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**AN EXAMINATION OF FUNDAMENTAL INDEXATION USING THE EURO
STOXX 50 INDEX**

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Εγκρίνουμε την εργασία του

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ΒΕΒΑΙΩΣΗ ΕΚΠΟΝΗΣΗΣ ΔΙΠΛΩΜΑΤΙΚΗΣ ΕΡΓΑΣΙΑΣ

«Δηλώνω υπεύθυνα ότι η συγκεκριμένη πτυχιακή εργασία για τη λήψη του Μεταπτυχιακού Διπλώματος Ειδίκευσης στη Λογιστική και Χρηματοοικονομική έχει συγγραφεί από εμένα προσωπικά και δεν έχει υποβληθεί ούτε έχει εγκριθεί στο πλαίσιο κάποιου άλλου μεταπτυχιακού ή προπτυχιακού τίτλου σπουδών, στην Ελλάδα ή στο εξωτερικό. Η εργασία αυτή έχοντας εκπονηθεί από εμένα, αντιπροσωπεύει τις προσωπικές μου απόψεις επί του θέματος. Οι πηγές στις οποίες ανέτρεξα για την εκπόνηση της συγκεκριμένης διπλωματικής αναφέρονται στο σύνολό τους, δίνοντας πλήρεις αναφορές στους συγγραφείς, συμπεριλαμβανομένων και των πηγών που ενδεχομένως χρησιμοποιήθηκαν από το διαδίκτυο».

ΑΓΓΕΛΟΣ Α. ΚΟΚΚΙΝΙΑΣ

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TABLE OF CONTENTS

ABSTRACT.....	6
1. INTRODUCTION.....	7
1.1 MARKET INDICES.....	7
1.2 INDEX CLASSIFICATION.....	8
1.3 STOCK WEIGHTING.....	8
1.4 PURPOSE OF DISSERTATION.....	9
2. LITERATURE REVIEW.....	10
2.1 ADVANTAGES OF CAPITALIZATION WEIGHTING.....	10
2.2 DISADVANTAGES OF CAPITALIZATION WEIGHTING.....	11
2.3 PRICE INEFFICIENCY.....	11
2.4 FUNDAMENTAL INDEX AS A BENCHMARK.....	14
2.5 ACTIVE vs. PASSIVE STRATEGIES.....	15
2.6 REBALANCING COSTS.....	17
2.7 SIZE AND VALUE FACTORS.....	19
2.8 EMPIRICAL EVIDENCE.....	21
2.9 INTERNATIONAL APPLICATIONS.....	24
2.10 SECTOR APPLICATIONS.....	25
3. METHODOLOGY.....	26
3.1 REFERENCE INDEX.....	26
3.2 FUNDAMENTAL METRICS.....	27
3.3 ESTIMATION TECHNIQUES.....	28
3.4 CONSTRUCTION OF FUNDAMENTAL METRICS.....	28
3.5 FACTOR ANALYSIS.....	29



4. RESULTS.....	31
4.1 ANNUALIZED RETURNS.....	31
4.2 VOLATILITY MEASUREMENTS.....	32
4.3 INDEX CORRELATIONS.....	33
4.4 ANNUAL RETURNS.....	34
4.5 FACTOR MODELS.....	34
5. DISCUSSION.....	36
5.1 COMPARISON OF RETURNS.....	36
5.2 VOLATILITY ISSUES.....	38
5.3 ANNUAL CHARACTERISTICS.....	38
5.4 RISK-RETURN PERFORMANCE.....	39
6. CONCLUSION.....	41
REFERENCES.....	43



ABSTRACT

The purpose of this dissertation is to examine the benefits of fundamental indexation using European data. Proponents claim that the concept of fundamental indexation forms an innovative investment approach, outperforming traditional capitalization-weighted schemes. A series of fundamental-weighted indices are constructed by re-weighting a capitalization-weighted index based on dividends, book value, cash flow, sales, as well as a composite index. The aim is to compare the risk-return characteristics with those of the Euro Stoxx 50 index, who serves as a reference index. Using the CAPM model, together with the Fama-French three-factor model, it is tested whether a fundamental indexing strategy generates positive alpha after correcting for risk factors. The constructed fundamental-weighted indices provide positive excess returns over the reference index, during an 11-year period. However, an assessment of the risk factor exposures reveals a value tilt. When adjusting for this value tilt, and for the exposure to the small cap factor in addition to the market factor, the abnormal returns are significantly reduced. The argument that fundamental indexation, as an alternative strategy, produces superior performance against a capitalization-weighting index is not supported by empirical evidence.



1. INTRODUCTION

In today's globalized economy, thousands of stocks are traded in major stock exchanges around the world. Given the difficulty with tracking every single security trading in an equity market, the necessity to measure the average performance of the market as a whole led to the construction of the indices. By definition, an index is a statistical measure of performance change in securities markets. The Dow Jones Industrial Average was founded in 1896, and it constituted only twelve stocks. Today, the Wilshire 5000 Total Market Index lists more than five thousand companies headquartered in the United States. There is a variety of indices offered from index providers. Index families represent a wide range of stocks covering different market segments and different investment strategies, such as benchmark or style indices.

1.1 MARKET INDICES

Market indices are important in many ways. First, they give an overall view of the trend in an equity market. Also, they allow comparisons between the performance of a stock or a portfolio with that of the market, namely, using an index for benchmarking purposes. Furthermore, index funds can be constructed to match or track the performance of a market index. Market indices are useful in technical analysis as well as in academic and applied research. Some reasons why indexing strategies is an effective way of investing include being transparent and unambiguous, as well as facing lower acquisition, trading and management costs. However, one must be cautious with index-based investing. There are two major concerns, named the calculation bias and the representative bias. The first one has to do with the way an index is calculated. For instance, if it is capitalization-weighted it will overweight the larger stocks and underweight the smaller stocks. It could be argued then, that capitalization-weighting is not a proper way to capture the image of the market. The second concern has to do with the limitations of an index. An index is comprised of a relative small number of stocks compared to the market as a whole. So, one has to be careful with the informational context of an index.



1.2 INDEX CLASSIFICATION

Equity market indices are classified in many ways. A global equity market index includes companies without regard of where they are traded, for example in New York Stock Exchange or in London Stock Exchange. A national index represents the performance of the equity market of a given country. The most regularly quoted market indices are national indices which are composed of the stocks of companies listed on a country's stock exchange, such as the S&P 500 in the United States or the Athex Composite Price Index in Greece. More specialized indices exist with the purpose of tracking the performance of specific sectors of the market. Some examples include size and style indices, theme indices, and faith-based indices. Other indices may track companies of a certain size, a certain type of management, or even using criteria that are more specialized. An index may also be classified according to the methodology used to determine its price. In a price-weighted index, the price of each component stock is the determinant of the value of the index. In contrast, a capitalization-weighted index is a type of index whose individual components are weighted according to their market capitalization.

1.3 STOCK WEIGHTING

Capitalization-weighting is the standard practice in equity index construction. In a capitalization-weighted index, each individual stock is weighted according to its market capitalization, with larger stocks carrying a higher percentage weighting, and smaller stocks a lower percentage weighting. The value of a capitalization-weighted index can be computed by adding up the collective market capitalizations of the participating stocks and divide the total sum by the number of stocks in the index. An alternative to capitalization-weighting is a type of index in which the stocks chosen are based on fundamental metrics, such as revenues, dividends, cash flow, and book value. This is known as a fundamental-weighted index. In fundamental-weighted indexing, each stock is weighted in proportion to its fundamentals. Proponents of fundamental indexation claim that this is a groundbreaking approach in index investing, whereas opponents argue it is merely another alternative-weighted scheme.



1.4 PURPOSE OF DISSERTATION

It is widely accepted that the goal in investments is to earn higher returns with lower risk. Given that a vast amount of money worldwide is invested to or benchmarked in market indices, it is essential whether fundamental indexation is a superior strategy compared to the standard practice of capitalization-weighting in the construction of equity market indices. A vast amount of literature examines the theoretical aspects, as well as the practical perspectives of fundamental indexation, most of it focusing in U.S. equity markets. The present research first provides an overview of the findings on fundamental indexation based on literature. Using data from Eurozone, a series of fundamental-weighted indices are set up using various fundamental metrics, for a period lasting 11 years. Several statistical measures are used to quantify and interpret the results. The aim is to examine the risk-return characteristics of fundamental-weighted indices using as reference index the Euro Stoxx 50 index. The assumption is that an indexing strategy not only provides credible performance in the past, but should also provide similar results in the future.



2. LITERATURE REVIEW

Fundamental indexation appeared in 2005, as a promising indexing strategy and an alternative to capitalization weighting. At that year, Financial Analysts Journal published an academic paper titled “Fundamental Indexation”, of Arnott, Hsu and Moore. A debate started in the academic literature about the pros and cons of this novel investment approach. At the end of 2005, FTSE Company and Research Affiliates LLC launched the FTSE/RAFI Index Series as a set of indices for markets of varying sizes in several countries. This section presents a review of the existing literature on fundamental indexation.

2.1 ADVANTAGES OF CAPITALIZATION WEIGHTING

Indexing strategy is a powerful method of equity investing, easy to implement, and highly liquid. Before departing from capitalization weighting, it is important to review its merits. Capitalization weighting is a standard practice in the investment community all over the world, with trillions of money invested in or benchmarked to capitalization-weighted indices. Capitalization weighting is a passive strategy, requiring little or no rebalancing, thus exhibiting small rebalancing costs and a high level of diversification. Furthermore, it provides a convenient way to participate in the broad equity market, mostly in the more liquid stocks, thus reducing portfolio transaction costs. Individual and institutional investors have a growing variety of indices to choose from, contributing to the popularity of index investing. The benefits of capitalization weighting are numerous. Arnott et al (2005) point out that fundamental-weighted indices retain these benefits and at same time provide better risk-adjusted returns. They state their arguments within the CAPM framework. Prominent role in the CAPM framework has the so-called market portfolio.



2.2 DISADVANTAGES OF CAPITALIZATION WEIGHTING

Until recently, the Capital Asset Pricing Model (CAPM) provides the basis for a number of practices in the investment industry. CAPM suggests that the market portfolio is a portfolio consisting of all securities, in which the proportion invested in each security corresponds to its relative market value, thus, a capitalization-weighted portfolio. The market portfolio is the one that offers the best combination of risk and return, and therefore preferred by all investors who seek to maximize their mean-variance utility. Furthermore, CAPM theory proposes that passive investors should seek to invest in the market portfolio, which provides the broader diversification and serves as a universal performance evaluation standard. In reality, identifying the true market portfolio is a difficult task. Mayers (1976) argues that the efficient market portfolio should include all risky assets, not just stocks. The difficulties involved in determining it has led to the use of market portfolio proxies. Thereby, academics and practitioners define the market portfolio as a broad market index, like the S&P 500 in the U.S. equity market. On the other hand, rejecting the idea that capitalization-weighted indices are ex-ante good market proxies¹ leaves space in identifying alternative-weighted indices that are more mean-variance efficient, thus, providing higher risk-adjusted returns. Following this criticism, Arnott et al (2005) propose fundamental indexation as a better indexing strategy. Based the assumption of price inefficiency, their argument is that capitalization-weighted portfolios are sub-optimal portfolios.

2.3 PRICE INEFFICIENCY

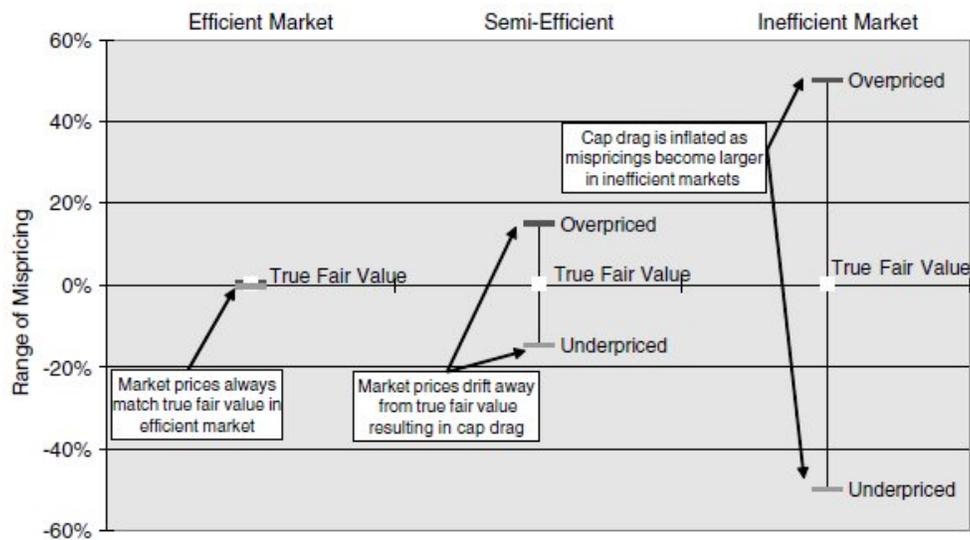
Efficient Market Hypothesis (EMH), a cornerstone of modern financial theory, assumes that the price of a stock at any point in time is the best unbiased estimator of the true value of the firm. EMH suggests that stock prices will always reflect and incorporate all relevant market information, therefore making it impossible for the individual investor to outperform the market through stock selection or market timing. If stocks are priced according to the EMH, then capitalization-weighted indices will

¹ Roll and Ross (1994)



offer investors the best risk-return combination. Of course, disputers contend that market forces drive stock prices above or below their true fair value, thus, in an inefficient market, some stocks are overvalued and some others are undervalued. In a capitalization-weighted portfolio, overvalued stocks will be overweighted and undervalued stocks will be underweighted. As a result, a passive index investor should be forced to allocate more of his or her portfolio in overvalued stocks and less in undervalued stocks, exactly the opposite of what common sense investing would suggest. Arnott and West (2006) describe stocks that are priced above true fair value as having an erroneously high capitalization and, therefore, erroneously high index weighting. These stocks compose the majority of an indexed portfolio and suffer from a performance drag. Stocks priced below true fair value have an erroneously low capitalization, hence, an erroneously low index weighting, offering a performance boost, one that is too small however to offset the damage of the overpriced stocks, because they comprise less of the portfolio. Stock prices will be therefore inefficient or noisy, in a sense that they will not fully reflect firm fundamentals, leading to a drag on performance². Figure 1 illustrates how drag on performance fluctuates with mispricing in an inefficient market.

Figure 1: Return Drag of Capitalization-Weighted Indices.



Source: Fundamental Indexes: Current and Future Applications. Arnott and West (2006).

² Arnott et al (2005)



Hsu (2006) shows that capitalization weighting schemes do suffer from a return drag, with the size of the drag being proportional to the size of the mispricing in the equity market. He empirically examines whether the cost of implementing an alternative-weighted portfolio would overcome the return drag, finding that it should have to turnover excessively in order to cancel out its performance advantage. His conclusion is that capitalization-weighted portfolios are sub-optimal portfolios. Hsu and Campollo (2006) find that the return drag on a capitalization-weighted portfolio is significantly increased when mispricing is temporary. Treynor (2005) confirm that market-valuation-indifferent indices are superior because they avoid the problem of overweighting overvalued stocks and underweighting undervalued stocks. Siegel (2006) goes a step further, proposing a new paradigm, which he calls the Noisy Market Hypothesis (NMH). According to NMH, stock prices are not always the best estimate of the true underlying value of the firm because they are influenced by investors, like speculators or momentum traders, who buy and sell stocks for reasons unrelated to fundamental value, such as for diversification or liquidity. In other words, stock prices are subject to temporary shocks, that is, they become noisy. The duration of these shocks is indefinable, which makes it difficult to design a trading strategy to produce consistently superior returns. He further claims that the NMH explains the size and value anomalies. If a stock price falls for reasons unrelated to changes in fundamental value, then it is likely that overweighting such a stock will yield better than normal returns. On the other hand, a stock that rises in price more than its fundamentals, becomes a large stock with a high Price-to-Earnings (P/E) ratio, and is likely to underperform. Hsu and Campollo (2006) summarize the above by stating that if the market is efficient, fundamental indices are as good as capitalization-weighted indices. If the market is inefficient, they expect fundamental indexing to outperform capitalization-weighted indexing. As much valid these arguments are, fundamental indexation has been challenged by several authors. The remainder of the section will highlight some of this criticism, starting from the concession that a fundamental index is a benchmark.



2.4 FUNDAMENTAL INDEX AS A BENCHMARK

Estrada (2008) questions the attribute of fundamental indexation as a proper benchmark. He suggests that a capitalization-weighted benchmark should have three desirable features. First, it should properly represent the investment opportunities available to investors. Second, it should show the returns of the average investor. Third, it should enable all investors to link their portfolios to this benchmark at current market prices. It is clear that a fundamental-weighted portfolio is not fulfilling these conditions, making it an improper benchmark. Some researchers go further and question whether fundamental-weighted indices are indices at all. According to Waid (2007), a problem with investment strategy indices is the inclusion of the word “index”. Just because an enhanced index strategy can be created using factors that are more efficient than a target index with higher returns and similar volatility, does not mean that the resulting product should be considered a benchmark or an alternative measure of beta. He marks that market prices respond quicker to changes in company valuations than fundamental metrics. This is because market prices reflect the expectations of all investors at that moment, while fundamental metrics use the past reporting of a company’s financials after their release. Stock manipulation is difficult and illegal, and fundamental metrics are susceptible to both legal and illegal distortions. For instance, a company’s management controls the size and frequency of dividend payments, and consequently these payments affect the company’s weight in a fundamental-weighted index. The market on the other hand, evaluates all news including changes in dividend payouts and adjusts the stock price. Chen, Chen and Bassett (2007) point that fundamental weighting will not be profitable if actual prices stray far from fundamentals for long periods. Arnott and West (2006) claim that if information is incorrect, the error is correlated with the weight in a capitalization-weighted portfolio. The use of fundamental measures of firm size removes the structural return drag of capitalization weighting. This leads to another controversy surrounding fundamental indexation, namely, whether it amounts to active or passive investing.



2.5 ACTIVE vs. PASSIVE STRATEGIES

The EMH says that a market is efficient if it is not possible to make abnormal profits on a constant basis. Consequently, the more efficient a security market is, the lower the expected returns are for investors who buy and sell securities in search of abnormally high returns. Investors, who concede the market efficiency, adopt an investment approach referred to as passive management. Passive management involves a long-term, buy-and-hold approach to investing. The investor selects a target and then buys a portfolio designed to track the performance of that target. Because the target is usually a broad market index, passive management is also referred to as indexation. Active management, on the other hand, involves an effort to exceed the performance of an index by searching for mispriced securities, the true nature of active investing. Trading these mispriced securities provides an active investor with the potential to outperform the passive investor. Active and passive strategies represent different investing styles, but they have at least one thing in common: in most cases, the securities in the benchmark are weighted by capitalization. Arnott et al (2005) categorize fundamental-weighted indices as passive strategies, alternative to capitalization weighting. However, whether an investor who invests in a fundamental-weighted index follows an active or passive strategy is not entirely clear. Calling a transparent, structured portfolio as index, does not make it passive. Estrada (2008) argues that a passive strategy implemented by buying and holding an Exchange-Traded Fund (ETF) that aims to track a capitalization-weighted index has low turnover, transaction costs and taxes. Buying and holding an ETF that tracks a fundamental index, however, is a strategy that has not only different risk-return characteristics but also higher turnover, transaction costs and taxes. Therefore, it is important for investors to know whether they are investing in passive indices or in disguised active indices, with their correspondingly higher turnover, transaction costs and taxes. Arnott and West (2006) respond to this criticism by arguing that active management suffer from flaws, such as higher management fees and trading expenses, limited capacity of assets under management and broad asset class coverage, necessitating multiple managers. Indexing in a more efficient fundamental-weighted benchmark solves all of these problems without giving up expected excess returns. This strategy, they argue, is clearly passive, transparent, and objectively constructed. Waid (2007) points that a non-judgmental buy-sell methodology does not make the



investment passive. Low turnover is the appeal of a passive index and a major selling point for capitalization-weighted investing. On the other hand, alternatively weighted indices have turnover built into the construction methodology. He emphasizes that weighting by capitalization an index does not make it passive. Fundamental index goals, like those of any active manager, are to outperform. The problem with investing in these structured portfolios as an active index strategy is that the process to improve them ceases once the index is released. Perold (2007) stresses that the NMH is seeking to position an active management strategy in a passive management framework, and it asserts rather than derives the inferiority of capitalization weighting. The fallacy of the NMH is located in going from the assumption that any given stock is likely to be overvalued or undervalued, to the conclusion that capitalization weighting systematically skews investment towards overvalued stocks. His analysis shows that capitalization weighting imposes no drag on expected returns because capitalization weighting does not cause an investor to invest more in overvalued stocks and less in undervalued stocks. Blitz and Swinkels (2008) track down the differences between a fundamental-weighted index and a capitalization-weighted index. First, a capitalization-weighted index is unique in the sense that it is the only portfolio which every investor can hold. Fundamental-weighted indices, on the other hand, cannot be held in equilibrium by every investor. For every stock that is overweighted by fundamental investors, there must be some other investor who underweights the same stock, and the opposite. However, it is not clear which investor characteristics determine that it is optimal to be a fundamental indexer or not. The proponents of fundamental indexation also fail to explain why a certain group of investors would want to invest in fundamentally unattractive stocks. Second, contrary to a capitalization-weighted index, a fundamental-weighted index does not represent a passive, buy-and-hold strategy. Mirroring a capitalization-weighted index requires no turnover, except in case of index changes due to new share issuance. A fundamental-weighted index, on the other hand, requires some kind of rebalancing strategy, as changes in stock prices continuously push weights away from their fundamental levels. In the absence of transaction costs, the ideal fundamental-weighted index would be rebalanced continuously. A continuously rebalanced fundamental index, however, will exhibit a negative exposure towards momentum compared to a capitalization-weighted index, as it continuously needs to sell stocks that have done well and buy stocks that have done poorly. This may explain why fundamental index



providers propose low rebalancing frequencies, which make their indices deviate more from the theoretical ideal. In addition to saving on transaction costs, this prevents the fundamental-weighted indices from getting a negative exposure to the momentum effect, which historically would have hurt performance. Third, several subjective choices need to be made in order to define a fundamental index. Most notably, which particular fundamentals are considered in the construction of the index, and how exactly should these be defined. These characteristics of fundamental-weighted indices actually resemble more to an active investment strategy, rather than a traditional passive index.

2.6 REBALANCING COSTS

Another important issue is that of the costs associated with executing an investment strategy. As it was mentioned above, in a capitalization-weighted index weights of stocks automatically adjust as stocks prices fluctuate. There is no need to rebalance, except in cases of stock buybacks and secondary equity offerings. This implies that there are no rebalancing costs with executing this strategy. Material adjustment is required when a company enters an index, faces a reduction in capitalization, or disappears through a merger. In the case of a fundamental-weighted index however, an amount of rebalancing is required, in addition to the usual reconstitution. As stock prices go up and down, the stock weights are drawn away from their fundamental values. The critical issue here is the amount of the rebalancing costs, which in turn relates to number of the rebalancing periods. If the rebalancing periods are too short, then the costs will be unprofitable in executing the strategy. If the rebalancing periods are too long, the difference between the policy weights and the actual portfolio weights will become so large that some of the negative attributes of the capitalization weighting might be introduced. Arnott et al (2005) demonstrate that with annual rebalancing, the resulting turnover only modestly exceeds the turnover of a capitalization-weighted index. When they rebalance their index more frequently, they find increased turnover but no appreciable return advantage over annual rebalancing. They also note that no adjustment is made for trading costs in the index construction, which is consistent with the standard practice in commercial indices and in academic research. Hsu and Campollo (2006) argue that the turnover in the fundamental indices



is largely due to rebalancing the large names. Therefore, the true rebalancing cost, associated with maintaining a fundamental-weighted index versus a capitalization-weighted index, may be comparable if not in favor of the fundamental-weighted index. An advantage of capitalization weighting over any alternative-weighted approach is that capitalization weighting does not need to be continuously rebalanced, so transaction costs are kept to a minimum. In contrast, any alternative-weighted scheme requires regular rebalancing, thus generating transaction costs that must be overcome by superior performance. Weighting solely on market value, however, can produce portfolios with volatile levels of diversification. Capitalization-weighted portfolios are almost never rebalanced, so a stock that keeps rising has an increasingly large portfolio weight. Most investors would never allow this decreasing diversification. In a similar fashion, by rebalancing a portfolio, fundamental indexation promotes diversification. Arnott and West (2006) support this view and report that the turnover of a fundamentally weighted index remains low relative to an actively managed portfolio, and slightly above that of a capitalization-weighted index. Further, they find that the fundamental-weighted index's turnover tends to be in larger-capitalization companies, presuming lower transaction costs, whereas a capitalization-weighted index tends to experience most of its turnover in smaller-capitalization companies, with higher transaction costs. To retain low turnover, but control the level of diversification, Arya and Kaplan (2006) use fundamental weights to set boundaries on portfolio weights rather than being the portfolio weights themselves. These boundaries are fixed multiples of the fundamental weights, such as a lower bound of half the fundamental weight and an upper bound of twice the fundamental weight. Stocks with market value weights that fall within the boundaries are held at market value weights, whereas stocks with market value weights that fall outside these boundaries are held at boundary weights. The idea is to hold the portfolio at market value weights most of the time, while avoiding concentration in few large stocks during market run-ups. In addition, Blitz, Grient and Vliet (2010) note that the existing literature is silent on whether rebalancing assumptions matter, thereby implicitly suggesting that these are not of major concern. They show that the performance of a fundamental index can be highly sensitive to the choice of the annual rebalancing moment, introducing a degree of arbitrariness, which is an undesirable feature for an objective benchmark index. This arbitrariness arises because fundamental index weights are allowed to deviate from fundamental values in



between rebalancing moments. They introduce the idea of blending multiple underlying fundamental-weighted indices, each one rebalanced annually, but at different dates, as an example of an index which is more representative for the general concept of fundamental indexing, without resulting in increased turnover. The sensitivity of fundamental-weighted index returns to the subjectively chosen rebalancing moment arises because rebalancing can change the value exposure of a fundamental index. They comment that the choice of rebalancing date is crucial for the performance of the fundamental-weighted indices. Blitz, Grient and Vliet (2010) also find a large performance discrepancy between fundamental indices with different rebalancing dates. They perform Augmented Dickey-Fuller (ADF) tests, with results supporting their intuition that divergences in the performance of one fundamental-weighted index versus another tend to have a permanent nature. The underlying cause of performance differences between fundamental-weighted indices is a time-varying exposure to value. A solution would be to rebalance a fundamental-weighted index more frequently, but this could be at the expense of increased turnover. That is why they consider a blended fundamental-weighted index. A blended index can mitigate the sensitivity of a fundamental-weighted index to rebalancing assumptions, while maintaining a low level of turnover. The question is, how large the trading costs must be in order to eliminate the overperformance of fundamental-weighted indices relative to capitalization-weighted indices. This question leads to the issue of the relative performance of the fundamental-weighted indices.

2.7 SIZE AND VALUE FACTORS

In academic finance, and among practitioners, a consensus exists that the simple single-factor model is not adequate for measuring market returns. This insight led to the development of multifactor models that account for other priced risk factors, in addition to the single market factor used in the CAPM. Researchers in the 1980s discovered that stocks with low P/E ratios had significantly higher returns than stocks with high P/E ratios; small stocks with low P/E ratios (small value stocks) enjoyed particularly outstanding returns. The magnitude of these size- and value-based returns



could not be rationalized using the standard asset pricing models of the EMH³. Fama and French (1992) expanded the CAPM by adding size and value factors. They found that value stocks outperform growth stocks (HML) and small capitalization stocks outperform large capitalization stocks (SMB). There is a debate about whether the outperformance tendency is due to market efficiency or market inefficiency. On the efficiency side of the debate, the outperformance is generally explained by the excess risk that value and small capitalization stocks face because of their higher cost of capital and greater business risk. With regards to market efficiency, the outperformance is explained by market participants mispricing the value of these companies, which provides the excess return in the end as the value adjusts. It is argued that fundamental indices are a near-passive means of capturing the value and small capitalization attributes popularized by Fama and French. As Blitz and Swinkels (2008) argue, fundamental indices are nothing more than a new breed of value indices. The stock weights in a traditional index are proportional to their market capitalization. Fundamental indices, however, weight stocks in proportion to their economic fundamentals. Thus, weight differences are entirely due to differences in valuation levels. For example, if a fundamental index is created based on book value, then the weight differences compared to a capitalization-weighted index are entirely due to differences in the book-to-market ratios of the stocks included in the index. In other words, compared to a capitalization-weighted index, a fundamental-weighted index simply overweights value stocks and underweights growth stocks. Of course, value and growth indices have been already in the market for many years, but traditionally these tend to be based on a different approach. The traditional approach consists of first classifying each stock as either a value stock or a growth stock, and next creating a value or growth index by capitalization weighting all value and growth stocks. Splitting up the universe into two mutually exclusive parts is a rather crude approach compared to fundamental indices, which elegantly re-weight the entire universe of stocks based on fundamental values. Since the weight differences between a fundamental-weighted index and a traditional index are entirely due to differences in valuation levels, any difference in return between a fundamental index and a traditional index must be due to the difference in return between value and growth stocks. The proponents of fundamental indexation claim that capitalization weighting

³ Siegel (2006)



by itself introduces a drag on performance, because in a capitalization-weighted index, overvalued stocks tend to be overrepresented and undervalued stocks tend to be underrepresented. A fundamentally weighted index is claimed to be superior by avoiding this drag on performance. The proponents of fundamental indexation assume that stocks with high valuation ratios are more likely to be overvalued than stocks with low valuation ratios. Empirically, there is indeed a large amount of evidence for the value premium, as historically value stocks have outperformed growth stocks. This also explains the finding that fundamental indices have outperformed capitalization-weighted indices historically. Blitz and Swinkels (2008) suggest that a historical outperformance due to being exposed to an already known empirical return irregularity is something, which is quite different from a superior theoretical performance, because of avoiding some structural drag on performance that is supposedly associated with capitalization-weighted indices. Fundamental indexers are proposing that if one is not going to invest according to capitalization weights, a good strategy is to tilt the portfolio towards value stocks. Historically, as Perold (2007) mention, value stocks have generated higher-than-index returns, and the effect has been well documented and widely debated. At issue is whether value stocks have high returns because they are riskier or because they are mispriced. If the effect is about risk, then fundamental indexers cannot expect to obtain high returns after adjusting for risk. If the effect is about mispricing, fundamental indexers will need to rely on a continuation of that pattern of mispricing in order to obtain high future returns, with the pattern being that the market does not fully account for companies' book values, sales, and other readily obtainable fundamental information when determining stock prices. If value stocks are systematically mispriced, fundamental indexing may perform well, along with other value-oriented strategies, because it is exploiting this particular inefficiency, not because capitalization weighting creates a performance bias.

2.8 EMPIRICAL EVIDENCE

In addition to the advantages and disadvantages of fundamental indexation, investors are also interested in selecting the strategy that maximizes the risk-adjusted return of their portfolio. Mention was made above that capitalization weighting leads to return



drag relative to fair-value-weighting, and the size of the return drag is proportional to the size of the mispricing in the equity market. What remains in doubt is whether one can construct fair-value-weighted portfolios. Most would give a negative reply, that is, one cannot observe companies' fair values. Arnott et al (2005) however argue that it is not necessary to construct fair-value-weighted portfolios in order to outperform capitalization-weighted portfolios. They proceed with constructing six fundamental indices with equal in number metrics of firm size, that is, book value, income, revenues, sales, dividends and total employment. They compare the return characteristics in the U.S. market, over a 42-year period, with the S&P 500. Their results show that, on average, fundamental indices exhibited returns that are 1.91% higher than the S&P 500. They also report similar results when they compare the performances in various decades of the sample, in recessionary and expansionary phases of the business cycle, in bull and bear markets, in rising and falling interest rate regimes. The theme with fundamental-weighted indices is that they fully participate in typical bull markets, slightly lag in bubble periods, and have superior performance in bear markets. Arnott et al claim that the observed excess return of the fundamental indices is consistent with the hypothesis that stock prices are inefficient. They ran a Fama-French three-factor regression, which showed that fundamental indices had factor exposure to the value factor, and thereby earned a value premium relative to a capitalization-weighted index. Arnott et al conclude that the observed excess returns can also be attributed to hidden risk exposures rather than return anomalies from price inefficiency. Waid (2007) questions whether fundamental weighting protects investors from market bubbles. He argues that the S&P 500 is not an appropriate benchmark to compare with a fundamental-weighted index. Another problem with these comparisons is that they were implemented with back-tested data, using rules that kept out the young large-capitalization companies, thus raising the question of data-mining. Bernstein (2006) reports that two-thirds of the excess return of the RAFI over the S&P 500 is due to naïve factor exposure, and one-third seems to be inherent to the technique. Siegel (2006), on the other hand, advocates the use of dividend-weighted indices. Dividends, says, is the only fundamental variable that is objective, transparent and managers cannot manipulate it, so it offers better risk-return characteristics. Arnott and West (2006) in a study, over a 44-year evaluation period, report that the Large Composite index produces annual excess return of 2.1% over a capitalization-weighted index, and the Small Composite index a corresponding 3.6%.



Waid (2007) comments that a dividend-weighting scheme that eliminates a large fraction of the non-dividend paying universe cannot be considered a core investment. As for the European region, Hemminki and Puttonen (2008) provide evidence comparing, for an 11-year period, with the DJ Euro Stoxx 50 index. Their results suggest an annual excess return of the Composite index on the Euro Stoxx 50 index by 1.76%. Amenc, Goltz and Sourd (2008) briefly enumerate a number of index providers and their constructed index portfolios, reaching the conclusion that their indices outperform capitalization-weighted indices. However, index providers doesn't take as benchmarks indices with different weighting schemes, even though they are an alternative that is not value weighted and does not rely on proprietary weighting mechanisms. Further comparisons involving indices from different providers need to be done. Chen, et al (2007) argue, that the fundamental index proposed by Arnott et al (2005) uses economic determinants to measure fundamentals. Due to the difficulty in finding a comprehensive measurement of fundamental value using economic determinants, they resort to simple accounting data as proxies for the fundamental value. Chen et al (2007) implement the idea of fundamental indexation without measuring directly fundamental values. Their approach consists of using statistical methods to infer fundamental values from past prices. In this model, the past price data is a representation of fundamental economic determinants, which is more accurate than the current price. A statistical estimate, based on past prices, can therefore be used to represent the fundamental value. They find their approach working about as well as the methods using accounting data, but with easier implementation and analytical justification. They consider a monthly market index consisting of the one thousand largest capitalization stocks for the period 1962-2003. They report a 1.00% per annum outperformance of their index above the benchmark capitalization-weighted index. Blitz and Swinkels (2008) conclude that, although this is not something unique, fundamental indexation might still be a useful idea in practice. There could remain a case for fundamental indexation, if it is an efficient way of capturing the value premium. However, fundamental indexation is more likely to be a sub-optimal way of benefiting from the value premium. This is because fundamental-weighted indices are primarily designed for simplicity, and not for optimal risk-return characteristics. Quantitative strategies, which are designed for optimal risk-return characteristics, should be able to beat fundamental indexation strategies, not just historically but also in the future.



2.9 INTERNATIONAL APPLICATIONS

It has been suggested that investors who aim to diversify in an equity market, should weight the stocks in their portfolios by price-insensitive fundamentals rather than by capitalization. The globalization of capital markets however has made possible to build globally diversified portfolios using widely available country index funds and ETF. Estrada (2008) elaborates on the relationship between fundamental indexation and international diversification, by examining whether capitalization, price-insensitive fundamentals, or other measures is the best way to weight country index funds and ETF when building global portfolios. Estrada (2008) uses dividends per share in order to evaluate his fundamental indexation strategy. He compares a dividend-weighted index with a capitalization-weighted index, for a period of 32 years and for 16 countries, and reports a mean annual compound return of 14.1% for the dividend-weighted index and a 12.2% for the capitalization-weighted index. The differential performance of the dividend-weighted index and the capitalization-weighted index followed exclusively from the different weights these indices gave to each country benchmark. This, in turn, invited the question about the relative performance of these indices. The results indicated that at least part of the superior performance of the dividend-weighted index was due to its exposure to the value factor and, to a lesser extent, to the size factor. This was consistent with Arnott's et al (2005) findings on the sources of excess returns of fundamental-weighted indices. Estrada considers the possibility that other weighting schemes may have even better results. He constructs a dividend yield-weighted index, which produces annual compound returns of 15.8%, thus outperforming both the aforementioned indices. An intuitive explanation offered by Arnott and West (2006), of why a global fundamental index outperforms a capitalization-weighted index is the volatility of the capitalization index's country exposure versus the fundamental index's country exposure. Not only does capitalization weighting overweights the overvalued and underweights the undervalued companies, but it overweights the overvalued and underweights the undervalued countries.



2.10 SECTOR APPLICATIONS

Sector index funds and ETF are an increasingly popular option amongst investors. Essentially all sector-based funds and ETF use capitalization weighting in the construction methodology, and correspondingly suffer from the same return drag, as Arnott and West (2006) report. Therefore, they compared the sector performance of a fundamental-weighted index to that of the S&P 500. The results showed that fundamental indexing produced excess returns in each sector examined over the selected evaluation period, demonstrating superior stock selection ability within sectors over time.

Before moving on to methodology section, one should complement with an investment question: If it is assumed that a market anomaly exists and is exploitable, will it persist? Portfolio managers look for market anomalies to construct model portfolios, and capture these anomalies until they are gone. If the assumption that fundamental indexation does exploits a market anomaly holds, what will happen when it is gone? The anomaly has been made public. As with any perceived market anomaly, it will be exploited until either it is found to have never existed or it will go away, leaving the investor with an expensive strategy. On the other hand, there is also no conclusive proof that fundamental indexation is inferior to capitalization weighting. Empirical tests of these strategies should determine the value of fundamental indexation.



3. METHODOLOGY

In this section, the methodology implementation is described. The data sources are reported, their features and limitations. Furthermore, the estimation techniques used in order to obtain the results for the discussion section are presented. The objective is to perform a comparison between a capitalization-weighted reference index and a series of fundamental-weighted indices, using the same universe of stocks. In order to evaluate the attributes of the fundamental-weighted indices, several statistics were calculated. Following Houwer and Plantinga (2009), a Fama-French three factor model was used to measure the risk-adjusted performance. The data were obtained from Datastream and processed with Excel. The one-month Euribor was used as the risk-free rate.

3.1 REFERENCE INDEX

The selected reference index was the Euro Stoxx 50 index, constructed by STOXX Ltd. The Euro Stoxx 50 index provides a blue-chip representation of supersector leaders in the Eurozone, covering 50 stocks from 12 Eurozone countries. The index is licensed to financial institutions to serve as an underline for a wide range of investment products such as ETF, futures, options, and structured products worldwide. It captures approximately 60% of the free float market capitalization of the Euro Stoxx Total Market Index, which in turn covers approximately 95% of the free float market capitalization of the represented countries. It also serves as the basis for single country indices for all 12 Eurozone countries. The index is weighted by free float market capitalization. Each component's weight is capped at 10% of the index's total free float market capitalization. The free float weights are reviewed quarterly. The review frequency is annual every September, the base value is 1.000, and the base date is 31 December 1991. The introduction date of the index is 26 February 1998, and the currency is Euro. Constituent lists for the index were available at Datastream from September 1999 and onwards. The Euro Stoxx 50 index is a well-established index in the finance community including shares from 50 of the largest companies by



capitalization in the Eurozone, thereby representing the total market in an efficient manner.

3.2 FUNDAMENTAL METRICS

The period under review extended from 31 December 1999 to 31 December 2010, an 11-year period. The data collected were monthly price index data for the Euro Stoxx 50 index, as well as monthly prices and annual book value per share, sales per share, dividends per share, and cash flow per share data for all the index constituents. The selected frequency of the fundamental metrics was based on the fact that most of the necessary data were available only on an annual basis, providing the basis for constructing the fundamental-weighted indices. Dividends per share represented the total dividends declared during a fiscal year, based on the gross dividend of a security before normal withholding tax was deducted at a country's basic rate. Book value per share represented the book value -proportioned common equity divided by outstanding shares- at the company's fiscal year end. Cash flow per share represented the cash earnings per share of the company. The numerator used for this calculation was Funds from Operations. Sales per share represented the per share amount of the company's sales or revenues. Due to the relative short 11-year period, there were no missing observations. However, restricting the analysis in the selected period, one could introduce survivorship bias. The measures of firm size were representative of the companies' financial condition and were also used in the academic literature. The fundamental metrics were expressed on a per share basis in order to reflect the company size, and retrieved from companies' financial statements. While accounting rules require a certain amount of minimum disclosure, there is ambiguity about potentially poor or distorted accounting data. This issue could affect the book value metric resulting in over- or under-exposure of companies with aggressive or conservative accounting practices. A potential flaw of the sales metric could be that it is not well-defined in the service industry. Instead of using a single metric one could use a mixture of multiple measures for better results.



3.3 ESTIMATION TECHNIQUES

The method applied was back-testing. Back-testing is a process of evaluating a strategy, theory, or model by applying it to historical data. A key element of back-testing is that it calculates how a strategy would have performed if it had actually been applied in the past. This requires the back-test to replicate the conditions of the time in question in order to get an accurate result. Back-testing is a common and methodologically accepted approach in finance. However, a high correlation between a back-tested strategy and historical results can never prove a theory correct, since past results do not necessarily indicate future results.

3.4 CONSTRUCTION OF FUNDAMENTAL INDICES

Every fundamental indexation strategy is based on a set of price-insensitive weights. In order to make comparisons with the performance of the reference index, several fundamental-weighted indices were constructed. Each fundamental index was comprised by the constituents of Euro Stoxx 50 index. The constituents were held constant in the fundamental index until the last trading day of each year for reasons of comparability, and rebalanced at that date according to the fundamental value of year-end. In addition, at the last trading day of each year, the fundamental index was reconstituted in a similar fashion with the Euro Stoxx 50 index. The next step was the calculation of the stock weights in the fundamental index. The weight of stock i in the fundamental index was calculated as:

$$W_{i,t} = \frac{FV_{i,t}}{\sum_{j=1}^n FV_{j,t}} \quad (1)$$

where $W_{i,t}$ was the weight of stock i in the benchmark index in month t , and $FV_{i,t}$ was the value of the fundamental metric of stock i in month t . A composite index was also constructed for purposes of further analysis. The composite index was constructed using the simple average of the indices for individual fundamentals. The weight of a



constituent in the composite index was calculated by taking the average weight of that constituent in the book value, sales, dividend, and cash flow index. The calculation of weights in the fundamental-weighted indices requires further explanation. The methodology must attribute only positive weights to the assets. If some measures reported by the companies were negative, the corresponding assets would receive a null weight in the portfolio. The alternative would be to allow short positions in the assets of the constituents, which should be an undesirable feature. Nevertheless, for the 2200 observations concerning the fundamental metrics for the constituents of the Euro Stoxx 50 index, only in 39 cases did the companies reported null or negative values. This could be explained by the structure of the Euro Stoxx 50 index, which provides a representation of Eurozone supersector leaders, with strong fundamentals. As Houwer and Plantinga (2009) state, since Arnott et al (2005) include stocks outside the universe of a capitalization-weighted index, the performance of fundamental indexing may have been overstated. This is because these stocks are likely to be less liquid, and therefore buying them incurs higher liquidity costs. The liquidity costs come in the form of a larger bid-ask spread. The fundamental-weighted indices constructed here were comprised of the same constituents as in the Euro Stoxx 50 index.

3.5 FACTOR ANALYSIS

To address the question of risk-adjusted performance, an assessment took place for the risk factor exposures, as well as an estimation of the abnormal returns or alpha, using standard factor models. This analysis will provide an insight into the potential factors of fundamental-weighted indices, as well as an idea of the risk-adjusted performance. A one-factor model was estimated, using the following regression equation:

$$R_{i,t} - R_{f,t} = a + b_m (R_{m,t} - R_{f,t}) + e_{i,t} \quad (2)$$

where $R_{i,t}$ was the return of fundamental index i in month t , $R_{f,t}$ the one month Euribor rate in month t , and $R_{m,t}$ the return of the Euro Stoxx 50 index in month t . The t -



statistic was also indicated, for the null hypothesis that the regression parameter was zero, on the alternative hypothesis that the regression parameter was different from zero. When the null hypothesis was rejected, the t-statistic was indicated in bold. For a measure of goodness of fit, the adjusted R-squared was also reported. As Amenc et al (2008) report, there is a consensus in finance that the single-factor model isn't doing the right job in capturing the cross section of expected stock returns, and multi-factor models should be used in addition to the single market factor. So, apart from the one-factor model, a three-factor model was estimated. Following Houwer and Plantinga (2009), proxies were created for the Fama and French HML and SMB factors from commercial indices. The difference between the returns of the Euro Stoxx TMI Value index and the Euro Stoxx TMI Growth index was used as proxy for the HML factor, and the difference between the returns of the Euro Stoxx Large index and the Euro Stoxx Small index was used as a proxy for the SMB factor. The following regression equation was estimated:

$$R_{i,t} - R_{f,t} = a + b_m (R_{m,t} - R_{f,t}) + b_{hml} R_{hml,t} + b_{smb} R_{smb,t} + e_{i,t} \quad (3)$$

where $R_{i,t}$ was the return of fundamental index i in month t , $R_{f,t}$ the one month Euribor rate in month t , $R_{m,t}$ the return of the Euro Stoxx 50 index in month t , $R_{hml,t}$ the difference in returns between the Euro Stoxx TMI Value index and the Euro Stoxx TMI Growth index in month t , and $R_{smb,t}$ the difference in returns between the Euro Stoxx Large index and the Euro Stoxx Small index in month t . The next section presents in detail the results of back-testing and other descriptive statistics.



4. RESULTS

To determine whether fundamental-weighted indices yield higher returns than standard stock market indices, various statistical measures are compared.

4.1 ANNUALIZED RETURNS

Table 1A shows the return attributes of the fundamental indices against the reference index over the 11-year period.

Table 1A: Descriptive Statistics.

Table 1A presents the terminal value at the end of 2010 of €100 invested at the end of 1999 in each fundamental index, and the annualized arithmetic mean and geometric mean of each fundamental index over the 1999-2010 period. The reference index is the Euro Stoxx 50 index. The composite index is the simple average of the indices for individual fundamentals. Table 1A also presents the excess return of each fundamental index over the reference index. Last column presents the t-statistic for the null hypothesis that the parameter is zero, on the alternative hypothesis that the parameter is different from zero. When the null hypothesis is rejected the t-statistic is indicated in bold.

Index	Ending Value of €100	Arithmetic Mean	Geometric Mean	Excess Return vs. Reference	t-statistic for Excess Return
Reference	56	-3.13%	-5.11%	-	-
Composite	94	1.73%	-0.58%	4.53%	2.51
Dividend	103	2.23%	0.30%	5.41%	3.56
Book Value	87	1.30%	-1.25%	3.85%	2.20
Cash Flow	103	2.55%	0.30%	5.41%	2.64
Sales	82	0.83%	-1.80%	3.31%	1.58

From table 1A one can see that the returns produced by the fundamental indices were, as the composite index indicates, 4.53% higher than the reference index. The best of the fundamental indices, i.e. the dividend-weighted index and the cash flow-weighted index, outpaced the reference index by 5.41% per annum. Inversely, the reference index produced an annual return of -5.11%, which was the worst result recorded in



Table 1A over the 11-year period. Even the sales-weighted index, the worst fundamental index in terms of returns, exceeded the reference index by 3.31% per annum. Amongst the fundamental indices, only the dividend-weighted index and the cash flow-weighted index succeeded a positive annualized geometric mean return of 0.30%. Over the investment period, only the dividend-weighted index and the cash flow-weighted index experienced a theoretical growth, with ending values of 103€. The reference index, which faced a decline, almost lost half of its value. The book value-weighted index and the sales-weighted index also experienced a decline in value, but to a lesser extent compared with the reference index. In the last column of Table 1A the t-statistic values are reported, by running a two-sided paired t-test for the null hypothesis that the difference in the mean of the return series was zero. The excess returns of fundamental indices, and the composite index, were statistically significant at a level of 5%, with the exception of the sales-weighted index, which was statistically insignificant at a 5% level.

4.2 VOLATILITY MEASUREMENTS

Table 1B shows four indicators of investment risk, intended to assess the risk-reward parameters of the various fundamental indices.

Table 1B: Descriptive Statistics.

Table 1B presents the standard deviation, Sharpe ratio, tracking error, and information ratio of each fundamental index, the reference index, and the composite index over the 1999-2010 period. The reference index is the Euro Stoxx 50 index. The composite index is the simple average of the indices for individual fundamentals.

Index	Standard Deviation	Sharpe Ratio	Tracking Error	Information Ratio
Reference	19.75%	-0.30	-	-
Composite	21.34%	-0.05	6.41%	0.71
Dividend	19.47%	-0.03	5.00%	1.08
Book Value	22.44%	-0.07	6.69%	0.58
Cash Flow	21.11%	-0.01	7.14%	0.76
Sales	22.79%	-0.09	8.32%	0.40



In terms of volatility, the reference index appeared to have an annualized monthly standard deviation of 19.75%, the second lowest after the dividend-weighted index with a standard deviation of 19.47%. The rest of the fundamental indices experienced higher volatilities, with the sales-weighted index presenting the highest volatility of 22.79%. In table 1B, risk-adjusted returns are also presented using the Sharpe ratio. It can be seen that all six indices presented a negative Sharpe ratio. In relative terms though, the reference index experienced the lowest Sharpe ratio with -0.3, with the next least worse of sales-weighted index with -0.09, and the best Sharpe ratio with almost zero from the cash flow-weighted index. In the last two columns of Table 1B, one can review the tracking error and information ratio of the fundamental indices in examination. The sales-weighted index exhibited the highest tracking error, and at same time the lowest information ratio with 8.32% and 0.40 correspondingly. In the opposite side, the dividend-weighted index exhibited the lowest tracking error and the highest information ratio with 5.00% and 1.08. The composite index was somewhat in the middle, with an information ratio of 0.71 and a tracking error of 6.41%.

4.3 INDEX CORRELATIONS

In Table 2, the correlation coefficients between the various indices are reported. It can be seen that all coefficients were above 0.97, varying from 0.977 between the dividend-weighted index and the sales-weighted index, to 0.997 between the composite index and the book value-weighted index.

Table 2: Cross Correlations.

Table 2 presents the correlation coefficients between the fundamental indices returns over the 1999-2010 period.

Index	Composite	Dividend	Book Value	Cash Flow	Sales
Composite		0.990	0.997	0.996	0.996
Dividend			0.986	0.979	0.977
Book Value				0.989	0.992
Cash Flow					0.993



4.4 ANNUAL RETURNS

In Table 3 the index returns are revisited, on an annual basis this time. It can be seen that the reference index recorded the lowest returns among the fundamental indices for eight different years of the 11-year period. Indeed, for four consecutive years, which was from 2005 to 2008, the reference index experienced the worst returns. On the other hand, the composite index, neither had the best nor the worst outcome between the fundamental indices.

Table 3: Annual Returns.

Table 3 presents the annual returns of each fundamental index, the reference index, and the composite index over the 1999-2010 period. The reference index is the Euro Stoxx 50 index. The composite index is the simple average of the indices for individual fundamentals.

Index	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Reference	-0.23%	-1.87%	-3.82%	1.22%	0.56%	1.62%	1.18%	0.55%	-4.77%	1.61%	-0.50%
Composite	0.40%	-1.42%	-3.87%	1.81%	0.46%	1.88%	1.55%	0.94%	-3.67%	1.32%	0.28%
Dividend	0.20%	-1.38%	-3.20%	1.66%	0.57%	1.84%	1.57%	0.84%	-3.52%	1.56%	0.33%
Book Value	0.36%	-1.52%	-4.19%	1.95%	0.41%	1.82%	1.54%	0.87%	-4.09%	1.65%	0.30%
Cash Flow	0.52%	-1.24%	-3.56%	1.78%	0.52%	1.98%	1.55%	1.07%	-3.40%	1.04%	0.21%
Sales	0.52%	-1.54%	-4.56%	1.84%	0.34%	1.88%	1.53%	0.96%	-3.68%	1.00%	0.30%

4.5 FACTOR MODELS

Until now, it was ascertained that, on average, the fundamental-weighted indices had outperformed the capitalization-weighted reference index. The analysis however, had ignored the aspect of risk. That is, the higher returns an investor would experience from fundamental indexation could come from taking on higher risk. To examine if that was the case, an assessment of the abnormal returns took place. In Table 4, the results of regression equation (2) are presented. It can be seen that only the alpha of the sales-weighted index is statistically insignificant.



Table 4: One-factor Model.

Table 4 presents the calculated alpha, beta, and t-statistic values of each fundamental index and the composite index, using regression equation (2). Last column presents the adjusted R-squared measure. The composite index is the simple average of the indices for individual fundamentals. When the null hypothesis is rejected the t-statistic is indicated in bold.

Index	a	t-statistic	b _m	t-statistic	R ² _{adj}
Dividend	0.42%	3.41	0.95	43.93	93.64%
Book Value	0.41%	2.52	1.09	38.05	91.70%
Cash Flow	0.48%	2.63	1.00	31.82	88.54%
Sales	0.37%	1.77	1.08	29.74	87.09%
Composite	0.42%	2.60	1.03	36.53	91.05%

In a similar fashion, Table 5 presents the results of regression equation (3). In the three-factor model, all the exposures to the small cap factor are negative and statistically insignificant.

Table 5: Three-factor Model.

Table 5 presents the calculated alpha, beta, and t-statistic values of each fundamental index and the composite index, using regression equation (3). Last column presents the adjusted R-squared measure. The composite index is the simple average of the indices for individual fundamentals. When the null hypothesis is rejected the t-statistic is indicated in bold.

Index	a	t-statistic	b _m	t-statistic	b _{hml}	t-statistic	b _{smb}	t-statistic	R ² _{adj}
Dividend	0.42%	3.60	0.94	46.49	0.21	5.44	-0.07	-1.68	94.77%
Book Value	0.39%	2.42	1.07	38.45	0.21	3.85	-0.04	-0.71	92.45%
Cash Flow	0.48%	2.80	0.98	32.99	0.29	4.99	-0.11	-1.81	90.31%
Sales	0.37%	1.79	1.06	29.66	0.24	3.51	-0.09	-1.19	88.06%
Composite	0.41%	2.66	1.01	37.50	0.24	4.55	-0.08	-1.39	92.20%

In the next section, the discussion and analysis of results is presented.



5. DISCUSSION

The aim of the analysis was to examine whether a fundamental-weighted index did outperform a capitalization-weighted index over a certain time-period. In the discussion section, the results previously presented are analyzed, in order to determine whether fundamental-weighted indices do present a better investment strategy.

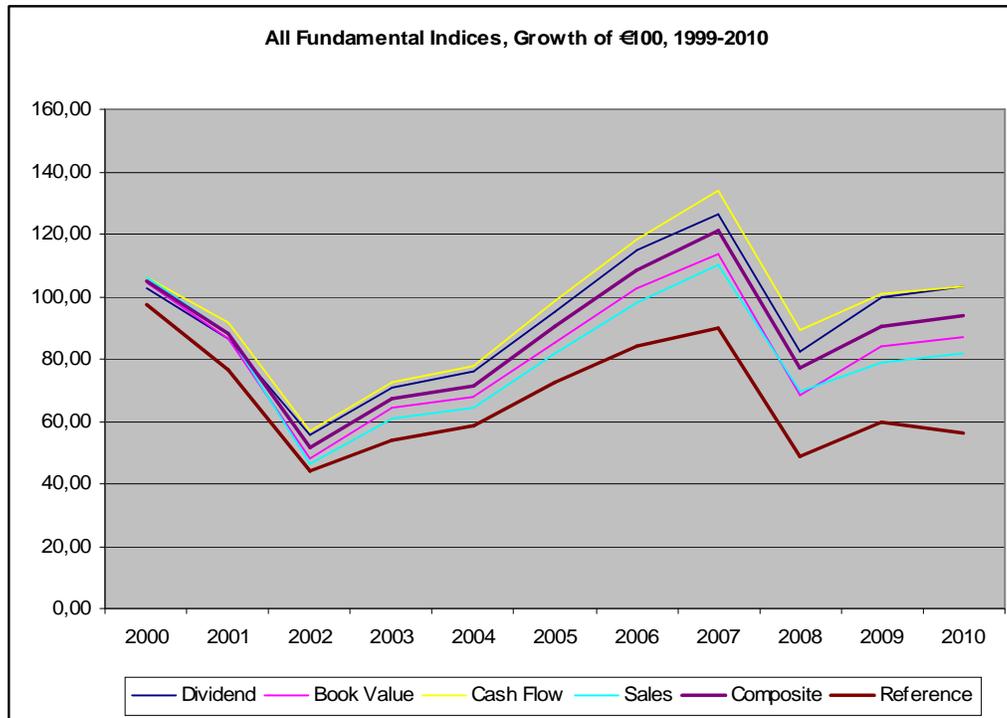
5.1 COMPARISON OF RETURNS

The same constituents comprised the asset composition of each fundamental index under examination. The differential performance then, came from different weighting schemes. Table 1A confirms that every fundamental-weighted index outperformed the reference index over the 11-year period. The excess returns were statistically significant and presented an average t-statistic of 2.49. The composite index verified the outcome. By applying a mixed strategy of taking the average weights of the constituents in the fundamental indices, one could achieve higher returns over the reference index. Figure 1 shows the cumulative growth of a €100 investment in each fundamental index.



Figure 1: Growth of €100, Various Indexation Metrics, 1999-2010.

Figure 1 shows the cumulative growth of €100 invested in each fundamental index over the 1999-2010 period. The bold lines correspond to the Composite and the Reference index.



The results seemed to be confirmed with those reported by Arnott et al (2005). The difference however was that Arnott et al (2005) made comparisons with the S&P 500 for a 42-year period, whereas in the present framework the Euro Stoxx 50 index was used for an 11-year period. If someone invested in a fundamental-weighted index, she would face a theoretical decline in value of his portfolio, with an ending value of €94 for the composite index. The exceptions were the dividend-weighted index and the cash flow-weighted index with a modest amount of €103 at the end of the period. Hemminki and Puttonen (2008) found an €413,45 ending value for their composite index. Although with different index composition and nonidentical evaluation period, the gap remains high. By solely examine the fundamental-weighted indices, it could be inferred that by investing in the reference index, one could loose almost half of her initial investment. Estrada (2008) suggests that better choice, between a



capitalization-weighted index and a fundamental index, is a weighting scheme that provides an even better performance.

5.2 VOLATILITY ISSUES

Taking into account volatility as measured by standard deviation, again, the dividend-weighted index and the cash flow-weighted index exhibited lower volatility as compared with the rest fundamental-weighted indices. It can be concluded that dividends per share are a better choice in forming a fundamental-weighted index, with a view to volatility. In order to better measure the risk-return performance, one should move on to the Sharpe ratio. Table 1B shows that the dividend-weighted index and the cash flow-weighted index provided greater Sharpe Ratios than the other fundamental indices. Of course, the negative Sharpe ratios indicated that a risk-free asset should provide better performance than the fundamental-weighted indices. Another approach to risk-return performance is the information ratio. The dividend-weighted index presented the highest information ratio of 1.08, followed by the cash flow-weighted index with a corresponding 0.76. These risk-adjusted measures reveal that the dividend-weighted index and the cash flow-weighted index provided better results among the other fundamental-weighted indices and the composite index. Given the wide range of choices available, one might ask if there is a difference between these fundamental indices, or they simply represent the same investment strategy. From the correlation coefficients in Table 2, one can infer that the fundamental indices were highly correlated overall, with every correlation coefficient higher than 0.99, implying that the fundamental indices under examination displayed quite similar behavior.

5.3 ANNUAL CHARACTERISTICS

While the results above seem to confirm that the fundamental-weighted indices outperform the reference index, it is not clear whether this average performance is robust over time. There might be periods in which fundamental-weighted indices outperformed, but they might be alternated with periods in which the capitalization-weighted reference index outperformed. Table 3 shows the annual returns of the



various fundamental indices over the 11-year period. It can be seen that the dividend-weighted index and the cash flow-weighted index recorded the highest returns for nine of the eleven years. The risk an investor is taking is that an index might actually yield losses over sustained periods if she chooses to invest in a fundamental-weighted index rather than the reference index. If an investor had chosen to invest in the reference index, she would have earned higher returns over a fundamental-weighted index only in years 2002, 2004, and 2009. In two of the three years, still the dividend-weighted index performed better, proving the superior performance among the other fundamental indices, in alignment with Estrada (2008) who characterizes the dividends per share as a price-insensitive, objective and transparent fundamental variable.

5.4 RISK-RETURN PERFORMANCE

Several empirical studies have been made in order to identify the fundamental factors that explain average asset returns, as a complement to market beta. The advantage of regression equation (3) is that incorporates the investment style of an equity portfolio. It is already known that the value or small cap tilt of a stock portfolio will yield enhanced returns, that is, by capturing the HML and SMB factors of the Fama-French model. The alpha from both the single-factor and the three-factor model was considered, but with more caution for the alpha from regression equation (2). As, Amenc et al (2008) report, the CAPM alpha does not take into account the exposure to the value premium or the small cap premium. Therefore, the abnormal returns of a portfolio with a strong value or small cap tilt may be misestimated. In other words, a portfolio that loads heavily on additional risk factors will show abnormal returns in the single-factor model, though these returns can be explained by additional risk exposure. As it can be seen from table 4, the adjusted R-squared was above 87% for all fundamental indices, indicating that the fit of the single-factor model was sufficient. The CAPM alphas generated by the fundamental indices were positive, and only one of five fundamental indices experienced an alpha that was insignificantly different from zero, namely the sales-weighted index. Overall, CAPM alphas had an average of 42 basis points across all indices considered. For the three-factor model, the adjusted R-squared was likewise above 88%, with the three-factor alphas positive



and significantly different from zero for every fundamental index, except the sales-weighted index. Similarly, the alphas had an average of 41 basis points. For the one-factor model, the CAPM betas were positive and statistically significant. For the three-factor model, the exposures to value and small cap factors were now taken into account. Exposures to the HML factor were positive and statistically significant for all fundamental indices, ranging from 0.21 to 0.29. Exposures to the SMB factor were altogether different, with every beta being negative and statistically insignificant. The magnitude exposures for the betas were also different, ranging from 0.04 to 0.11 in absolute values. It can be inferred that the fundamental-weighted indices had a value tilt that accounted for most of the outperformance. The negative exposures to the SMB factor showed that fundamental-weighted indices tended to reduce weights in small-capitalization stocks and increase weights in large-capitalization stocks, the opposite of the strategy underlying the SMB factor. From tables 4 and 5 one can also see that, adjusted for beta risk, the performance of the composite index decreased from 4.53% to 0.42%, and adjusted for other risk factors, remained at 0.41%. It can be concluded that, when taken into account the market factor and other risk factors, the abnormal returns were greatly reduced.



6. CONCLUSION

In the present dissertation, an attempt has been made to assess the risk-return characteristics of fundamentally based indices using European data. The index construction method was based on selection and weighting with metrics of firm size other than capitalization weighting. These size measures included book value, cash flow, dividends, and sales. Selecting the Euro Stoxx 50 index as a reference index, the construction of fundamental-weighted indices made it possible to analyze their properties and compare them with those of a well-established reference index.

Several authors have questioned the efficiency of stock weighting, based on market capitalization. Proponents of fundamental indexation claim that fundamental-weighted indices are the next wave of investing. Opponents respond that the so-called novel investment approach suffers from fundamental flaws. Empirical examination revealed that all fundamental-weighted indices had positive excess returns over the reference index, and in any case, the excess return was statistically significant, with the exception of sales-weighted index. However, the outperformance came with higher volatility as measured with standard deviation. Only the dividend-weighted index achieved higher returns with lower volatility. In terms of risk-adjusted returns, again the dividend-weighted index recorded the highest information ratio amongst all fundamental indices. The annual performances showed that the dividend-weighted index tracked the second best results, achieving the highest performance in four different years over the 11-year period. The return produced by the composite index was, on average, 4.53%. However, when the market factor alone was taken into account, the CAPM alpha of the composite index reduced at 0.42%, though statistically significant. Furthermore, when accounted for small cap and value risk with the three-factor model, the alpha remained at a modest 0.41%. The positive and statistically significant exposure to the value premium of the composite index, and for the other fundamental-weighted indices solely, might have accounted for these findings. It could be concluded that the fundamental-weighted indices did not produce economically significant outperformance, when the risk factors were taken into



account. The findings suggest that an investor should use the dividend metric to invest on a fundamental index, or construct a composite portfolio.

It is acknowledged that the period under review was relatively short, and a longer selected period might have provided more accurate results, combined with an expanded universe of stocks. By doing this, one could examine the performance attributes in various macroeconomic regimes such as rising and falling rate environments, bull and bear markets, expansions and recessions. Also, the reference index and the constructed fundamental-weighted indices weren't rebalanced in the same manner. The reason was that the composition of the Euro Stoxx 50 index was reviewed annually every September, whereas all the re-weighted indices were reviewed according to the information at year-end. The re-weighted portfolios were not weighted simultaneously with the Euro Stoxx 50 index every September, because most of the necessary data were available only on annual basis. Therefore, it would be more accurate to compare the fundamental-weighted indices with a reference index, re-weighted at year end.

If the reason for moving away from traditional indexation into fundamental indexation is better performance, one could also consider alternative weighting schemes that may provide even better one. In addition, no studies have assessed the performance of fundamental-weighted indices in multifactor frameworks. Although the market of alternative-weighted indices has grown in recent years, with index providers launching more and more of them, extensive assessments or comparisons involving indices from different providers have yet to be done.

As Arnott et al (2005) conclude, if higher returns and lower volatility is the goal in investment management, and if there is reason to expect that these historical results will continue and into the future, then investment in these fundamental-weighted market indices will be preferred to traditional capitalization-weighted market indices.



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