) of the data comprising 29 observations of portfolio performance. Specifically, the hypothesis could be examined by testing the difference between the 29-year average return of each fundamental index ($Z = EARN, BOOK, EMPL, SALE$) versus their relevant benchmark index (*MCAP*).

The four fundamental indices and the *MCAP* benchmark index comprising exactly the same stocks so these samples are not independent. Instead they are dependent. To test for abnormal return vis-à-vis *MCAP*, I therefore create four matched pairs of the 29 instances of annual returns of respective fundamental index minus the annual return of the benchmark index *MCAP*. The test I apply here is called the “Test of the Difference Between Population Means: Matched Pairs” and is shown in Newbold (1995) on page 352. However, the samples I use are not large ($n > 30$) since they contain 29 observations each. As stated in the data section I assume in line with Modern Portfolio Theory that the population of stock return is normally distributed. I do not know the variance of this population and the sample is small because it is less than 30 observations. This implies I am able to apply a student’s t-test.

The research hypothesis (H_1) is the probability model that describes my belief about the underlying aspect of the data. Therefore I set up my hypothesis test as follows.

H_0 : Fundamental index Z generates equal or less return than the *MCAP* benchmark

H_1 : Fundamental index Z generates more return than the *MCAP* benchmark

Note that I apply four instances of these hypotheses pertaining to the four unique combinations of ($Z = EARN, BOOK, EMPL, SALE$) and (*MCAP*). Written in equation notation, I test the null hypothesis that the average annual return of a specific fundamental index is equal or less than the average annual return of the benchmark during the 29-year period.

$$H_0 : \mu_Z - \mu_{MCAP} = D_0 \leq 0$$

$$H_1 : \mu_Z - \mu_{MCAP} = D_0 > 0$$

This is the test statistic and rejection rule.

$$t_{obs} = \frac{\bar{d} - D_0}{\sqrt{\frac{s_d^2}{n_d}}} > t_{cri}(\alpha; df=(n-1)) \tag{8}$$

The outcome of the four instances of this right sided matched pairs t -test is presented in Table IV below.

Table IV
Output of Matched Pairs t -Tests of Fundamental Index Abnormal Return vs *MCAP*

This table shows the outcome of one-sided paired t -tests for abnormal return of the four fundamental indices versus its relevant benchmark index *MCAP*. If the null hypothesis of relatively equal or negative return of a fundamental index is rejected at a certain level of significance (10%, 5%, 1%) it is explicitly written out as “Reject H_0 !”. When I fail to reject the null I simple state a “No!” at each level of significance. Note that the degrees of freedom ($df = n - 1$) in all the tests below are 28 since the sample size (n) is 29 years of data.

Fundamental index	EARN	BOOK	EMPL	SALE
Sample size (n)	29	29	29	29
t-observed	1,9490	2,1363	2,9654	1,8269
p-value	0,0307	0,0208	0,0031	0,0392
t-Critical @ 10% 1,3125	n/m	n/m	n/m	n/m
t-Critical @ 5% 1,7011	T _{(obs)>T(cri)} Reject H0!	T _{(obs)>T(cri)} Reject H0!	n/m	T _{(obs)>T(cri)} Reject H0!
t-Critical @ 1% 2,4671	n/m	n/m	T _{(obs)>T(cri)} Reject H0!	n/m

As seen in Table IV above I reject the null hypotheses of no abnormal return of *EARN*, *BOOK*, and *SALE* above their *MCAP* benchmark index at a 5% significance level. The hypothesis of no

abnormal return of *EMPL* over its *MCAP* benchmark index is rejected even at a 1% significance level.

Thus on basis of my relevant benchmark index, *MCAP*, I find strong support for my first research hypothesis with regard to all fundamental indices. Now, having explored a key performance characteristic of my fundamental indices, my next step is to examine a likely key performance determinant: its potential small cap bias. Since a fundamental index by definition involves weighting more towards large fundamentals stocks I believe it implies weighting more towards small cap stocks in comparison to a capitalization index and this is my second hypothesis.

Hypothesis 2: Fundamental index *Z* is relatively small cap biased versus the *MCAP* benchmark

This second hypothesis can be examined by using the individual level (B) of the data comprising individual fundamental weights and market capitalization and stock performance of 100 stocks for 29 years, i.e. 2,900 annual returns for each fundamental index as well as for the benchmark index. Specifically, this hypothesis can be examined by testing the difference between the market capitalizations of the stocks included in the two different indices. The two indices comprise exactly the same stocks so I cannot however test the difference directly. The difference is only in the metric weights of the different indices. However, the weights of the fundamental indices contain no information with regard to their capitalization. However, if I put the fundamental index weights (e.g. 90% in A and 10% in B) and the cap index weights (e.g. 10% in A and 90% in B) in relation to the capitalization (e.g. SEK10 of A and SEK90 of B), I am able to compare the difference in capitalization of the two indices. As shown by this example, the fundamental index portfolio here has a lower weighted capitalization of 18 ($90\% \cdot 10 + 10\% \cdot 90$) here in comparison to the capitalization weighted index of 82 ($90\% \cdot 90 + 10\% \cdot 10$) and is thus small cap biased. It is small cap biased since it invests 90% of the portfolio capital into the stock that has only SEK10 in value whereas the capitalization-weighted index invests 90% of its portfolio into the SEK90 stock. As long as the weighted capitalization of the fundamental index is lower than that of the capitalization-weighted index it is thus low-cap biased.

In order to test the difference between the weighted market capitalization of a fundamental index versus its benchmark index I create matched pairs of all fundamentally weighted market caps for all four fundamental indices, including all companies and all 29 years, versus their capitalization weighted market caps of the reference index *MCAP*. The test applied is called the “Test of the Difference Between Population Means: Matched Pairs” and is shown in Newbold (1995:352) and is the same econometric test as applied in testing the first hypothesis above. However, now I have a large number of observations of weighted market caps for all four

fundamental indices. I assume all instances of the weighted market caps are random variables. For all random variables, if I subtract the average and divide it by the standard deviation, I get a standardized random variable z with average of zero and variance of one. By applying the Central Limit Theorem (CLT), when the number of random variables is large the random variable z of the mean of the difference in weighted market caps will tend to have a standard normal distribution as seen in equation (8) below.

$$z = \frac{\bar{x} - \mu_{\bar{x}}}{\sigma_{\bar{x}}} = \frac{\bar{x} - \mu_{\bar{x}}}{\sqrt{\frac{\sigma_{\bar{x}}^2}{n}}} \xrightarrow{n > 30} N(0,1) \quad (9)$$

The research hypothesis (H_1) is the probability model that describes my belief about the underlying aspect of the data. Therefore I set up my hypothesis test as follows

H_0 : Fundamental index Z has an equal or large cap bias vs. $MCAP$

H_1 : Fundamental index Z has a small cap bias vs. $MCAP$

Note that I apply four instances of this hypothesis test ($Z = EARN, BOOK, EMPL, SALE$). Written in equation notation, I test the null hypotheses that the mean size of the fundamental-weighted capitalization is equal or larger than the mean size of the capitalization-weighted capitalization.

$$H_0 : \mu_Z - \mu_{MCAP} = D_0 \geq 0$$

$$H_1 : \mu_Z - \mu_{MCAP} = D_0 < 0$$

This is the test statistic and rejection rule.

$$z_{obs} = \frac{\bar{d} - D_0}{\sqrt{\frac{S_d^2}{n_d}}} < -z_{cri(\alpha)} \quad (10)$$

The outcome of the four instances of this left sided matched pairs z-test is presented in Table V below.

Table V

Output of Matched Pairs z-Tests of Small-Cap Bias of Fundamental Portfolios

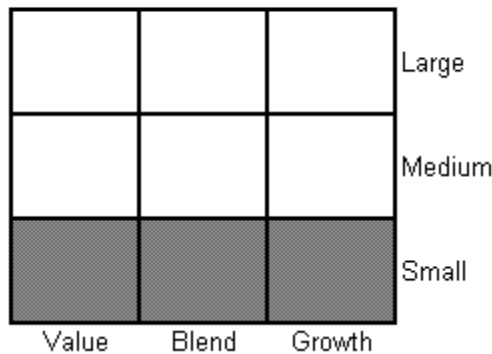
This table shows the outcome of a one-sided matched z-test of low-cap bias among the fundamental indices vs its relevant benchmark index *MCAP*. If I manage to reject the null hypothesis of a relatively equal or large cap bias of a fundamental index at a certain level of significance (10%, 5%, 1%) it is explicitly written as “Reject H_0 !”. When I fail to reject the null, I simply state “No!” at each relevant level of significance.

Fundamental index	EARN	BOOK	EMPL	SALE
Sample size (n)	1851	1851	1868	1868
z-observed	-2,2801	-2,9568	-3,1686	-3,0463
p-value	0,0113	0,0016	0,0008	0,0012
z-Critical @ 10% -1,2816	n/m	n/m	n/m	n/m
z-Critical @ 5% -1,6449	$Z_{\text{obs}} < Z_{\text{cri}}$ Reject H_0 !	n/m	n/m	n/m
z-Critical @ 1% -2,3263	$Z_{\text{obs}} > Z_{\text{cri}}$ No!	$Z_{\text{obs}} < Z_{\text{cri}}$ Reject H_0 !	$Z_{\text{obs}} < Z_{\text{cri}}$ Reject H_0 !	$Z_{\text{obs}} < Z_{\text{cri}}$ Reject H_0 !

As seen in Table V above I manage to reject the three null hypotheses of equal cap- or a large cap bias of *BOOK*, *EMPL* and *SALE* versus the *MCAP* benchmark index at a 1% significance level. I manage to reject the hypothesis of no equal cap- or large cap bias of *EARN* versus the *MCAP* benchmark at a 5% significance level but I fail to reject it at a 1% level.

This provides strong supports for my second research hypothesis that fundamental indices tend to be relatively small cap biased in comparison to their cap-weighted benchmark index *MCAP*. In summary I could classify fundamental index fund according to Morningstar’s well-known style box as a small cap strategy.

Morningstar Style Box™



A small cap investment strategy is generally thought as a high-risk-high return strategy for investors who deem markets to be pretty rational. According to classic US financial research such as Banz (1981) small cap stocks should outperform large cap stocks. I would expect that the small cap premium also is present in Swedish stock market data. Such a premium would also help explain why fundamental indices tend to outperform the benchmark index. My third hypothesis is therefore concerned with examining the Swedish small cap premium.

Hypothesis 3: There is a Swedish small cap premium

This third hypothesis can be examined by using the individual level (B) of the data comprising individual fundamental weights and market capitalization and stock performance of 2,900 stocks during 29 years. In order to examine this hypothesis I divide the 100 stocks each year into two independent samples of 50 stocks each: large cap stocks and small cap stocks. One of the samples comprises the 50 companies with highest market capitalization each year during the 29 years: their market capitalization and respective stock return. The other sample comprises the 50 companies with lowest market capitalization each year during the 29 years. Then I apply a test called the “Test for the difference between populations means: independent samples (known variances or large sample sizes)” which is shown in Newbold (1995:355). I believe that the small cap stocks should outperform large cap stocks in line with the original US research by Banz (1981) and form the following hypothesis test in order to test this.

H₀: Small cap stocks generate equal or less return than large cap stocks

H₁: Small cap stocks generate more return than large cap stocks

I use the annual arithmetic average of the individual return of all large cap stocks and compare that to the average of the individual return of all small cap stocks.

$$H_0: \mu_{large} - \mu_{small} \geq 0$$

$$H_1: \mu_{large} - \mu_{small} < 0$$

This is the test statistic and rejection rule.

$$z_{obs} = \frac{(\bar{x}_{large} - \bar{x}_{small}) - D_0}{\sqrt{\frac{s_{large}^2}{n_{large}} + \frac{s_{small}^2}{n_{small}}}} < z_{cri(\alpha)} \Rightarrow \frac{(0.1912 - 0.2191) - 0}{\sqrt{\frac{0.4948^2}{926} + \frac{0.7083^2}{926}}} = -0.982 \quad (11)$$

Since the observed z-value (-0.982) is larger than the critical z-value at 10% significance level (-1.282), I fail to reject the null hypothesis at a 90% confidence level. The p-value is 16.3% which means that I could reject the null hypothesis at 83.7% confidence level. As seen in equation 11 above the arithmetic average return of the individual return of low cap stocks is 21.91% and for large cap stocks 19.12%. As seen in equation 11 above, the volatility of low cap stocks is 70.83% versus the 49.48% for large cap stocks. This shows that low cap stocks are more volatile and thus risky in comparison to large cap stocks. It is therefore natural that low cap stocks generate a higher return than large cap stocks as compensation for the higher risk. However, in order to show that low cap stocks outperform large cap stocks with strong statistical significance (i.e. 1% or 5% significance level) I would have needed a few thousands more observations. Or I would have needed markedly smaller stocks than bottom-50 stocks of the Top-100 stocks by market cap. This is because the smaller size of a company the larger is the expected premium. According to Siegel (2002), the small cap premium is especially present in micro cap stocks whereas I have merely drawn the bottom-50 stocks from the top-100 elephant stocks.

In conclusion I find very weak statistical support (83.7% confidence level) of my third hypothesis. Since fundamental indices generate statistical significant abnormal returns as shown when examining my first hypothesis above, there must simple be another more significant reason than the small cap premium behind the fundamental index premium.

Even Robert Arnott admits fundamental indices have a value stock bias and he claims this value effect is more important than any small cap effect. The most likely reason behind the fundamental index premium is accordingly a potential value stock bias and premium. Note that I above implicitly already proved that fundamental indices are relatively value stock biased, which means that these indices are biased towards companies with relatively low capitalization in relation to their fundamentals. Fundamental indexation is about picking companies with the highest fundamentals. If we link large fundamentals to the proof provided above (2nd hypothesis) that all fundamental indices are small cap biased we clearly understand they must be relatively small cap-to-fundamental biased. I will examine this potential value stock bias explicitly by testing my fourth hypothesis below.

Hypothesis 4: Fundamental index Z is value stock biased vs the $MCAP$ benchmark

This fourth hypothesis can be examined by using the individual level (B) of the data comprising individual fundamental weights and market capitalization and stock performance of 2,900 stocks during 29 years. Specifically, this hypothesis could be examined by testing the difference between the relevant average price-to-fundamental ratios of the stocks included in each

fundamental index ($Z = EARN, BOOK, EMPL, SALE$) versus $MCAP$, the relevant capitalization benchmark index. However, all my pairs comprise exactly the same stocks so they have exactly the same average price-to-fundamental ratios. The difference is the weight a fundamental index puts on certain price-to-fundamental stocks in comparison to a capitalization-weighted benchmark index. Therefore, I need to test the difference in weights in relation to the price-to-fundamental ratios in order to determine which of the two indices that has a relative low price-to-fundamental stocks bias. I call these metrics the weighted price-to-fundamental ratios. This is the same logic as used in second hypothesis test above of weighted capitalization. In order to test this I create matched pairs the weighted price-to-fundamental ratios of fundamental indices and their benchmark capitalization indices. The test applied is called the “Test of the Difference Between Population Means: Matched Pairs” and is shown in Newbold (1995:352). For each of my four indices I pick the most relevant price-to-fundamental ratio for my examination. For example, in the matched pairs of the fundamental earnings index vs. its $MCAP$ benchmark I use the price-to-earnings ratio. In the matched pairs of the fundamental book equity index vs. its $MCAP$ index I use the market-to-book ratio. I have not managed to get reliable estimates of enterprise value (i.e. market capitalization plus net debt), which would be the most relevant use in a ratio with whole-company fundamentals such as sales and employees. Therefore, I also use the market cap instead in the price-to-fundamental ratios for the matched pairs of the fundamental employee index vs. the cap index and the fundamental sales index vs. the cap index.

I have a large number of observations of weighted price-to-fundamental ratios ($n > 30$) so I am able to invoke the Central Limit Theorem and assume that the mean of the difference in weighted ratios follows a normal distribution, regardless of the distribution of the individual data. In this way I am able to apply the standardized normal distribution. My null and research hypotheses are set up as following.

H_0 : Fundamental index Z is equally or less low price-to-fundamental biased than $MCAP$

H_1 : Fundamental index Z is more low price-to-fundamental biased than $MCAP$

I have in total four instances of these hypotheses since I have four different fundamental indices: ($Z = EARN, BOOK, EMPL, SALE$). I use the arithmetic average of weighted price-to-fundamental ratios for the fundamental index and compare that to the annual arithmetic average weighted price-to-fundamental of the benchmark index ($MCAP$).

$$H_0 : \mu_Z - \mu_{MCAP} \geq 0$$

$$H_1 : \mu_Z - \mu_{MCAP} < 0$$

The test statistic and rejection rule is as follows:

$$z_{obs} = \frac{\bar{d} - D_0}{\sqrt{\frac{s_d^2}{n_d}}} < -z_{cri(\alpha)} \tag{12}$$

The outcome of the four instances of this left sided matched pairs z-test is presented in Table VI below.

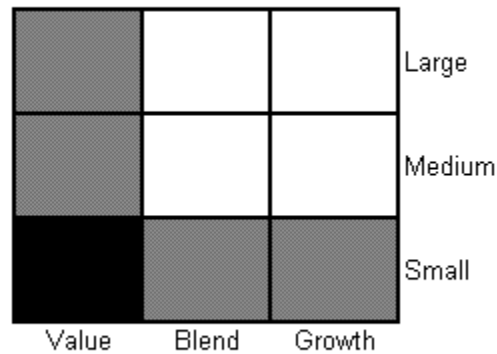
Table VI
Output of Matched z-Test of Low Price-to-Fundamental Bias

This table shows the outcome of a one-sided matched z-test of low price-to-fundamental bias among the fundamental indices. If I manage to reject the null hypothesis of a relatively equal or less low price-to-fundamental of a fundamental index at a certain level of significance (10%, 5%, 1%) it is explicitly written out as “Reject H_0 !”.

Fundamental index	EARN	BOOK	EMPL	SALE
Sample size (n)	1868	1868	1868	1868
z-observed	-8,2753	-6,1911	-8,8123	-8,1625
p-value	0,0000	0,0000	0,0000	0,0000
z-Critical @ 10% -1,2816	n/m	n/m	n/m	n/m
z-Critical @ 5% -1,6449	n/m	n/m	n/m	n/m
z-Critical @ 1% -2,3263	Z _{{obs}<Z{cri}} Reject H0!	Z _{{obs}<Z{cri}} Reject H0!	Z _{{obs}<Z{cri}} Reject H0!	Z _{{obs}<Z{cri}} Reject H0!

As seen in Table VI above I manage to reject the null hypothesis in all of the four instances above at a 1% significance level. This is a very strong support to my fourth hypothesis that fundamental indices are heavily biased to value stocks. The p-values of above are much lower than the p-values I got when I tested for small cap bias. Therefore, the low price-to-fundamental bias is the most prominent characteristic of fundamental indices. Note however that the small cap bias and the value stock bias are closely linked. In summary I could classify all fundamental indices according to Morningstar’s style box also as a value stock strategy.

Morningstar Style Box™



Clearly, the Style Box shows us that a fundamental index strategy is a joint small cap and value stock strategy. Fundamental indices are thus situated in the black lower left area. This is where the highest risk and return is expected according to Morningstar and the three factor Fama-French three factor model which the matrix it is based upon.

Real-world fundamental indices are based on especially fundamentals such as cash flow, dividends, earnings, and book value. Price ratios comprising these fundamentals are associated with — and could also potentially predict — future average return of common stocks. The significant value stock bias found shows that fundamental indexing is far new and pioneering from a theoretical point of view. It is basically an application a vast amount of financial research which shows that average returns on common stocks are related to and could be predicted by value stock ratios such as price-to-earnings, price-to-cash flow, price-to-book, price-to-dividend, in addition to size and perhaps past sales growth, and past stock returns. This also sheds light on why fundamental index managers tend to pick fundamentals commonly researched with respect to the stock market predictions and value premiums such as earnings, cash flow, book equity, dividend, and sales.

Especially stocks with low price-to-earnings ratios and market-to-book ratios tend to outperform according to Basu (1977) and Fama and French (1992). Potentially any stock with a low price-to-fundamental ratio would be expected to generate abnormal return. My next step is to examine my fifth research hypothesis about a low price-to-fundamental premium in Sweden.

Hypothesis 5: Value stocks generate more return than growth stocks

This fifth hypothesis could be examined by using the individual level (B) of the data comprising individual fundamental weights and market capitalization and stock performance of 2,900 stocks during 29 years. Specifically, I start by dividing each of the four full 29-year samples of

company-specific price-to-fundamental ratios into two parts: the 50% of the low price-to-fundamental ratios by each year versus the 50% of the large price-to-fundamental ratios by each year. In any given year, the two samples contain different stocks so these are two independent samples. Now, I can apply the test for the difference between population means with independent samples. The test used is called “Tests for the difference between populations means: independent samples (known variances or large sample sizes)” and is shown in Newbold (1995:355). I believe that the low price-to-fundamental stocks should outperform large price-to-fundamental stocks and form a hypothesis test in order to test this.

H₀: Value stocks generate equal or less return than growth stocks

H₁: Value stocks generate more return than growth stocks

I have in total four instances of these hypotheses since I have four different fundamental indices ($Z = EARN, BOOK, EMPL, SALE$). To test my research hypothesis I use the arithmetic average of annual total return of large price-to-fundamental stocks and compare that to the annual arithmetic average of the annual total return of small price-to-fundamental stocks.

$$H_0: \mu_{large} - \mu_{small} \geq 0$$

$$H_1: \mu_{large} - \mu_{small} < 0$$

The test statistic and rejection rule is as follows:

$$z_{obs} = \frac{(\bar{x}_{large} - \bar{x}_{small}) - D_0}{\sqrt{\frac{s_{large}^2}{n_{large}} + \frac{s_{small}^2}{n_{small}}}} < -z_{cri(\alpha)} \quad (13)$$

The outcome of the four instances of this left sided independent sample z-test is presented in Table VII below.

Table VII**Output of Independent z-Tests of Positive Price-to-Fundamental Premium**

This table shows the outcome of a one-sided test of the difference of return of large price-to-fundamental stocks versus small price-to-fundamental stocks.

	EARN	BOOK	EMPL	SALE
Sample size (n)	925	925	926	926
z-observed	-3,4239	-2,3694	-2,4009	-2,9937
p-value	0,0003	0,0089	0,0082	0,0014
z-Critical @ 10% -1,2816	n/m	n/m	n/m	n/m
z-Critical @ 5% -1,6449	n/m	n/m	n/m	n/m
z-Critical @ 1% -2,3263	Z _{[obs]<Z[ori]} Reject H0!	Z _{[obs]<Z[ori]} Reject H0!	Z _{[obs]<Z[ori]} Reject H0!	Z _{[obs]<Z[ori]} Reject H0!

As seen in Table VII above I manage to reject the null hypothesis regarding all fundamental indices at a 1% significance level. Note also that even though all fundamental indices are highly biased toward their specific fundamental they are also closely related as seen in Appendix D.

Having established the key performance determinant of the fundamental index premium it is now interesting to extend the first hypothesis on abnormal return and test if the fundamental indices generate abnormal return also after having adjusted for the systematic CAPM risk. This extension is important because even though the abnormal return of the *EMPL* index is statistically significant at a 99-95% confidence level it might not be so after having adjusted for the extra risk in holding an *EMPL* index. My sixth and last hypothesis puts the abnormal return of the four indices ($Z = EARN, BOOK, EMPL, SALE$) in relation to the benchmark (*MCAP*) as well as the CAPM beta risk.

Hypothesis 6: Fundamental index Z generates positive Jensen's alpha vs. the *MCAP* benchmark

This sixth hypothesis could be examined by using the composite level (A) of the data comprising 29 observations of portfolio performance. All my fundamental indices generate abnormal return according to my results of my first hypothesis in comparison to *MCAP*, the most relevant benchmark. However, a fundamental index is only truly superior if it generates abnormal risk-adjusted return in comparison to its relevant benchmark. To examine the risk-adjusted reward the most natural test is to examine Jensen's alpha (Jensen, 1968) in relation to *MCAP*, the relevant cap-weighted benchmark index comprising exactly the same stocks as the fundamental indices.

Robert Arnott found that all his fundamental indices generated a statistically significant positive Jensen's alpha whereas Amenc, Goltz, and Le Sourd (2008) found that it was difficult to find statistical significant Jensen's alpha among fundamental indices and so did Grufman and Sjöholm (2008). My research hypothesis is that Robert Arnott is correct and I apply the test of Jensen's alpha, which is lucidly explained by John L. Teall (1999:192). The Jensen's alpha measures the degree to which a fund manager is earning significant returns after accounting for market risk, as measured by CAPM beta. If the manager is earning a fair return for the given portfolios' systematic risk, then the alpha would be zero. A positive alpha indicates good performance whereas a negative alpha indicates poor performance. I set up my hypothesis test as following.

H₀: Fundamental index *Z* generates zero or negative Jensen's alpha vs. *MCAP*

H₁: Fundamental index *Z* generates positive Jensen's alpha vs. *MCAP*

I have in total four instances of these hypothesis tests since I have four unique combinations of the four fundamental indices (*Z* = *EARN*, *BOOK*, *EMPL*, *SALE*) and their relevant benchmark (*MCAP*). The hypothesis could also be written in equation form.

$$H_0 : \alpha \leq 0$$

$$H_1 : \alpha > 0$$

The test statistic and rejection rule is as following:

$$t_{obs} = \frac{\alpha - \alpha_0}{s.e(\alpha)} = \frac{\alpha - \alpha_0}{\sqrt{\frac{s_x^2}{n} \left[1 + \frac{(\bar{x})^2}{s_x^2} \right]}} > t_{cri(\alpha; df=n-2)} \quad (14)$$

To estimate the four individual alphas I need to run four instances of the following ordinary least squares CAPM regression.

$$R(Z) - R(REFR) = \alpha + \beta[R(MCAP) - R(REFR)] + \varepsilon \quad (15)$$

Then I insert the generated alphas from (15) in the test statistic above (14) and compare each of the four observed t-values with their respective critical t-value. The output of the four CAPM regressions performed is presented in Table IIX below.

Table IIX

Regression Outputs for the Four CAPM Regressions vs. *MCAP* (1980-2008)

Earnings CAPM Regression			Book Equity CAPM Regression			Employee CAPM Regression			Sales CAPM Regression		
$R(\text{EARN}) - R(\text{REFR}) = \alpha + \beta[R(\text{MCAP}) - R(\text{REFR})] + \varepsilon$			$R(\text{BOOK}) - R(\text{REFR}) = \alpha + \beta[R(\text{MCAP}) - R(\text{REFR})] + \varepsilon$			$R(\text{EMPL}) - R(\text{REFR}) = \alpha + \beta[R(\text{MCAP}) - R(\text{REFR})] + \varepsilon$			$R(\text{SALE}) - R(\text{REFR}) = \alpha + \beta[R(\text{MCAP}) - R(\text{REFR})] + \varepsilon$		
Regression Statistics			Regression Statistics			Regression Statistics			Regression Statistics		
Multiple R	0.9723		Multiple R	0.9307		Multiple R	0.9648		Multiple R	0.9566	
R Square	0.9453		R Square	0.8662		R Square	0.9308		R Square	0.9152	
Adj. R Square	0.9432		Adj. R Square	0.8613		Adj. R Square	0.9282		Adj. R-square	0.9120	
Standard Error	0.0794		Standard Error	0.1383		Standard Error	0.0927		Standard Error	0.1022	
Observations (n)	29		Observations (n)	29		Observations (n)	29		Observations (n)	29	
Regression Residual Total			Regression Residual Total			Regression Residual Total			Regression Residual Total		
df	1	27	28	df	1	27	28	df	1	27	28
SS	2.9426	0.1704	3.1129	SS	3.3423	0.5162	3.8585	SS	3.1200	0.2320	3.3520
MS	2.9426	0.0063		MS	3.3423	0.0191		MS	3.1200	0.0086	
F	466.3493			F	174.8297			F	363.0313		
Sign. F	0.0000			Sign. F	0.0000			Sign. F	0.0000		
Alpha Beta			Alpha Beta			Alpha Beta			Alpha Beta		
Coefficients	0.0288	0.9964		Coefficients	0.0442	1.0619		Coefficients	0.0461	1.0260	
Standard Error	0.0166	0.0461		Standard Error	0.0289	0.0803		Standard Error	0.0194	0.0538	
t Stat	1.7362	21.5951		t Stat	1.5295	13.2223		t Stat	2.3759	19.0534	
P-value	0.0939	0.0000		P-value	0.1378	0.0000		P-value	0.0249	0.0000	
Upper 99.5%	0.0796	1.1374		Upper 99.5%	0.1326	1.3074		Upper 99.5%	0.1053	1.1906	
Upper 99.0%	0.0748	1.1242		Upper 99.0%	0.1243	1.2844		Upper 99.0%	0.0998	1.1752	
Upper 97.5%	0.0683	1.1059		Upper 97.5%	0.1128	1.2525		Upper 97.5%	0.0921	1.1538	
Upper 95.0%	0.0629	1.0910		Upper 95.0%	0.1035	1.2267		Upper 95.0%	0.0858	1.1365	
Upper 90.0%	0.0571	1.0750		Upper 90.0%	0.0935	1.1987		Upper 90.0%	0.0791	1.1177	
Lower 90.0%	0.0005	0.9178		Lower 90.0%	-0.0050	0.9251		Lower 90.0%	0.0130	0.9342	
Lower 95.0%	-0.0052	0.9017		Lower 95.0%	-0.0151	0.8971		Lower 95.0%	0.0063	0.9155	
Lower 97.5%	-0.0106	0.8869		Lower 97.5%	-0.0244	0.8713		Lower 97.5%	0.0000	0.8982	
Lower 99.0%	-0.0172	0.8685		Lower 99.0%	-0.0359	0.8394		Lower 99.0%	-0.0077	0.8768	
Lower 99.5%	-0.0219	0.8553		Lower 99.5%	-0.0441	0.8164		Lower 99.5%	-0.0132	0.8614	

As seen in Table IIX above, all the regressions renders positive estimates of alpha, although it is only statistically significant for the fundamental earnings index at a 10% significance level and for the fundamental employee index at a 5% significance level. Note that I in my first hypothesis, which excludes the CAPM risk, generated a positive alpha (abnormal return) at the 1%-5% significance levels. Since I have now added the systematic CAPM risk, the confidence level in my test is necessary lower. The positive alphas and rejection rules could be seen by studying the p-values of the different alphas in Table IIX above.

Strangely, the reference index used in *Fundamental Indexation* by Robert Arnott has lower return than the S&P500 index. The most natural would be that it is higher since it should comprise more low-cap stocks and there has been a proven small cap premium in the US market. Further, the bid-ask spread transaction cost is not being included in his reference index so it should naturally outperform also because of this reason. He does not explain how he has constructed his reference capitalization-weighted index so I do not know if it is understated as is so common among asset managers (Karlsson and Kase, 2008). Albeit my data would have shown that the fundamental indices were superior an interpretation could be that CAPM is inferior and is flawed as a model, especially since it cannot capture the small cap and the value bias of fundamental indices.

I present a summary of my six hypothesis tests and their outcome in Table IX below.

Table IX
Summary of Results

This table presents my research hypotheses tested above. Note that if I manage to reject the null hypothesis it provided support to the research hypothesis since the two events are mutually exclusive. If I did not manage to reject the null, I also failed to provide support to my research hypothesis at a given significance level. Note that I find support for all of my six hypotheses albeit I would have needed larger data samples in order to attain strong support in all instances.

H1: Fundamental index Z generates abnormal return vs the MCAP benchmark			
Z = EARN	1. Supported at 95.0% confidence level	Z = EMPL	3. Supported at 99.0% confidence level
Z = BOOK	2. Supported at 95.0% confidence level	Z = SALE	4. Supported at 95.0% confidence level
H2: Fundamental index Z is relatively low cap biased vs MCAP			
Z = EARN	1. Supported at 95.0% confidence level	Z = EMPL	3. Supported at 99.0% confidence level
Z = BOOK	2. Supported at 99.0% confidence level	Z = SALE	4. Supported at 99.0% confidence level
H3: There is a Swedish low cap premium			
1. Weak support at 83.7% confidence level and by ocular inspection of data			
H4: Fundamental index Z is more low price-to-fundamental Z biased than MCAP			
Z = EARN	1. Supported at 99.9% confidence level	Z = EMPL	3. Supported at 99.9% confidence level
Z = BOOK	2. Supported at 99.9% confidence level	Z = SALE	4. Supported at 99.9% confidence level
H5: There is a Swedish low price-to-fundamental Z premium			
Z = EARN	1. Supported at 99.9% confidence level	Z = EMPL	3. Supported at a 99.0% confidence level
Z = BOOK	2. Supported at 99.0% confidence level	Z = SALE	4. Supported at a 99.0% confidence level
H6: Fundamental index Z generates Jensen's alpha vs the MCAP benchmark			
Z = EARN	1. Supported at a 90.0% confidence level	Z = EMPL	3. Supported at 95.0% confidence level
Z = BOOK	2. Weak support at 86.2% confidence level	Z = SALE	4. Weak support at 85.2% confidence level

Before concluding this thesis, I will do a critical evaluation of my results in the Discussion section below. I will also compare my results with the results of the existing literature and outline the wider implications.

VI. DISCUSSION

The six results to the six hypotheses will be critically evaluated in this section. First I evaluate the results of my first and sixth hypothesis since they are highly inter-related.

In social science research, the 95% confidence level is most commonly used whereas I use 90%, 95% and 99%. It could be seen in Table X above (Hypothesis 1) that all four fundamental indices generate abnormal return with high to medium statistical confidence: 99%-95%. However, after having adjusted for the CAPM beta risk (Hypothesis 6) of holding the fundamental employee portfolio I find that two of the four fundamental indices generate statistical significant abnormal risk-adjusted return with medium to low statistical confidence: 95%-90%. My findings therefore, to some extent, support the findings of Robert Arnott who found that fundamental indices tend to generate abnormal return also after having adjusted for the systematic CAPM risk. If I would have increased my sample size, e.g. by using monthly data

instead of annual, I would be able to show that all fundamental indices generate abnormal return after having adjusted for the CAPM risk. As long as there is a tiny tendency of abnormal return among fundamental indices I could always show that it is statistically significant by expanding my sample size. It is therefore credible that Robert Arnott who uses a larger sample size than me arrives at statistical significant abnormal risk adjusted return for all fundamental indices he examines. My findings of statistical significant abnormal return before adjusting for risk among all fundamental indices could be contrasted with Grufman and Sjöholm (2008) who found it very difficult to find statistical significant abnormal returns among fundamental indices.

My research supports one key finding of Martinson, Ramel and Vikström (2005) that the fundamental employee index is among the relatively best performing fundamental indices in a Swedish context. It is interesting to note that Martinsson, Ramel and Vikström (2005) cannot find any theoretical rationale why the fundamental employee index might perform so well. I would like to suggest a theoretical reason from *Wealth of Nations* by Adam Smith (1776:47), the founding father of economics: "*Labour alone [...] is alone the ultimate and real standard by which the value of all commodities can at all times and places be estimated and compared. It is the real price; money is their nominal price only.*" According to Smith, labor is a very useful benchmark since it is the very source of all value generated in an economy.

It must be noted that my analysis might fail to take any extra risk of small cap and value stocks into account since I have only considered volatility as a measure of risk. In my analysis I have assumed in line with Robert Arnott that the fundamental index performance does not involve any additional risk exposure besides the risk aspects captured by price volatility or the systematic CAPM risk. As shown in the theoretical framework, there are also several perfectly rational high-risk-high-return reasons why small cap and value stocks should outperform other stocks. If I would adjust for this additional risk the performance of fundamental indices might be worse and it might in a rational sense be the case that there is no statistical significant abnormal return whatsoever after having adjusted for the systematic CAPM risk as well as the small cap risk. To adjust for the small cap risk another research design would be needed which would involve for example zero survivorship bias. My data involves some survivorship bias since it only includes the stocks for any year which were among the Top-100 stocks by market cap at time 0 (1st of January) and time 1 (31st of December) during this year. Stocks which left the Top-100 sample because of depressed stock prizes are excluded that year as well as stocks which joined the Top-100 sample because of appreciated stock prices. This is also a reason why it would not be relevant to compare my fundamental indices with any real-world indices, albeit they commonly suffer from similar biases.

The result of my second hypothesis is that all four fundamental indices are small cap biased with high statistical confidence level. This conclusion is quite intuitive considering that fundamentals and market caps are on the whole always somewhat correlated but never perfectly

correlated. They are correlated in the sense that a high amount of earnings is associated with a large market capitalization so that not a few companies with large fundamentals would have vastly larger market capitalization than other companies. If a few companies with large fundamentals had vastly larger market caps than other companies, a fundamental index could be more large cap-biased than a cap-weighted index and the cap-weighted index would be relatively low-cap biased. However, there is a strong positive correlation between the size of fundamentals and their market caps but this correlation is never perfect. Therefore, it seems as if a fundamental index is always more low-cap biased. A likely reason for this strong positive correlation is likely that the value and market cap of companies are often based on accounting fundamentals such as EBITDA, EBIT, earnings, book equity, cash flow and dividends. In this sense, fundamental indexation is thus not really value indifferent indexing as claimed by Robert Arnott, since it is commonly based on the very fundamentals that drive the stock market value of companies.

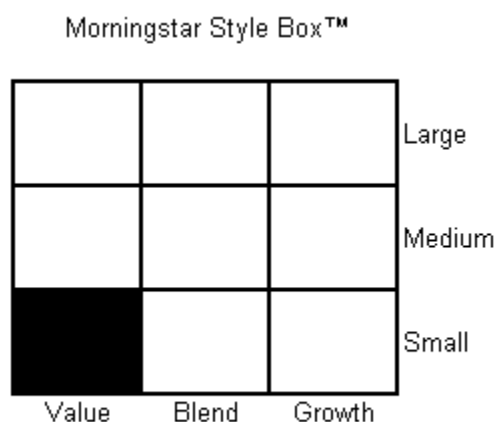
The result of my third hypothesis is that I find quite strong statistical support for a small cap premium in Sweden. This premium is in line with the original work done by Banz (1981) on US data. It is also in line with Heston, Rouwenhorst and Wessels (1995) who show there is a small cap premium even internationally. My support of a small cap premium could probably be much stronger if I increased my sample size so I also include micro-sized stocks. Researchers such as Siegel (2007) have shown that especially micro cap stocks significantly outperform elephant-sized stocks whereas I have no micro-sized stocks in my sample.

My result of my fourth hypothesis is that all fundamental indices are low price-to-fundamental biased with high statistical confidence. Some intelligent readers may already have noticed that it has already been proven in the thesis before the fourth hypothesis test. This is because a fundamental index focuses on buying stocks with large fundamentals and that my answer to my second hypotheses was that all fundamental indices are small cap biased. Small cap (low priced) stocks in combination with large fundamentals translates into a low price-to-fundamental ratios. Fundamental indices are by design thus highly value stock biased.

My result of my fifth hypothesis is that there have been for example statistical significant low price-to-earnings and low market-to-book premiums in Sweden during the last 29 years. This is two of the most well-documented value stocks effect as reviewed by for example Fama and French (1992). The value premium discovered in the Swedish markets during the last 29 years is in line with Malkiel (2003) who shows that US value stocks tended to outperform growth stocks during the last +30 years. However, Malkiel shows also there is a reversion to the mean and that value stocks do not outperform if a longer period is examined. Thus, even if a fundamental index has outperformed during the last 29 years in a Swedish context by virtue of its value stock bias, there is no proof that the value stock premium *will* be persistent in the future.

VII. CONCLUSION

I show that all fundamental indices are small cap-tilted. Since fundamental indexing means picking stocks with largest fundamentals, these two tilts translate into a quite extreme value stock tilt, which is also show. If I would classify my fundamental index portfolios in line with the investment portfolio classification methodology used by Morningstar, they would all be situated in the bottom left corner indicating a relatively high risk and high return profile.



Indeed, I show that both the small cap and the value stock tilts have been associated with abnormal return in 29 years of Swedish empirical data. Since all fundamental indices rides on the small cap and the value cap premium, it is no surprise I find that all fundamental indices also generate statistical significant abnormal return. I also find that it is possible to generate statistical significant abnormal return also after having adjusted for the systematic CAPM risk. This is also rational since CAPM fails to capture fully the small cap and value premiums. The small cap and value stock effects are among the so-called CAPM anomalies or the anomalies to the claim that stock markets are efficient in a semi-strong form. It is therefore only natural that a fundamental index model has a potential to beat performance as predicted by CAPM. The abnormal return of fundamental indices is expected because of the higher risk of holding small cap stocks and does not indicate that fundamental indices are superior indices. Investors simple get a higher return for holding a more risky investment portfolio. Based on my findings, the investment advice would be to buy a fundamental index portfolio if you have a positive view of stocks with relatively high fundamentals, value stocks and small caps and to go short in a fundamental index portfolio if you have a negative view of such stocks.

I show that fundamental indexation is motivated by Robert Arnott's irrational rationale and a very irrational stock market view among investors. This is why I have decided to rename it *Irrational Indexation*™. According to this view small caps and value stocks carry no more risk than large cap stocks — although as I have shown small cap stocks are more volatile and risky —

and these stocks are constantly undervalued by the stock market. This would imply that the stock market is not efficient in a semi-strong form.

There are at least two avenues of further research into fundamental indexation. First, it would be interesting to extend the study into other metrics excluded in this study such as EBITDA, EBIT, cash flow and dividends, especially these metrics are probably more relevant as value drivers in contrast to sales and employees which are seldom used by investors as valuation tools. Second, it would be interesting to examine how it is possible to enhance any fundamental index performance generated, for example by separating the winners from the losers in line with the research by for example Piotroski (2000). It should be possible to enhance the empirical performance of fundamental indices for example by adding for example screens of financial distress, taking differences in taxes, dividend pay-out ratios, into account, and by applying a more dynamic quarterly re-weighting.

Journal Articles, News Articles, and Books

Amenc, N., *et al.*, 2008, A Comparison of Fundamentally Weighted Indices: Overview and Performance Analysis, EDHEC Risk and Asset Management Research Centre.

Arnott, R., *et al.*, 2004, Fundamental Indexing, Working Paper Series, 7 October draft.

Arnott, R., *et al.*, 2005a, Fundamental Indexing, *Financial Analysts Journal*, Mar-Apr, pp. 83-99.

Arnott, R., 2005b, Disentangling Size and Value, Editor's Corner, *Financial Analysts Journal*, Sep-Oct, pp. 12-15.

Banz, R. 1981, The Relationship Between Return and Market Value of Common Stock, *Journal of Financial Economics*, 9, pp. 3-18.

Basu, S. 1975, The Information Content of Price-Earnings Ratios. *Financial Management*, 4, pp. 53-64.

Basu, S., 1977, Investment Performance of Common Stocks in Relation to Their Price Earnings Ratios: A Test of Market Efficiency, *Journal of Finance*, 32, pp. 663-682.

Black, F., 1980, The Magic in Earnings: Economic Earnings versus Accounting Earnings, *Financial Analysts Journal*, Nov-Dec, pp. 19-24.

Bogle, J.C., and B.G. Malkiel, 2006, Turn on a Paradigm?, June 27, Wall Street Journal, p. A14.

Campbell, J.Y., A.W. Lo, and C. MacKinlay, *The Econometrics of Financial Markets*, Princeton University Press, Princeton, NJ, 1997.

Campbell, J.Y., and R.J. Shiller, Stock Prices, Earnings and Expected Dividends, *Journal of Finance*, 43, pp. 661-676.

Carhart, M., 1997, On Persistence in Mutual Fund Performance, *Journal of Finance*, 52, pp. 57-82.

Chan, K.C., N. Chen, D.A. Hsieh, 1985, An Exploratory Investigation of the Firm Size Effect, *Journal of Financial Economics*, 14, pp. 451-471.

Cochrane, J. 1999, New Facts in Finance, *Economics Perspectives*, 23:36-58.

Coleman, R., 2006, Asset Pricing Simultaneities: Phases and Patterns, *Annals of Economics and Finance* 1, pp. 49-76.

Daniel, K., and S. Titman, 1997, Evidence on the Characteristics of Cross Sectional Variation of Stock Returns, *Journal of Finance*, 52, pp. 1-33.

Davis, J.L., E.F. Fama, and K.R. French, 2000, Characteristics, Covariances, and Average Returns: 1929-1997, *Journal of Finance*, 55, pp. 389-406.

Dimson and Marsh, 1998, Murphy's Law and Market Anomalies, Forthcoming in *Journal of Portfolio Management*.

- Engström, S., 2004, Investment Strategies, Fund Performance and Portfolio Characteristics, SSE/EFI Working Paper Series in Economics and Finance No 554.
- Fama, E.F., 1970, Efficient Capital Markets: A Review of Theory and Empirical Work, *Journal of Finance*, 25, pp. 383-417.
- Fama, E.F., 1991, Efficient Capital Markets: II, *Journal of Finance*, 46, pp. 1575-1617.
- Fama, E.F. and K.R. French, 1992, The Cross-Section of Expected Stock Returns, *Journal of Financial Studies*, 47, pp. 427-465.
- Fama, E.F. and K.R. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics*, 33, pp. 3-56.
- Fama, E.F. and K.R. French, 1996, Multifactor Explanations of Asset Pricing Anomalies, *Journal of Finance*, 51, pp. 55-84.
- Fama, E.F. and K.R. French, 1998, Value versus Growth: The International Evidence, *Journal of Finance*, 53, pp 1975-1979.
- Gordon, M. J., and E. Shapiro, 1956, Capital Equipment Analysis: The Required Rate of Profit, *Management Science*, 2, pp. 102-110.
- Heston, S.L., K.G. Rouwenhorst, and R.E. Wessels, 1995, The structure of international stock returns and integration in emerging markets, *Journal of Empirical Finance*, 2, 173-197.
- Jensen, M., 1968, The Performance of Mutual Funds in the Period 1945-64, *Journal of Finance*, 23, pp. 389-416.
- Jun, D. and B.G. Malkiel, 2008, New Paradigms in Stock Market Indexing, CEPS Working Paper No. 166.
- Kaplan, P.D., 2008, Why Fundamental Indexation Might—or Might Not—Work, *Financial Analysts Journal*, 64, pp. 32-39.
- Lakonishok, *et al.*, 1994, Contrarian Investment, Extrapolation, and Risk, *Journal of Finance*, 49, pp. 1541-1578.
- Ledoit, O., and M. Wolf., 2008, Robust Performance Hypothesis Testing with the Sharpe Ratio, *Journal of Empirical Finance*, 15, pp. 850-859.
- Lintner, J., 1965, The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets, *Review of Economics and Statistics*, 47, pp. 13-37.
- Malkiel, B., 2003, *A Random Walk Down Wall Street*, p. 245.
- Markowitz, H. M., 1952, Portfolio Selection, *Journal of Finance*, 7, 77-91.
- Newbold, P., 1995, *Statistics for Business and Economics*.
- Nicolson, S. F., 1960, Price-Earnings Ratios, *Financial Analysts Journal*, 16, pp. 43-45.
- Perold, A., 2007, Fundamentally Flawed Indexing, *Financial Analysts Journal*, 63, pp 31-37.

Piotroski, J.D., 2000, Value Investing: The Use of Historical Financial Information to Separate Winners from Losers, *Journal of Accounting Research*, 38, pp. 1-41.

Ray Ball, 1998, The Theory of Stock Market Efficiency: Accomplishment and Limitations, The Revolution in Corporate Finance.

Sharpe, W., 1964, Capital Asset Prices: A Theory of market equilibrium under conditions of risk, *Journal of Finance*, 19, pp. 425-442.

Sharpe, W., 2007, *An Interview with William F. Sharpe*, Advisor Perspectives, October 16.

Siegel, J., 2002, *Stocks for the long Run*, Estados Unidos: McGraw-Hill, Inc. pp. 231.

Smith, A., 1776, *An Inquiry into the Nature and Causes of the Wealth of Nations*.

Teall, J.L., 1999, *Financial Market Analytics*, Greenwood Publishing Group.

Swedish Bachelor & Master Theses

Falk, O. and H. Callervik, 2005, *Alternativa Index – En studie av mean-variance-effektivitet hos index baserade på fundamentalvärde kontra börsvärde*, Master Thesis, Lund University.

Grufman, M., Sjölund, C., 2008, *Are Market Weighted Indices Suboptimal?*, Master Thesis, Stockholm School of Economics.

Holm, M. and W. Moberg, 2006, *Fundamentalindex: En studie av fundamentalindex, avkastning och risk*, Master Thesis, Stockholm University.

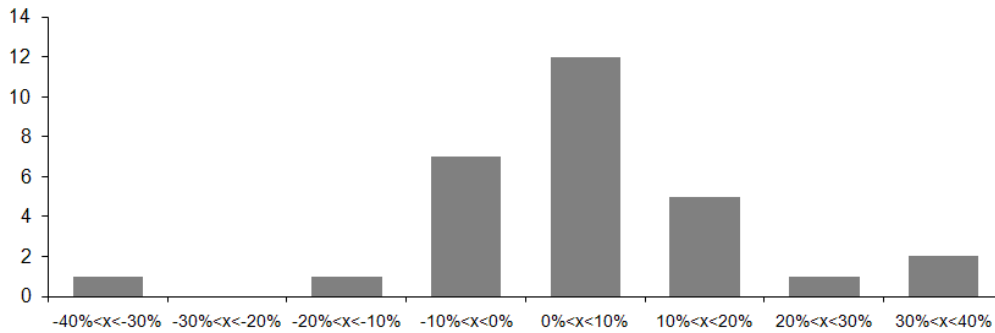
Karlsson, D., and R. Kase, 2008, *Benchmark Changes Matter: The Case for Mutual Fund Relative Performance*, Master Thesis, Stockholm School of Economics.

Martinsson, G., C. Ramel, and G. Vikström, 2005, *Alternativt viktade aktieportföljer*, Bachelor Thesis, Lund University.

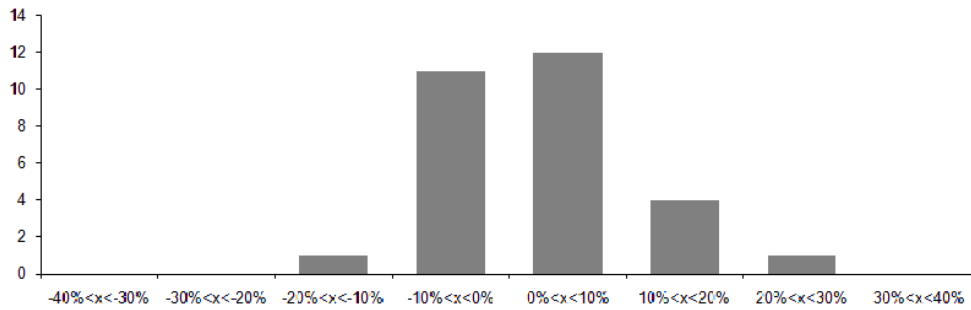
Uhrdin, S., C. Walljaeger, 2005, *Index viktat efter omsättning: Presterar ett index viktat efter omsättning bättre än index viktat efter börsvärde?*, Master Thesis, Stockholm University.

Histograms of Annual Fundamental Index Abnormal Return (AR)

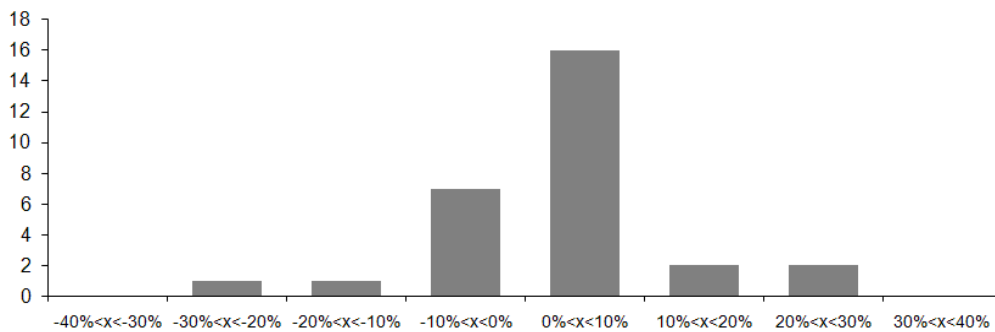
$$AR(EARN) = R(EARN) - R(MCAP)$$



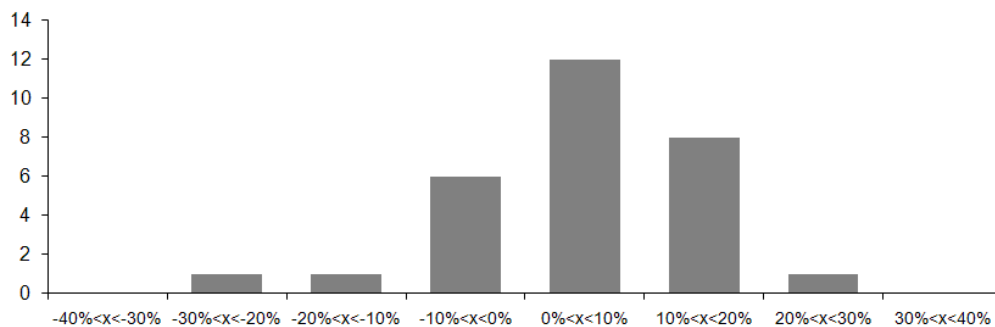
$$AR(BOOK) = R(BOOK) - R(MCAP)$$



$$AR(EMPL) = R(EMPL) - R(MCAP)$$



$$AR(SALE) = R(SALE) - R(MCAP)$$



Bowman-Shelton Tests of Annual Abnormal Return of Fundamental Indices

H_0 : Abnormal Return (AR) of fundamental index Z is normally distributed

H_1 : Abnormal Return (AR) of fundamental index Z not normally distributed

This is the test statistic is as follows:

$$B = n \left[\frac{(\text{Skewness})^2}{6} + \frac{(\text{Kurtosis} - 3)^2}{24} \right]$$

The rejection rule is to reject H_0 if $B(\text{obs}) > B(\text{cri})$. At 10% significance level and with a sample of 29 observations the $B(\text{cri})$ is 2.45 and at a 5% significance level and with a sample of 29 observations the $B(\text{cri})$ is 3.67.

Then I calculate the observed Bowman-Shelton values:

$$B[AR(EARN_{\text{obs}})] = 29 \left[\frac{(0.24)^2}{6} + \frac{(3.48 - 3)^2}{24} \right] = 0.556$$

Conclusion: since $B(\text{obs}) = 0.556 < 2.45 = B(\text{cri})$ I cannot reject H_0 , i.e. normality.

$$B[AR(BOOK_{\text{obs}})] = 29 \left[\frac{(0.16)^2}{6} + \frac{(4.50 - 3)^2}{24} \right] = 2.857$$

Conclusion: since $B(\text{obs}) = 2.857 > 2.45 = B(\text{cri})$ @ 10% level I reject H_0 but I fail to reject it at a 5% level ($2.857 < 3.67$).

$$B[AR(EMPL_{\text{obs}})] = 29 \left[\frac{(-0.62)^2}{6} + \frac{(3.46 - 3)^2}{24} \right] = 2.084$$

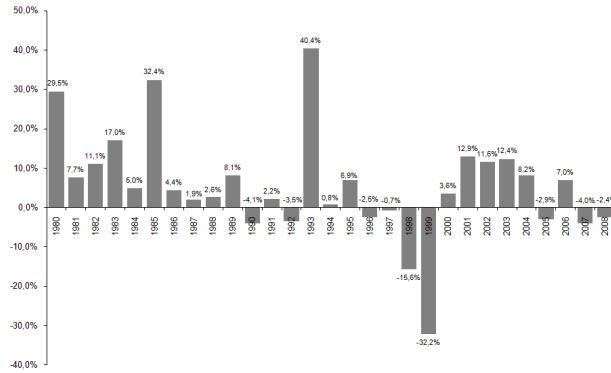
Conclusion: since $B(\text{obs}) = 2.084 < 2.45 = B(\text{cri})$ I cannot reject H_0 .

$$B[AR(SALE_{\text{obs}})] = 29 \left[\frac{(-0.64)^2}{6} + \frac{(4.58 - 3)^2}{24} \right] = 4.983$$

Conclusion: since $B(\text{obs}) = 4.983 > 3.67 = B(\text{cri})$ I reject H_0 at a 5% significance level. This is probably because I have so few ($n=29$) observations. According to the histogram for $AR(SALE)$ the distribution appears normal distributed.

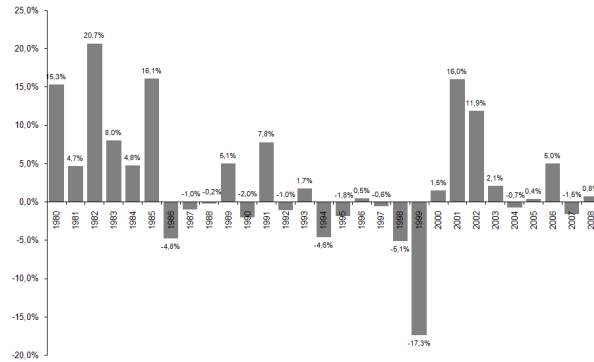
29-year geometric mean abnormal return of the fundamental earnings index: +2.5%

$$AR(EARN) = R(EARN) - R(MCAP)$$



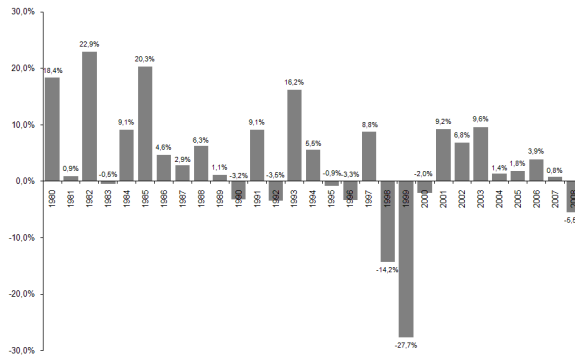
29-year geometric mean abnormal return of the fundamental book equity index: +4.6%

$$AR(BOOK) = R(BOOK) - R(MCAP)$$



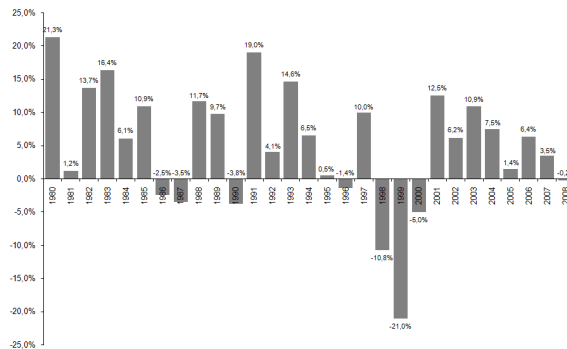
29-year geometric mean abnormal return of the fundamental employee index: +4.6%

$$AR(EMPL) = R(EMPL) - R(MCAP)$$



29-year geometric mean abnormal return of the fundamental sales index: +2.9%

$$AR(SALE) = R(SALE) - R(MCAP)$$



Correlation Matrix of Returns

This table displays the correlation matrix of the 29 annual returns of respective fundamental index (*EARN*, *BOOK*, *EMPL*, & *SALE*) and benchmark (*MCAP*).

	R(REFR)	R(AFGX)	R(MCAP)	R(EARN)	R(BOOK)	R(EMPL)	R(SALE)
R(REFR)	1,00000	0,14323	0,23891	0,31740	0,35090	0,31797	0,33997
R(AFGX)	0,14323	1,00000	0,89775	0,84447	0,82874	0,86524	0,84205
R(MCAP)	0,23891	0,89775	1,00000	0,97374	0,93546	0,96688	0,95932
R(EARN)	0,31740	0,84447	0,97374	1,00000	0,96799	0,98454	0,98451
R(BOOK)	0,35090	0,82874	0,93546	0,96799	1,00000	0,97275	0,97973
R(EMPL)	0,31797	0,86524	0,96688	0,98454	0,97275	1,00000	0,98702
R(SALE)	0,33997	0,84205	0,95932	0,98451	0,97973	0,98702	1,00000

Correlation Matrix of Weights

This table displays the correlation of the 29 annual weights of respective fundamental index (*EARN*, *BOOK*, *EMPL*, & *SALE*) and benchmark (*MCAP*). This table helps further explain the correlations of returns above since the portfolio return is calculated by multiplying annual individual stock return times the annual weight. The highest correlation is between the fundamental sales (*SALE*) index and the fundamental earnings (*EARN*) index: 0.952. This is quite intuitive since earnings are closely linked to sales in the income statement. The lowest correlation is between the fundamental employee (*EMPL*) index and the benchmark (*MCAP*) index: 0.697. This is also quite intuitive since the employee figure is probably the least important fundamental in terms of valuing a company (i.e. arriving at *MCAP*) in comparison to sales, earnings and book equity which are all commonly used valuation metrics. Earnings are generally thought as the primary drivers of stock returns which could probably explain why the market cap is most closely correlated to earnings in comparison to the correlation of market cap and the other fundamental indices.

	R(MCAP)	R(EARN)	R(BOOK)	R(EMPL)	R(SALE)
R(MCAP)	1,000	0,767	0,720	0,697	0,716
R(EARN)	0,767	1,000	0,834	0,729	0,952
R(BOOK)	0,720	0,834	1,000	0,799	0,832
R(EMPL)	0,697	0,729	0,799	1,000	0,787
R(SALE)	0,716	0,952	0,832	0,787	1,000

Investment Implications

This table is just Table III sorted by total return of *MCAP* from high to low. It shows that fundamental indices might fail when different business sectors are being re-valued. Fundamental indices do relatively worse in *boom* times when companies with low fundamentals such as dotcom stocks increased markedly in market value such as during 1996-1999. This is simple because fundamental indices are relatively under-weighted in stocks with low fundamentals. This table also shows that fundamental indices do relatively worse in *bad* times when companies with large fundamentals such as banks decreased markedly in market values such as during the banking crisis of 1990 and 2008. This is simple because fundamental indices are relatively over-weighted in stocks with large fundamentals such as banks.

#	YEAR	R(MCAP)	R(EARN)	R(BOOK)	R(EMPL)	R(SALE)
2	1981	86,8%	91,5%	94,5%	88,0%	87,7%
1	1980	80,8%	96,2%	110,3%	102,2%	99,2%
20	1999	73,7%	56,4%	41,5%	52,7%	46,1%
4	1983	65,8%	73,8%	82,8%	82,2%	65,3%
14	1993	61,7%	63,4%	102,1%	76,3%	77,9%
3	1982	59,9%	80,6%	71,0%	73,6%	82,8%
7	1986	46,3%	41,5%	50,6%	43,8%	50,9%
26	2005	38,2%	38,5%	35,3%	39,6%	39,9%
18	1997	35,7%	35,1%	35,0%	45,7%	44,5%
6	1985	34,7%	50,8%	67,2%	45,6%	55,0%
17	1996	34,4%	34,9%	31,9%	33,1%	31,1%
10	1989	30,9%	36,0%	39,0%	40,7%	32,0%
19	1998	27,2%	22,1%	11,5%	16,4%	12,9%
9	1988	26,2%	26,0%	28,8%	37,8%	32,5%
15	1994	18,2%	13,6%	19,0%	24,7%	23,7%
27	2006	17,9%	23,0%	24,9%	24,3%	21,9%
24	2003	16,3%	18,4%	28,7%	27,2%	25,9%
13	1992	12,9%	11,9%	9,4%	17,0%	9,4%
25	2004	8,1%	7,4%	16,3%	15,6%	9,5%
12	1991	7,4%	15,3%	9,6%	26,5%	16,6%
16	1995	7,4%	5,6%	14,3%	7,9%	6,5%
28	2007	0,2%	-1,4%	-3,8%	3,7%	1,0%
21	2000	-2,9%	-1,4%	0,7%	-7,8%	-4,9%
5	1984	-8,9%	-4,2%	-3,9%	-2,8%	0,2%
8	1987	-9,3%	-10,3%	-7,4%	-12,8%	-6,4%
22	2001	-14,3%	1,7%	-1,4%	-1,7%	-5,1%
11	1990	-27,0%	-29,0%	-31,0%	-30,8%	-30,2%
23	2002	-34,1%	-22,2%	-22,5%	-27,9%	-27,3%
29	2008	-36,5%	-35,7%	-38,9%	-36,7%	-42,0%

Gray = Fundamental index Z underperforms benchmark index MCAP
 White = Fundamental index Z outperform benchmark index MCAP