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Application of fundamental indexation for South African equities

Abstract

Recent literature suggests that indexes weighted by firms' fundamental attributes are more mean-variance efficient compared to market capitalization-weighted (cap-weighted) indexes. The performance drag in the price-sensitive indexes, such as the cap-weighted indexes could be attributed to the trading noises inherent in stock price movements due to the presence of investor overreaction to new information in the market. This study evaluates the performances of fundamentally-weighted indexes versus cap-weighted indexes constructed from the constituents of the FTSE/JSE. All Share index (ALSI) on the Johannesburg Stock Exchange (now the JSE Ltd) in South Africa over the period from 01 January 2000 to 31 December 2009. In line with prior studies, the fundamentally-weighted indexes constructed in this research are found to be more mean-variance efficient compared to their cap-weighted counterparts, whilst displaying significant value bias in their performances. Study results also indicate that most of the fundamental indexes earn lower risk-adjusted returns when rebalanced less frequently, except for the sales-weighted indexes. The sales-weighted indexes are also the best performing fundamental indexes over the examination period. Since fundamental indexation is designed to benefit from the mean reversion of mispriced securities, these findings suggest that South African investors might be over-sensitive to the release of firms' sales data. Evidence also suggests that having stocks with high book values in the portfolio serves as a natural hedge during stock market downturns.

Keywords: fundamental indexation, investor overreaction, value effect, size effect, asset allocation, rebalancing.
JEL Classfication: G11, G12, G14, G15.

Introduction

Stock market indexes are useful tools for investors to track the broad market movements or the performance of firms operating in a specific segment of the market. Stock market indexes also serve as benchmarks for active managers against which to match their fund's performance. In South Africa, the FTSE/JSE All-Share index (ALSI) is used as the benchmark index that reflects the general stock market performance on the Johannesburg Stock Exchange (now the JSE Limited). The JSE has undergone reforms in the early 2000s and in 2002 adopted the London Stock Exchange SETS trading platform. In the same year the JSE launched the FTSE/JSE Africa index series which enhances passive investments in tradable indexes. Most of the indexes within the FTSE/JSE index series are constructed and rebalanced according to the market capitalizations of their constituents. Examples of such indexes include the ALSI index, Top 40 index, Mid Cap index, Industrial 25 index and the Financial 15 index.

There are numerous weighting methods for the construction of indexes. An index can be weighted by its constituents' prices, market capitalizations, attributes of the constituents or be simply equally-weighted. The capitalization-weighted (cap-weighted) method amongst all is the most popular weighting methodology. Most of the broad market indexes such as the Standard & Poor 500 index (S&P500) in the United States; Financial Times-London Stock Exchange 100 index (FTSE100) in the United Kingdom and ALSI that track stock market performance on the JSE all follow the cap-weighted methodology. Cap-weighted indexes require minimal rebalancing needs as the weights of the constituents essentially self-adjust to price movements. In addition, the cap-weighted methodology is intuitivelpy supported by Modern Portfolio Theory (MPT) pioneered by Markowitz (1952) under conditions outlined in the efficient market hypothesis (EMH) of Fama (1970). In an efficient capital market, all information related to an asset is incorporated in its market price at any given point in time, and hence the market capitalization of a firm is an unbiased estimate of its intrinsic value. Thus, the most efficient asset allocation approach is to distribute capital according to the relative market capitalizations of the constituents in the portfolio. This notion has been challenged by the successful evidence of fundamental indexation that employs price-insensitive fundamental attributes such as the company's book values, gross revenues and total employment in its weighting methodology. Originally proposed by Arnott, Hsue and Moore (2005), the belief behind the superior performance of fundamental indexes is based on the premise that unlike the cap-weighted indexes, fundamental indexes are not affected by irrational investor behavior partaking in noise trading that leads to mispricing of securities when basic tenets of the EMH are violated.

In 2007, RAFI 40 was introduced as the first fundamental index on the JSE with RAFI All-Share index launched in 2008. The constituents of the RAFI indexes are weighted by their composite fun-

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damental values derived from the average of their book value, sales, dividend and cash flow. The JSE is relatively new to index investment products in comparison to other developed markets. The index product offering gained much needed impetus in 2000 when the first exchange-traded fund (ETF), the SATRIX 40 was launched. There are 44 different ETFS listed on the JSE as of January 2015, and only 5 of which are based on fundamental indexes. To date, little literature exists on fundamental indexation on the JSE. The primary objectives of this research are to investigate whether portfolios constructed from fundamental attributes of ALSI constituents outperform portfolios weighted by market capitalizations on a risk-adjusted basis; determine the extent to which the performance of fundamental indexes could be explained by size and value risk factors; and analyze the effects of different rebalancing frequencies on the performance of fundamental indexes. This research attempts to provide insight into the application of fundamental indexation on the JSE, as a viable investment strategy in the asset management industry.

1. Literature review

1.1. Asset allocation according to fundamental values. The focus on fundamental attributes in investing originates from security analysis principles of Graham and Dodd (1934). After the stock market crash in 1929, they were driven to show that investing could be safe, if investors target on businesses with good fundamentals estimated from tangible assets such as earnings, dividends, stability and financial strength rather than relying on market valuation. This is particularly true if the market prices are determined by irrational investors who overemphasize the temporary impact of recent information on the long-term fundamentals of the firm, as suggested by the overreaction hypothesis of De Bondt and Thaler (1985). Research produced by Kahneman and Tversky (1979) on individual's psychological rationale for decision making has shown that individuals often use cognitive heuristics when making decisions that do not concur to rational laws of probability and the normative behavior that economic trading models are founded on. When market prices of securities are distorted by irrational exuberance of investors, market capitalizations are not true reflection of the company's intrinsic value and the cap-weighted methodology becomes a suboptimal asset allocation strategy. This is because cap-weighted indexes tend to overweigh overpriced stocks and underweigh undervalued stocks in the presence of investor overreaction.

Arnott et al. (2005) recommend using accounting measures as substitute measures of a company's size. The accounting measures suggested include the firm's book value, income, sales, revenues, dividends and employment. These measures are deemed a fair representation of a company's size as almost all large capitalization stocks exhibit strong liquidity and accounting performance. Using accounting measures that are highly correlated with market capitalization values ensures that investors do not deviate much from a cap-weighted index. The fundamental indexes proposed by Arnott et al. (2005) outperform comparable cap-weighted indexes with similar volatility and beta coefficients in the U.S. stock market over the period from 1962 through 2004. The performance is robust across various phases of the economic cycle. The authors attribute the abnormal returns earned by the fundamental indexes to superior portfolio construction, price inefficiency in the market and additional exposure to distress risk.

1.2. Literature supporting fundamental indexation. Fundamental indexation could be viewed as a method of exploiting the inefficiencies inherent in the market-cap indexes. Siegel (2006) announces a paradigm shift imminent within the field of investments known as the "noisy market hypothesis". According to the noisy market hypothesis, stock prices are biased to speculators and momentum traders, which create noise variables within security valuations unrelated to their fundamental values that cause distortion in stock prices.

Hsu and Campollo (2006) test the practicality of fundamental indexes for 23 countries over the period from 1984 through 2004. Their results indicate that the fundamental indexes achieve higher risk-adjusted returns than their counterpart MSCI cap-weighted indexes. Stotz, Döhnert and Wanzenreid (2007) investigate the merits of fundamental indexation in European markets using constituents of the Dow Jones (DJ) Stoxx Europe 600 index. The fundamental indexes realize higher risk-adjusted returns compared to their counterpart cap-weighted indexes and the DJ Stoxx Europe 600 index over the period from 1993 to 2007. They further note that combining firm fundamental ratios produce composite metrics that are better indicators of firm values compared to developing indexes based on any individual fundamental attribute independently. Further successful evidence of fundamental indexation in European markets is documented by Hemminki and Puttonen (2008) who test the performance of the DJ Stoxx Europe 50 index in comparison to fundamental indexes constructed from the same index participants. Their results reveal that fundamental indexes constructed from book values, dividends and composite attributes produce the best risk-adjusted returns over the period from 1996 to 2006.

Arnott and Sheperd (2011) examine the performances of the Emerging Markets RAFI index compared to the cap-weighted FTSE AW Emerging Markets index over the period from 1994 to 2009.

The results show that Emerging Markets RAFI index achieves higher return than the FTSE AW Emerging Markets index by a near 9% on average annually. The authors conclude that cap-weighted indexes are more inefficient in emerging markets because of the heightened noise variables affecting security prices in these markets. This results in cap-weighted indexes experiencing a larger drag in their performance. Within the South African context, Ferreira and Krige (2011) examine the viability of fundamental indexation on the JSE. They find that fundamental indexes comprised of the ALSI constituents realize higher risk-adjusted returns than the ALSI index over the period from 1996 to 2009. All fundamental indexes in the study exhibit similar risk profiles as that of the ALSI index.

Hsieh, Hodnett and van Rensburg (2012) evaluate the performance of fundamental indexes versus the cap-weighted indexes constructed from the constituents of the DJ Global Sector Titans Composite index over the period from 1991 through 2008. Test results indicate that the fundamental indexes outperform the cap-weighted indexes in both bull and bear markets over the examination period. In addition, it is found that while the performance of cap-weighted indexes deteriorates with less number of constituents in the portfolio, the performance of fundamental indexes is unaffected by the number of constituents in the portfolio. This observation suggests that when the price-element in measuring firm size is removed in index construction, the size effect that adversely affects the performance of large firms dissipates.

1.3. Criticisms and debates. Although vast amount of international literature from both developed and emerging markets have lent support to the use of fundamental indexes as alternatives to cap-weighted indexes, the theoretical justifications for their merits have come under scrutiny. Amenc, Goltz and Ye (2012) refute the results of prior literature supporting fundamental indexes over cap-weighted indexes based on their methodological biases. They point out that both fundamental and cap-weighted indexes must be based on the same constituent base and weight constraint rule for a fair comparison to be made. Various studies have also attempted to determine what exactly the drivers for the excess returns of fundamental indexes are; and if their outstanding performance is likely to persist in future market trends. Arnott et al. (2005) admit that fundamental indexes have inherent value and size biases and cap-weighted indexes could be argued to exhibit a growth bias. These biases are created by the noise trading of investors. Thus, fundamental indexes outperform cap-weighted indexes by taking advantage of cap-weighted indexes' tendency to overweigh investments in growth stocks relative to value stocks. Asness (2006), on the other hand, argues that excess returns that fundamental indexes obtain are attributed to their value tilt, which represents active bets against cap-weighted indexes. Similarly, Edesess (2008) is of the opinion that fundamental indexes are in actual fact active portfolios that tilt weighting towards value and small-cap shares, and hence fundamental indexes are merely claims to old empirical findings under a new name and on similar theoretical justifications.

On the contrary, Hsu and Campollo (2006) are of the view that fundamental indexation is not merely value investing. They examine the performance of the Russell value indexes in comparison to the U.S. fundamental indexes. Their results reveal that the fundamental indexes achieve higher risk-adjusted returns than the value indexes over the period from 1979 to 2004. Hsu and Campollo (2006) explain that fundamental indexes are more mean-variance efficient than value indexes because value indexes are generally poorly diversified and tend to remain prejudiced towards large-cap growth stocks. On the other hand, fundamental indexes invest in firms that exhibit balanced growth in their fundamentals.

Chow, Hsu, Kalesnik and Little (2011) evaluate the performance of alternative indexing strategies over the period from 1964 to 2009 for U.S. stocks; and over the period 1987 to 2009 for global stocks. The regression analysis indicates that the excess returns generated by most of the alternative indexing strategies, including fundamental indexes could be explained by the size and value risk proxies in the Carhart (1997) model. Recent study conducted by Hsieh (2013) attempts to investigate whether fundamental indexation represents a unique investment style in emerging stock markets over the period from 1996 through 2010. Test results indicate that fundamental indexes only outperform their cap-weighted counterparts when the size and value risks are not controlled for. In addition, it is found that fundamental indexes also exhibit significant drawdowns and exposures to known risk factors in emerging markets during financial market crises over the examination period.

Perold (2007) argues that fundamental indexation may not be able to take advantage of trading noises and benefit from mean reversion as their proponents suggest. Since mean reversions may be random from period to period, fundamental indexes may sell off stocks before they mean revert fully to their intrinsic values depending on their timing of rebalance. Perold (2007) further indicates that since momentum effects generally last over shorter periods while mean reversion tends to occur over longer

periods, investors who identify stocks with momentum might benefit more by riding on the stock's momentum rather than investing in fundamental indexes that employ naive rebalancing strategies.

Kaplan (2008), on the other hand, argues that in order for fundamental indexes to outperform the cap-weighted indexes, the fundamental metrics employed have to be better estimators of stocks' intrinsic values compared to the market capitalization. Hsu (2008) argues against the assumption of Kaplan (2008) and asserts that similar to how other price-insensitive indexes such as equally-weighted and randomly-weighted indexes outperform cap-weighted indexes, fundamental indexes have a stronger tendency to place heavier weights in undervalued stocks and lesser weights in overvalued stocks compared to the cap-weighted indexes. Since neither equally-weighted nor randomly-weighted indexes take into account the true intrinsic values of stocks in their weighting methodologies, Arnott and Hsu (2008) argue that Kaplan's (2008) assertions cannot hold. According to Arnott and Hsu (2008), pricing errors make cap-weighted indexes inferior to any price-insensitive indexes in an inefficient market, and hence there is no need to determine securities' fair values in the portfolio optimization process.

Estrada (2008) evaluates relative performance of the dividend-weighted fundamental index versus the dividend yield-weighted value index, equally-weighted index and the cap-weighted index using stock market indexes from 16 international markets over the period from December 1973 through December 2005. Study results reveal that although the dividend-weighted fundamental index outperforms the cap-weighted index, it underperforms the dividend yield-weighted value index and the equally-weighted index. Thus, there is no justification to state that fundamental indexation is the most mean-variance efficient asset allocation method.

2. Data and methodology

2.1. Research data and market background. The research sample for this study was sourced from the constituents that make up the FTSE/JSE ALSI index over the period from 01 January 2000 to 31 December 2009. Firm specific attributes data utilized for this study include the monthly constituents' total return inclusive of dividends, market prices, number of shares outstanding, book values, after-tax earnings, dividends and sales. Additional data necessary for this study are ALSI index's monthly returns and monthly risk free rates obtained from the yields on the South African 3-month treasury bills. To avoid look-ahead bias, firm-specific attributes are recorded with a 3-month delay from the financial year end of the companies.

Outliers within research dataset are likely to cause certain constituents to receive biased weight allocations. Stocks with abnormally large values in any firm-specific attribute in relation to the index's attribution will prejudicially dominate the weighting schemes within the index. Similarly, stocks that exhibit dismal firm-specific attribute values will not receive a meaningful weight allocation in the index. In order to mitigate the effect of outliers in the research, the values of the fundamental attributes in each monthly cross-section are winsorized to limit their values between the 5th percentile and the 95th percentile in the monthly distribution.

Survivorship bias is inevitable, as this research is based on historical data which would only include those constituents at the point of data collection. The constituents used in this study, form part of the JSE ALSI index and are approximately the top 164 largest shares from the greater JSE market's constituent universe. As this research focuses primarily on larger firms in the market, the impact of the survivorship bias is not expected to be severe on the results as larger firms are less likely to delist.

Research conducted by Arnott et al. (2005) was undertaken within well-established markets, but believed their findings to be applicable within other markets. Arnott and Sheperd (2011) further argue that fundamental indexation would likely be more beneficial within emerging markets. According to Arnott and Sheperd (2011), as pricing noise is more pronounced in emerging markets, the performance drag in cap-weighted indexes is likely to be more significant in these markets. According to Marais (2008), the South African equity market has improved immensely in the decade prior to 2007, and hence became more integrated with well-established markets. Prior to 1994, the JSE had to deal with many economic and political issues due to international sanctions against the Apartheid South African Regime. Following the 1994 democratic elections, international sanctions were raised and the JSE went through a deregulation phase in the 1995 to align the JSE with international trends. These changes aided the JSE to be more competitive and partake in the international market activities (Mkhize and Msweli-Mbanga, 2006).

Following the deregulation phase in 1996, the JSE introduced the Johannesburg Equities Trading (JET) system to improve trading efficiency. The JET system ensures that all orders are centralized and ranked according to date of order initiation and best bid and ask orders are matched. The JET system resolves the thin-trading problem by lowering trading costs and enhancing the liquidity, security and transparency in the market. In 1999, trading with

paper share certificate was replaced by STRATE (Share Transactions Totally Electronic), which significantly reduces trading failures and non-settlement errors.

In the same year (1999), the JSE experienced a bear market in which many well-established firms were forced to delist. Delisting reached epic proportions in 2001 and as 85 companies were delisted in a single year, while many companies opted for other platforms to raise their capital. As confidence in the JSE declined and the costs and requirements for listing increased, the JSE was forced to make critical changes to improve its competitiveness. In 2002, the JSE replaced the JET system with a more sophisticated London-based Shares Exchange Trading System (SETS), which executes transactions instantaneously and stringently on time priority and precise prices that promote efficient fair trading. In addition, Shares Exchange News Service (SENS) was also established to disseminate price-sensitive information to all market participants, which effectively prevents insider trading.

In 2005, Yield-X Exchange was introduced by the JSE with its other trading platforms, to facilitate the trading of a full range of interest rate derivatives. Competitively priced options are available with higher transparency, which promote amateur traders to have easy access to the market and consequently, increase the liquidity and efficiency of the JSE.

Mkhize and Msweli-Mbanga (2006) attribute the performance of the JSE to the restructuring phases it has undergone within the period from 1994 to 2004. Marais (2008) argues a similar point, that the reforms implemented by the JSE have significantly impacted on the performance of the JSE to become more alike with developed market behavior. It is thus interesting to see how fundamental indexes would perform relative to cap-weighted indexes, taking into account the rapid development of the JSE in the post-millennium.

2.2. Descriptive statistics and methodology. The steps undertaken by this study are as follows:

Step 1. Construct monthly-rebalanced fundamentally-weighted indexes of 40, 80 and 120 constituents based on sample stocks' fundamental values, including the book value, after-tax earnings, dividends, sales and a weighted-average fundamental metric that assembles the prior four fundamental values.

The weighted-average fundamental metric of the *i*th constituent in month *t* is calculated as follows:

$$C_{i,t} = \frac{B_{i,t\text{-}1}}{\sum_{n=1}^{N} B_{n,t\text{-}1}} + \frac{E_{i,t\text{-}1}}{\sum_{n=1}^{N} E_{n,t\text{-}1}} + \frac{D_{i,t\text{-}1}}{\sum_{n=1}^{N} D_{n,t\text{-}1}} + \frac{D_{i,t\text{-}1}}{\sum_{n=1}^{N} S_{n,t\text{-}1}}. \quad (1)$$

Where n represents the number of constituents (40, 80 or 120) in the index; $B_{i,t\text{-}1}$ is the book value for the ith constituent at the beginning of month t; $E_{i,t\text{-}1}$ is the after-tax earnings for the ith constituent at the beginning of month t; $D_{i,t\text{-}1}$ is the dividends for the ith constituent at the beginning of month t and $S_{i,t\text{-}1}$ is the sales for the ith constituent at the beginning of month.

Dissimilar to the fundamental composite metric proposed by Arnott et al. (2005), Equation 1 first computes the value of each firm's fundamental attribute relative to the entire cross-section at the beginning of the month. The weighted average of each firm's fundamental attributes is then calculated to arrive at the firm's fundamental composite metric. On the other hand, the fundamental composite metric proposed by Arnott et al. (2005) represents a naive simple average of the individual fundamental attributes. Such method could skew asset allocations prejudicially towards fundamental values that generally are larger in value in comparison to other fundamental measures. The adoption of the weighted-average method in the derivation of fundamental composite metric represents a methodological breakthrough to avoid the above-mentioned bias, and is hence a contribution within the field of fundamental indexation.

Once the weighted-average fundamental attribute for each sample stock is calculated, the attribute values of each stock in the sample are first ranked at the beginning of each month over the examination period. The top 40, 80, and 120 stocks for each attribute are selected based on the index specification for each month. The weight allocation to the ith constituent within an index formed by attribute A is calculated using Equation 2:

$$w_{Ai,t} = \frac{A_{i,t\text{-}1}}{\sum_{n=1}^{N} A_{n,t\text{-}1}}. \quad (2)$$

Step 2. Assess the risk-adjusted performance of fundamental indexes relative to the performance of the counterpart cap-weighted indexes over the evaluation period from 01 January 2000 to 31 December 2009. The risk-adjusted performance measures employed are the Sharpe ratio, Treynor measure and Jensen's alpha. The Sharpe ratio for index X, expressed as the excess return per unit of volatility, is calculated as follows:

$$SR_x = \frac{R_x - R_f}{\sigma_x}. \quad (3)$$

Where R_X represents the annualized return for index X, R_f is the annualized return on the risk proxy and σ_x is the annualized volatility of the returns on in-

dex *X*. On the other hand, Treynor measure estimates the excess return per unit of systematic risk measured by the beta coefficient:

$$TM_x = \frac{R_x - R_f}{\beta_x}. \quad (4)$$

The beta coefficient for index *X*, β_X is the slope coefficient estimated from the ordinary least square (OLS) regression shown in Equation 5, by regressing the monthly excess returns of index *X*, $r_X - r_f$ on the monthly market risk premium, $r_M - r_f$:

$$r_X - r_f = \alpha_X + \beta_{X,M} \times (r_M - r_f) + \varepsilon_X. \quad (5)$$

The error term, ε_X represents the unsystematic risk of index *X*, which has an expected value of zero. The regression intercept, α_x known as Jensen's alpha, represents the abnormal return earned by index *X* when compared to the risk-adjusted return indicated by the CAPM.

Step 3. Conduct performance attribution analysis on the constructed indices using the Fama and French (1993) three factor model over the examination periods. The monthly excess returns of the pre-specified indexes are regressed against the market risk premium, *MRP*; small firm risk premium, *SMB*; and the value risk premium, *HML* as shown in Equation 6:

$$r_X - r_f = \alpha_X + b_{X,M} \times MRP + b_{X,S} \times SMB + \\ + b_{X,V} \times HML + \varepsilon_X. \quad (6)$$

The small firm risk premium, *SMB*, known as "small-minus-big", is calculated by subtracting the average returns of the firms in the top market-cap quintile from that of the bottom market-cap quintile. The value risk premium, *HML*, known as "high-minus-low", is represented by the average returns of the firms in the top book-to-market quintile in excess of the average returns of the firms in the bottom book-to-market quintile. The index's coefficient to the *SMB* risk premium, $b_{X,S}$ provides an indication to the extent the index was exposed to the size risk factor whilst the index's coefficient to the *HML* risk premium, $b_{X,V}$ shows the index's exposure to the value risk factor.

Step 4. Evaluate the impact of quarterly and annual rebalancing frequencies on all constructed indices. Eatkins and Stansell (2007) stress that rebalancing is necessary to avoid a portfolio from over allocating investment within any asset. Portfolio rebalancing is an exercise of correcting portfolio proportions back to the original specified weighting allocation and composition. With time, asset prices fluctuate necessitating the need for portfolios to be reset back to the initial allocation strategy. Portfolio rebalancing could be based on predetermined calendar interval or threshold drift. Calendar interval method rebalances a portfolio according to specified points in time such as monthly, semi-annually or annually. Threshold drift method rebalances a portfolio whenever an asset allocation fluctuates to a predefined weighting limit. In addition, a hybrid method could be implemented when either the calendar or threshold drift criterion is met. The calendar interval method that allows indexes to be analyzed on comparative basis is tested in this study as threshold drift rebalancing might influence results unfairly as one index might be rebalanced earlier or more frequently than other indexes.

The three rebalancing frequencies being tested are; monthly, quarterly and annually. The rebalancing commence from the start of the examination period on 01 January 2000. The rebalancing dates for quarterly rebalancing are at end of March, June, September and December. These dates are in accordance to FTSE/JSE index rebalancing review dates. The rebalancing dates for annual rebalancing are at the end of every December, which is in line with the tests conducted by Arnott et al. (2005) and Ferreira and Krige (2011). The indexes that are chosen for the rebalancing performance comparisons are the top 40 indexes. The reason for the choosing the top 40, is due to the index breath containing less constituents and thus would provide clearer rebalancing effect than the top 80 and top 120 breadths. The effectiveness of rebalancing on index performance is evaluated based on the Sharpe ratios of the pre-specified indexes.

3. Empirical findings

The performances of fundamentally-weighted indexes comprised of 40, 80 and 120 constituents are demonstrated in Table 1, Table 2 and Table 3 respectively. The market cap-weighted indexes of comparable number of constituents are used as the reference benchmarks in each table. Panel A, Panel B and Panel C in each table demonstrate the performances of portfolios that are rebalanced monthly, quarterly and annually over the examination period.

Examining the performances of indexes with different number of constituents across Table 1, Table 2 and Table 3 reveals that more concentrated indexes (that is, indexes with less number of constituents) earn lower returns, higher standard deviations and thus lower Sharpe ratios relative to less concentrated indexes with more number of constituents. Due to the fact that less concentrated indexes are naturally better diversified and thus have higher total volatility measured by standard deviation, it is important to evaluate risk-adjusted performances of indexes using beta coefficient as an indication of their systematic risks.

The examination of the beta coefficients of the constructed indexes shows that the beta coefficients for all constructed indexes are below the average value of 1.0. Since the indexes are constructed using the

largest firms in the sample, this observation indicates that larger firms exhibit lower systematic risks compared to smaller firms. Regardless of the frequency of portfolio concentration, evidence reveals that more concentrated indexes comprised of fewer constituents tend to have higher systematic risk compared to less concentrated indexes with more constituents. With higher returns and lower systematic risk, less concentrated indexes are found to outperform more concentrated counterparts in terms of Treynor measure and Jensen's alpha. In addition, it is also observed that the most concentrated indexes comprised of 40 constituents exhibit the highest maximum drawdown during the examination period across all indexes. To sum up, there is a negative correlation between the risk-adjusted performances of the constructed indexes and their portfolio concentration for both the cap-weighted reference benchmarks and the fundamentally-weighted indexes, regardless of their rebalancing frequencies.

Analyzing the impact of rebalancing frequency on the performances of the constructed indexes indicated that most of the fundamentally-weighted indexes earn higher returns when rebalanced more frequently, except for the sales-weighted indexes. The higher returns of the more frequently-rebalanced fundamental indexes are accompanied by higher standard deviations and beta coefficients. However, the returns more than commensurate their inherent risks, which is evident inthe higher risk-adjusted returns for the more frequently-rebalanced fundamental indexes. The reverse is true for the sales-weighted indexes. For the sales-weighted indexes, there is a negative relationship between the rebalancing frequency and the index performance. Since the merit of fundamental indexation relies on its ability to benefit from mean reversion of mispriced securities, this evidence suggests that South African investors might be oversensitive to the release of sales information, leading to sustained momentum effect.

Comparing the performances amongst various fundamentally-weighted indexes and against their respective cap-weighted reference benchmarks reveals that all fundamentally-weighted indexes outperform their respective cap-weighted reference benchmarks on a risk-adjusted basis. The composite fundamental indexes outperform all other constructed indexes with the exception of the sales-weighted index. The sales-weighted indexes are amongst the best performing indexes in each category. The sales-weighted indexes also have one of the lowest correlations with the market proxy as evident in their beta coefficients. The book value-weighted indexes, on the other hand, are the ones that exhibit the lowest maximum drawdown amongst other fundamental indexes. Since the book value is regarded as a firm's liquidation value, having stocks with the highest book values in the portfolio serves as having good collaterals to hedge against global financial crises.

Table 1. Performance evaluation of indexes comprised of 40 constituents

Indexes	Market cap	Book value	Earnings	Dividend	Sales	Composite
Panel A: Rebalanced monthly						
Return	19.38%	23.38%	23.21%	22.70%	24.80%	23.78%
Std. deviation	20.91%	21.02%	21.15%	20.84%	20.05%	20.27%
Sharpe ratio	47.29%	66.02%	64.83%	63.39%	76.34%	70.49%
Treynor measure	10.17%	15.00%	14.51%	14.13%	18.31%	15.90%
Jensen's alpha	1.33%	5.74%	5.40%	4.99%	7.95%	6.38%
Beta Coefficient	0.973	0.925	0.945	0.935	0.836	0.899
Maximum DD.	-37.47%	-28.67%	-40.96%	-38.54%	-36.26%	-38.27%
Panel B: Rebalanced quarterly						
Return	19.37%	23.91%	22.71%	22.00%	25.45%	23.39%
Std. deviation	20.98%	21.04%	20.97%	20.78%	20.17%	20.09%
Sharpe ratio	47.05%	68.51%	62.99%	60.19%	79.09%	69.18%
Treynor measure	10.11%	15.51%	14.07%	13.41%	18.80%	15.57%
Jensen's alpha	1.28%	6.24%	4.95%	4.30%	8.49%	6.05%
Beta coefficient	0.976	0.930	0.939	0.933	0.849	0.892
Maximum DD.	-37.51%	-28.06%	-40.67%	-38.64%	-36.29%	-38.37%
Panel C: Rebalanced annually						
Return	18.82%	22.71%	20.66%	20.44%	26.15%	21.74%
Std. deviation	21.00%	20.44%	20.56%	20.64%	20.70%	19.89%
Sharpe ratio	44.42%	64.66%	54.31%	53.01%	80.47%	61.56%
Treynor measure	9.54%	14.39%	11.99%	11.64%	19.04%	13.80%
Jensen's Alpha	0.73%	5.14%	2.97%	2.67%	8.96%	4.44%
Beta Coefficient	0.978	0.918	0.932	0.940	0.875	0.887
Maximum DD.	-39.15%	-29.82%	-41.91%	-42.20%	-37.14%	-41.71%

Table 2. Performance evaluation of indexes comprised of 80 constituents

Indexes	Market cap	Book value	Earnings	Dividend	Sales	Composite
Panel A: Rebalanced monthly						
Return	19.78%	24.13%	23.55%	23.38%	24.84%	24.65%
Std. deviation	20.19%	20.13%	20.30%	19.93%	19.58%	19.30%
Sharpe ratio	50.93%	72.72%	69.27%	69.68%	78.37%	78.52%
Treynor measure	10.93%	16.62%	15.51%	15.52%	18.75%	17.98%
Jensen's alpha	2.01%	6.89%	6.09%	6.02%	8.15%	7.74%
Beta coefficient	0.940	0.881	0.906	0.894	0.819	0.843
Maximum DD.	-35.05%	-28.04%	-38.73%	-36.38%	-34.95%	-36.35%
Panel B: Rebalanced quarterly						
Return	19.91%	24.66%	23.16%	22.60%	25.42%	24.52%
Std. deviation	20.18%	20.11%	20.11%	19.83%	19.66%	19.20%
Sharpe ratio	51.59%	75.39%	67.95%	66.10%	80.99%	78.24%
Treynor measure	11.07%	17.15%	15.18%	14.70%	19.21%	17.84%
Jensen's alpha	2.14%	7.38%	5.75%	5.26%	8.63%	7.61%
Beta coefficient	0.940	0.884	0.900	0.891	0.829	0.842
Maximum DD.	-34.54%	-27.24%	-38.27%	-36.33%	-34.75%	-35.80%
Panel C: Rebalanced annually						
Return	19.68%	23.35%	21.23%	21.03%	26.11%	23.41%
Std. deviation	20.22%	19.53%	19.78%	19.68%	20.09%	18.90%
Sharpe ratio	50.35%	70.95%	59.32%	58.60%	82.68%	73.61%
Treynor measure	10.77%	15.86%	13.08%	12.83%	19.44%	16.68%
Jensen's alpha	1.87%	6.17%	3.84%	3.63%	9.09%	6.57%
Beta coefficient	0.945	0.874	0.897	0.899	0.855	0.834
Maximum DD.	-36.27%	-29.70%	-40.07%	-39.61%	-35.81%	-37.82%

Table 3. Performance evaluation of indexes comprised of 120 constituents

Indexes	Market cap	Book value	Earnings	Dividend	Sales	Composite
Panel A: Rebalanced monthly						
Return	19.92%	24.27%	23.62%	23.45%	24.96%	24.96%
Std. deviation	19.98%	19.93%	20.08%	19.77%	19.52%	18.93%
Sharpe ratio	52.17%	74.17%	70.35%	70.59%	79.24%	81.69%
Treynor measure	11.20%	16.93%	15.74%	15.72%	18.94%	18.75%
Jensen's alpha	2.24%	7.10%	6.23%	6.15%	8.28%	8.21%
Beta coefficient	0.931	0.873	0.897	0.888	0.816	0.825
Maximum DD.	-34.46%	-29.00%	-38.94%	-36.36%	-35.46%	-35.92%
Panel B: Rebalanced quarterly						
Return	20.04%	24.82%	23.20%	22.68%	25.52%	24.87%
Std. deviation	19.97%	19.91%	19.89%	19.66%	19.59%	18.82%
Sharpe ratio	52.81%	76.97%	68.92%	67.05%	81.82%	81.69%
Treynor measure	11.32%	17.49%	15.38%	14.90%	19.40%	18.67%
Jensen's alpha	2.35%	7.62%	5.87%	5.40%	8.76%	8.13%
Beta coefficient	0.931	0.876	0.891	0.885	0.826	0.823
Maximum DD.	-34.02%	-28.23%	-38.51%	-36.34%	-35.25%	-35.29%
Panel C: rebalanced annually						
Return	19.78%	23.61%	21.32%	21.17%	26.25%	23.71%
Std. deviation	20.01%	19.35%	19.57%	19.54%	20.01%	18.56%
Sharpe ratio	51.42%	72.97%	60.44%	59.77%	83.75%	76.58%
Treynor measure	10.98%	16.33%	13.32%	13.08%	19.70%	17.37%
Jensen's alpha	2.05%	6.51%	4.02%	3.82%	9.27%	7.01%
Beta coefficient	0.937	0.864	0.888	0.893	0.851	0.818
Maximum DD.	-35.90%	-30.18%	-40.23%	-39.52%	-36.06%	-37.42%

The Fama and French (1993) regression results for the monthly rebalanced indexes are demonstrated in Table 4. The results of the indexes that are comprised of 40, 80 and 120 constituents are demonstrated in Panel A, Panel B and Panel C respectively. The regression coefficients that are significant at the 10 percent level and 5 percent level are denoted by † and ‡ respectively. The market risk,

proxied by variations in the market risk premium, is the most important factor in explaining constructed index returns with all coefficients significant at 5% level.

As expected, the cap-weighted reference benchmarks load significantly negatively on the small cap risk premium, indicating a significant large cap bias. The cap-weighted reference benchmarks also have mild negative coefficients for the value risk premium, indicating a mild, insignificant bias towards selecting glamorous stocks as their constituents.

Regarding the influences of the small cap risk premium in explaining fundamentally-weighted index returns, most of the indexes load negatively on the small cap risk premium. Although the coefficients on the small cap premiums for the fundamentally-weighted indexes are not statistically significant for all constructed indexes with the exception of the sales-weighted indexes, the observation of negative coefficients nevertheless indicates that the performances of the fundamentally-weighted indexes do not exhibit small firm bias. On the contrary, the sales-weighted indexes have insignificant positive loadings on the small cap risk premium, which is distinctively different from the rest of the fundamentally-weighted indexes.

Regarding the influences of the value effect in explaining fundamentally-weighted index returns, all indexes load significantly positively on the value risk premium, with the exception of the dividend-weighted index comprised of 40 constituents, which has a positive yet insignificant coefficient for the value risk premium. In addition, study results reveal that the Fama and French (1993) 3-factor model is an appropriate model in explaining fundamentally-weighted index returns as the majority of the alpha coefficients appear to be insignificant. These findings provide strong evidence that fundamentally-weighted indexes are strongly tilted towards the value investment style on the JSE.

Table 4. Style attributions of fundamental indexes

Monthly-rebalanced indexes	Market cap	Book value	Earnings	Dividend	Sales	Composite
Panel A: 40 constituents						
Intercept (Alpha)	0.004	0.002	0.004	0.005†	0.002	0.001
b_MRP	0.934‡	0.906‡	0.962‡	0.943‡	0.783‡	0.911‡
b_SMB	-0.155‡	-0.084	-0.093	-0.090	0.011	-0.119
b_HML	-0.028	0.121†	0.175‡	0.085	0.276‡	0.264‡
Panel B: 80 constituents						
Intercept (alpha)	0.004	0.002	0.004	0.005	0.001	0.001
b_MRP	0.915‡	0.876‡	0.935‡	0.921‡	0.779‡	0.874‡
b_SMB	-0.098‡	-0.025	-0.048	-0.034	0.046	-0.035
b_HML	-0.018	0.115†	0.177‡	0.096†	0.251‡	0.244‡
Panel C: 120 constituents						
Intercept (alpha)	0.003	0.002	0.004	0.005	0.001	0.000
b_MRP	0.910‡	0.874‡	0.931‡	0.918‡	0.780‡	0.862‡
b_SMB	-0.080	-0.003	-0.030	-0.020	0.056	-0.002
b_HML	-0.015	0.112†	0.177‡	0.097†	0.248‡	0.236‡

Note: Regression coefficients that are significant at the 10 percent level and 5 percent level are denoted by † and ‡ respectively.

Conclusion

This paper investigates the performances of indexes weighted by book value, earnings, dividends, sales and the composite fundamental attribute on the JSE over the period from 01 January 2000 to 31 December 2009. Study results reveal a negative correlation between the risk-adjusted performances of the fundamentally-weighted indexes and their portfolio concentration as indexes comprised of fewer constituents appear to be more mean-variance efficient compared to indexes comprised of more constituents. This finding is contradictory to the results of Hsieh, Hodnett and van Rensburg (2012) who find the number of constituents is irrelevant to the performances of the fundamental indexes in the global market.

In general, monthly rebalanced fundamentally-weighted indexes deliver better performances compared to indexes that are rebalanced less frequently with the exception of the sales-weighted indexes. The sales-weighted indexes are also the best performers among other fundamental indexes. Since fundamental indexation is designed to benefit from the mean reversion of mispriced securities, this finding suggests that South African investors might potentially overreact to the release of the firms' sales data. Study results also suggest that having stocks with high book values in the portfolio serve as a natural hedge during stock market downturns. Similar to the study results obtained by Ferreira and Krige (2011), fundamentally-weighted indexes outperform their cap-weighted counterparts over the examination period.

While Hsieh (2013) finds that emerging market fundamental indexes exhibit significant small cap and value biases, this study provides evidence that the fundamentally-weighted indexes do not exhibit small firm bias, but load significantly positively on the value risk premium in general. This finding is in support of the view of Asness (2006) that fundamentally-weighted indexes are strongly tilted towards the value investment style on the JSE. In addition, study results reveal that the Fama and French (1993) 3-factor model is an appropriate model in explaining fundamentally-weighted index returns as the majority of the alpha coefficients appear to be insignificant.

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