Abstract:
This paper compares fundamental index strategies to strategies that start with the market index and then tilt towards high fundamental-to-price stocks. We find that the tilt strategies have similar return, volatility and turnover as the corresponding fundamental index, but have higher information ratios and lower tracking error. Using the same methodology, we also show that a modified index strategy that incorporates multiple distinct quantitative factors generates much higher information ratios with similar turnover.

Contact Info:

Gregg S. Fisher
Gerstein Fisher
Chief Investment Officer
565 Fifth Avenue, 27th Floor
New York, NY 10017
United States
212-968-0707 ext. 111 (Phone)
gfisher@gersteinfisher.com (Email)

Ronnie Shah
Gerstein Fisher
Senior Director of Research
565 Fifth Avenue, 27th Floor
New York, NY 10017
United States
212-968-0707 ext. 138 (Phone)
rshah@gersteinfisher.com (Email)

Sheridan Titman
University of Texas at Austin - Department of Finance
McCombs School of Business
Walter W. McAllister Centennial Chair in Financial Services
Austin, TX 78712
United States
512-232-2787 (Phone)
Sheridan.titman@mccombs.utexas.edu (Email)
Decomposing Fundamental Indexation

Fundamental indexing is a portfolio construction approach first proposed by Arnott, Hsu and Moore [2005] that weights stocks by firm characteristics instead of market capitalizations. Fundamental indexes are attractive because they are relatively passive portfolios with superior returns, low turnover and low tracking error relative to capitalization-weighted indexes. Proponents of fundamental indexing argue that the superior returns of fundamental indexing arise because capitalization-weighted portfolios tend to overweight overvalued stocks and underweight undervalued stocks. This paper proposes an alternative to fundamental indexing. As we show, our proposed approach constructs portfolios with lower tracking error, lower turnover, and slightly better returns than the fundamental indexes they resemble.

Before proceeding, it is useful to review the relation between fundamental indexes and capitalization-weighted indexes. First, note that the weight of a stock in a fundamental index is equal to the stock’s fundamental value; i.e., firm characteristic ($F_i$) divided by the sum of all fundamental values for stocks in the portfolio.

$$w_{FUND,i} = \frac{F_i}{\sum_{i=1}^{N} F_i}$$  \hspace{1cm} (1)

The return of a fundamental indexed portfolio is thus equal to the sum of the stock-level weights multiplied by the stock return ($r_i$).

$$r_{FUND} = \sum_{i=1}^{N} \frac{F_i}{\sum_{i=1}^{N} F_i} \times r_i$$  \hspace{1cm} (2)

In contrast, market capitalization weights are equal to a stock’s market capitalization weight divided by the sum of all market capitalizations ($M_i$) for stocks in the portfolio.

$$w_{MKT,i} = \frac{M_i}{\sum_{i=1}^{N} M_i}$$  \hspace{1cm} (3)

The return of a capitalization-weighted portfolio is thus equal to the sum of the stock-level weights multiplied by the stock return.

$$r_{MKT} = \sum_{i=1}^{N} \frac{M_i}{\sum_{i=1}^{N} M_i} \times r_i$$  \hspace{1cm} (4)
Decomposing Fundamental Indexation

The excess return of a fundamental indexed portfolio relative to a capitalization-weighted portfolio is thus equal to the sum of the differences in weights multiplied by each stock’s return.

\[ r_{FUND} - r_{MKT} = \sum_{i=1}^{N} \left( \frac{F_i}{\sum_{i=1}^{N} F_i} - \frac{M_i}{\sum_{i=1}^{N} M_i} \right) \times r_i \]  

(5)

As the above equation illustrates, the fundamental index outperforms the capitalization-weighted index when stocks with high fundamentals relative to price outperform their counterparts with low fundamentals relative to price.\(^2\)

The central question that we ask in this paper is whether a fundamental index provides the ideal quasi-passive tilt toward value. In particular, we provide a comparison between the portfolio returns of a fundamental indexed portfolio with an alternative approach that starts with the capitalization-weighted portfolio, which is mechanically tilted towards value by applying a multiplier that takes values between 0 for the security with the lowest fundamental-to-price ratio and 2 for the security with the highest fundamental-to-price ratio.

The multiplier is a linear function of the fundamental-to-price ratio, and thus the stock with the median ratio has a multiplier of 1. Since dispersion in fundamental-to-price ratios is higher for smaller stocks than larger stocks, fundamentally indexed small stock portfolios exhibit relatively larger value exposure. To match this stronger value tilt exhibited by fundamental indexes for smaller capitalization stocks, we apply a multiplier between 0 and 4 for stocks in the bottom half of the respective universe. The weights for the entire index are then re-scaled to sum to 1.

While the return patterns of the fundamental index portfolio and our modified market index portfolio are very similar, the modified approach achieves lower tracking error with respect to the value-weighted market index. As we will show, a substantial portion of the tracking error of fundamental indexes, as measured relative to traditional market cap weighted indexes, comes from a relatively small number of stocks with very high market values but low book values. This would not be a problem if those stocks had extremely low excess returns, but existing evidence indicates that this is not the case. The relation
between future returns and Fundamental-to-Price ratios tends to be log-linear rather than linear, and Fundamental-to-Price tends to be a relative weak predictor of returns for those larger stocks that are the most under-weighted by the fundamental indexes, and thus account for the bulk of the tracking error. Because our alternative approach under-weights these stocks less, the strategy generates lower tracking error and higher information ratios.

Although common formulations of these fundamental strategies incorporate multiple price-scaled factors, the fundamental indexing approach is not conducive to the incorporation of factors that are not scaled by price. In contrast, our modified index portfolio can utilize price-scaled characteristics, such as book to market, with non-price scaled characteristics, like profitability, asset growth and momentum, which provide greater factor diversification. As we show, by combining these characteristics, we can form portfolios with lower tracking error, lower turnover and higher information ratios than fundamental indexes.

The literature on fundamental indexation is extensive. The initial analysis presented in Arnott, Hsu and Moore [2005] for US large capitalization stocks, has been extended by Walkshausl and Lobe [2009] and Tamura and Shimizu [2005] to most major international equity markets, by Arnott et al [2010] to form global fixed income portfolios and by Hsu, Li and Kalesnick to create global REIT portfolios. Many such performance studies including Arnott et al (2010), Chow et al (2011) and Arnott et al (2013) find that fundamental index strategies generally outperform several other alternative portfolio weighting schemes including equal-weighting, maximum diversification and minimum variance. Hsu (2006) provides a theoretical argument for why fundamentally weighted portfolios should outperform capitalization-weighted indices.

We are, of course, not the first to suggest that the superior returns of fundamental indexing is driven by value exposure. Asness [2006] and Blitz and Swinkels [2008] explain that fundamental indexing is a semi-passive or low-tracking error “quantitative value tilt”, and reject the notion that these strategies provide any incremental alpha after
accounting for value exposure. These authors find small negative 3-factor alphas on a simulated top 1000 fundamental index. Our paper builds on Blitz and Swinkels [2008], who conjecture that fundamental indexes are dominated by quantitative strategies that allow for better targeting of the value effect and the incorporation of other identified return anomalies.

Hsu and Campollo [2006] show that fundamental indexes outperform standard value indexes such as the Russell 1000 Value or Russell 2000 Index. However, as we show, the comparison they present is misleading, since the universe of stocks of their fundamental index is not exactly the same as the universe used in these value indexes. Since our focus is on the weighting scheme implied by fundamental indexing, we are careful to keep the investment universes constant for each comparison.

The rest of this paper is organized as follows. The first section describes the data sources and methodology behind the different fundamental-to-price firm characteristics we analyze. The second section presents return sorts on various relative price characteristics and discusses how portfolios formed on different fundamentals are related. The third and fourth sections report weighting and performance for fundamental indexed and modified index portfolios. The final section concludes.

**Data**

The starting sample for this study includes all NYSE, AMEX, and NASDAQ stocks listed on the Center for Research in Security Prices (CRSP) return files during the period May 1975 – December 2014. Information on stock returns, industry codes, market capitalizations, and prices are taken from the CRSP database. Market, size, value and momentum factor returns and one-month Treasury rates are provided by Ken French. Financial statement information on revenues, operating income, dividends, assets and those data items used to construct book equity are taken from the COMPUSTAT database. Additionally, we exclude stocks that have negative book equity or have book equity, operating income before depreciation, or sales information that are missing. For a stock to be included in
the analysis, we require a valid stock price at the end of December of the previous year and a valid return in May, the first month following the rebalance. Returns are adjusted for stock delisting to avoid survivorship bias, following Shumway (1997). Portfolios are constructed for both the large capitalization universe (similar in composition to Russell 1000) and the small capitalization universe (similar to Russell 2000). Large capitalization stocks are the 1,000 largest firms based on market capitalization at the end of April, with all other stocks classified as small capitalization stocks. Book equity is equal to shareholders’ equity plus deferred taxes less preferred stock. Momentum is defined as the buy-and-hold return over the previous 12 months, excluding the most recent month. We rebalance portfolios once a year. 71% of firms in our sample have a December fiscal month-end for their financial statements. Instead of rebalancing at the beginning of the year, we instead rebalance on the last day in April, allowing for a minimum of a four-month lag between the end of the financial reporting period and portfolio formation. Consistent with Arnott, Hsu and Moore [2006] and Arnott and West [2006], we construct five-year averages for dividends, revenues and operating income before depreciation. For the initial portfolios we analyze, fundamental weights are given by Equation 1 and market capitalization weights are calculated using Equation 3.

**Relative Price: 1/P**

We start the analysis by examining whether relative price measures explain differences in average returns. In the first section of the paper, we explain that the portfolio weights of a fundamental indexed portfolio relative to a capitalization-weighted index are proportional to the fundamental scaled by price. Exhibit 1 displays value-weighted returns for portfolios formed on various Fundamental-to-Price ratios over the period January 1975 to December 2014. We scale the various fundamentals – book value, five-year averages for operating income before depreciation, revenues or dividends by market capitalization measured for each stock at the end of December of the previous year. At the end of April,
small and large stocks are separately sorted into five portfolios with roughly equal numbers of stocks based on Fundamental-to-Price ratios.

Exhibit 1. Value-weighted portfolio returns and characteristic values formed on different Fundamental-to-Price measures from May 1975 – December 2014. At the end of April of each year, stocks are sorted into five portfolios with roughly equal numbers of stocks using different Fundamental-to-Price measures. Panel A reports value-weighted portfolio returns for small stocks that are not in the largest 1,000 by market capitalization. Panel B reports value-weighted portfolio returns for large stocks that are in the largest 1,000 by market capitalization. We exclude from each portfolio return-sort stocks that have missing, zero or negative fundamental values. The fundamentals explored in this table include book equity and five-year averages of operating income before depreciation, revenues and dividends. High – Low is the long/short return equal to going long the portfolio of stocks with highest Fundamental-to-Price ratio and going short stocks with lowest Fundamental-to-Price ratio. Book Equity is calculated using the most recent financial statement, while Cash Flow, Sales, and Dividends are estimated using trailing five-year averages. HML reflects value exposure from a 4-factor regression of portfolio returns on the market, size, value and momentum factors. Below each average portfolio return, we report the value-weighted average Fundamental-to-Price measure in parenthesis and the value-weighted average log Fundamental-to-Price measure in brackets. All returns are reported on a monthly basis.

<table>
<thead>
<tr>
<th>Panel A. Small Capitalization Stocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
</tr>
<tr>
<td>Book Equity/Price</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Cash Flow/Price</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sales/Price</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dividends/Price</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B. Large Capitalization Stocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
</tr>
<tr>
<td>Book Equity/Price</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Cash Flow/Price</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sales/Price</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dividends/Price</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Decomposing Fundamental Indexation

Reading from left to right, portfolio returns generally increase monotonically as the Fundamental-to-Price ratio rises for each measure for both small and large capitalization portfolios. The average monthly return difference between the high Fundamental-to-Price stocks and low Fundamental-to-Price stocks are as high as 1.01% (Sales/Price) for small capitalization stocks and 0.48% (Sales/Price) for large capitalization stocks. We find relatively weak results for Dividends/Price. The T-statistic reported in the second-to-last column provides some insight into how reliably different High-Low portfolio returns are from zero. Similar to previous studies (e.g., Fama and French [1992]), we find stronger results for Fundamental/Price among small stocks. The T-statistics for most variables, with the exception of Book Equity/Price and Dividends/Price for large capitalization stocks, are greater than 2, indicating that most of the High-Low long/short portfolio returns are reliably different from zero.

The last column reports value factor exposure (HML) from a 4-factor regression of long/short Fundamental-to-Price portfolios on the market, size, value and momentum factors. Value exposure as measured by HML is greater than 1 for all measures, with the exception of Dividends/Price among small capitalization stocks, many of which do not pay dividends. These findings are consistent with previous research that shows that price-scaled variables explain differences in average stock returns and suggest that portfolios formed with the different price-scaled variables have similar factor exposures.

Exhibit 1 also reports value-weighted average Fundamental/Price ratios and log Fundamental/Price ratios. Ratios increase as we move from left to right, and moving from the 4th group to the 5th (Highest) group we observe large changes in the average ratio values. These large changes are due to extreme Fundamental/Price ratios. In contrast, the step-up in average returns from moving from the 5th group to the 4th group isn’t necessarily larger than moving up a group from the 1st to 3rd groups. Thus, log changes for these fundamental ratios do a better job in explaining differences in expected returns when compared to non-log changes. As we show later in the paper, this feature causes fundamental indexes to take extreme positions for high and low Fundamental-to-Price
stocks, which relative to our alternative index lowers the information ratio as the increase in average portfolio returns is not large enough to offset the increase in tracking error.

Next we turn our attention to understanding how portfolios formed on different Fundamental-to-Price ratios are related. The one commonality among all of the measures from Exhibit 1 is scaling a fundamental by price. Is the choice of fundamental more or less important than the decision to scale by price? To examine this question, Exhibit 2 reports correlations among different Fundamental-to-Price measures. As a point of comparison, we also include correlations with a long/short momentum portfolio that is formed in the same way. The upper right triangle of the table reports the return correlation for investment strategies formed on different Fundamental-to-Price factors and momentum; the lower left triangle of the table reflects characteristic correlations. Panel A reports results for small capitalization stocks; Panel B reports results for large capitalization stocks.
Exhibit 2. Average Correlations between Different Fundamental-to-Price measures from May 1975 – December 2014. The upper right triangle of the table reports the correlation between long/short portfolio returns formed on different Fundamental-to-Price ratios. The long/short portfolio return is equal to going long the value-weighted quintile portfolio of stocks with highest Fundamental-to-Price ratios and going short the value-weighted quintile portfolio of stocks with the lowest Fundamental-to-Price ratios. The lower left triangle of the table presents the average time-series Spearman correlation between different Fundamental-to-Price ratios at portfolio formation each year at the end of April. The average correlation is based on 39 cross-sectional Spearman correlations. Book Equity is calculated using the most recent financial statement, while Cash Flow, Sales, and Dividends are estimated using trailing five-year averages. Panel A reports results for small capitalization stock portfolios; Panel B reports results for large capitalization stock portfolios.

### Panel A. Small Capitalization Stocks

<table>
<thead>
<tr>
<th></th>
<th>Book Equity/Price</th>
<th>Cash Flow/Price</th>
<th>Sales/Price</th>
<th>Dividends/Price</th>
<th>Momentum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Book Equity/Price</td>
<td></td>
<td>0.92</td>
<td>0.91</td>
<td>0.79</td>
<td>-0.28</td>
</tr>
<tr>
<td>Cash Flow/Price</td>
<td>0.62</td>
<td></td>
<td>0.90</td>
<td>0.76</td>
<td>-0.22</td>
</tr>
<tr>
<td>Sales/Price</td>
<td>0.64</td>
<td>0.68</td>
<td></td>
<td>0.70</td>
<td>-0.19</td>
</tr>
<tr>
<td>Dividends/Price</td>
<td>0.37</td>
<td>0.41</td>
<td>0.31</td>
<td></td>
<td>-0.17</td>
</tr>
<tr>
<td>Momentum</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.05</td>
<td>-0.08</td>
<td></td>
</tr>
</tbody>
</table>

### Panel B. Large Capitalization Stocks

<table>
<thead>
<tr>
<th></th>
<th>Book Equity/Price</th>
<th>Cash Flow/Price</th>
<th>Sales/Price</th>
<th>Dividends/Price</th>
<th>Momentum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Book Equity/Price</td>
<td></td>
<td>0.89</td>
<td>0.82</td>
<td>0.67</td>
<td>-0.43</td>
</tr>
<tr>
<td>Cash Flow/Price</td>
<td>0.72</td>
<td></td>
<td>0.84</td>
<td>0.76</td>
<td>-0.41</td>
</tr>
<tr>
<td>Sales/Price</td>
<td>0.57</td>
<td>0.71</td>
<td></td>
<td>0.59</td>
<td>-0.42</td>
</tr>
<tr>
<td>Dividends/Price</td>
<td>0.49</td>
<td>0.59</td>
<td>0.36</td>
<td></td>
<td>-0.40</td>
</tr>
<tr>
<td>Momentum</td>
<td>-0.16</td>
<td>-0.15</td>
<td>-0.10</td>
<td>-0.12</td>
<td></td>
</tr>
</tbody>
</table>

The results reported in Exhibit 2 show considerable overlap for portfolios formed on different Fundamental/Price characteristics. For small capitalization stocks, the average cross-sectional Spearman correlations between different Fundamental/Price ratios are very high, taking values between 31% and 68%. The correlations between long/short portfolio returns formed on different relative price ratios are also very high, ranging from 70% to 92%. Portfolios formed on these metrics often select the same stocks, which causes the returns to be similar. To put these results in perspective, return and characteristic correlations among momentum and different Fundamental/Price and Momentum are all negative. As the price rises, Fundamental-to-Price falls and momentum
increases. This causes stocks owned and the returns associated with the high fundamental-to-price and high momentum portfolios to be different. We also find similar results for large capitalization stocks, which are displayed in Panel B.

The results in Tables 1 and 2 suggest these four price-scaled factors are interrelated and are potentially capturing the same phenomenon – value. As we show later in the paper, the decision to include four different value signals in a fundamental indexed portfolio relative to including signals that are less correlated has an impact on risk-adjusted performance and tracking error. In the next section, we examine the mechanism for how fundamental indexed portfolios lead to greater value exposure relative to the market index.

**Fundamental Indexation and Value**

As we explained in the introduction, deviations from market capitalization weights in fundamental indexed portfolios are driven by variation in fundamental scaled by price, which in turn leads to greater value exposure. To directly examine this concept, we explore how fundamental indexed portfolios over/under-weights relative to a market index are related to Book Equity / Price. We use a methodology similar to Arnott, Hsu and Moore [2006], where a stock’s weight is formed by averaging the fundamental weight implied by Equation 1 over all four fundamental insights.7

We define a stock’s *fundamental abnormal weight* as the log of the fundamental index weight less the log of the market index weight. We use log differences instead of simple differences to reduce the effect of outliers. We then compare the stock’s fundamental abnormal weights for both portfolios to the stock’s Book Equity / Price ratio at the end of April 2014, the last rebalance date in our sample for both small and large stock portfolios.

Exhibit 3 presents a scatter plot displaying a stock’s fundamental abnormal weight on the y-axis and Book Equity / Price ratio on the x-axis. For the small and large capitalization universes, we divide stocks into two groups by market capitalization. The light gray dots are the larger stocks, the dark gray dots are the smaller stocks. Thus, for the large
capitalization plot, light gray dots are S&P 500 stocks, while dark gray dots represent those stocks in the bottom half of the Russell 1000 that have market capitalizations that are in the top 1,000 but not in the top 500.\(^8\)

**Exhibit 3.** Scatter plot illustrating the relation between book equity scaled by price (x-axis) and fundamental abnormal weight (y-axis) as of April 30, 2014. The left-most graph reports results for small capitalization stock portfolios; the right-most graph reports results for large capitalization stock portfolios. The x-axis is a stock’s book equity divided by market capitalization. The y-axis is a stock’s fundamental abnormal weight, defined as the difference between the log fundamental portfolio weight and the log market index weight. Fundamental portfolios are formed by averaging fundamental weights implied from book equity and 5-year average revenues, operating income before depreciation and dividends. The light gray dots correspond to the larger top half of the stocks in the respective small and large capitalization portfolios; dark gray dots correspond to the smaller bottom half of stocks. Each graph also reports a dotted log-linear trend line and corresponding $R^2$.

Both graphs show a positive relation between book-to-price and abnormal fundamental weight. The light gray dots relative to the dark gray dots are clustered closer to the trend line, and to the right for each graph. This is important for two reasons. First, the deviations from the trend line are greater for the dark gray dots (smaller stocks) when compared to the light gray dots (larger stocks). This is potentially due to greater variation for smaller stocks in non-book equity fundamentals: revenues, operating income and dividends. Second, the dark gray dots have on average more extreme book equity / price
Decomposing Fundamental Indexation

ratios compared to the light gray dots. Additionally, when comparing the scatter plots, the large capitalization plot has fewer book-to-price outliers. Thus, fundamental index portfolios pick up size exposure through greater-than-market exposure to small stocks that tend to have high Book Equity / Price ratios. The fitted log-linear trend lines have a high $R^2$ of 0.52 for small capitalization stocks and 0.44 for large capitalization stocks, indicating that fundamental abnormal weights are correlated with book-to-price ratios.

**Enhanced Indexing: Fundamental Indexation versus Modified Market Index**

In our main analysis, we approximate the fundamental index portfolios using a modified market index. The modified market index tilts towards value by giving greater than market weight to stocks with high fundamentals relative to price and less than market weight to stocks with low fundamentals relative to price. Specifically, we modify market capitalization weights using the following equation:

$$w_{Tilt,i} = \frac{M_i}{\sum_{i=1}^{N} M_i} \times f_i$$

The first term, $\frac{M_i}{\sum_{i=1}^{N} M_i}$, is the market index weight from Equation 3. The second term, $f_i$, is a multiplier that is dependent on a stock’s Fundamental-to-Price ratio relative to other stocks in the portfolio. Specifically, $f_i$ is equal to the percentile rank (0 for the lowest, 0.5 for the median, and 1 for the highest Fundamental-to-Price stock) multiplied by 2 for the top half of stocks by market capitalization in the portfolio and 4 for the other, smaller stocks. The higher multiplier for smaller stocks reflects their more extreme Book Equity / Price ratios. The weights from equation 6 are then re-scaled to sum to 1.

We create two fundamental index portfolios and their modified index portfolio counterparts. The modified index portfolios start with the market index and then give greater-than-index weight to those stocks with higher relative Fundamentals-to-Price and less-than-market weight to those stocks with lower relative Fundamental-to-Price ratios. The fundamental portfolio, FI (Book Equity), uses only Book Equity to form fundamental weights. The corresponding modified market index, Tilt (Book Equity), uses the Book
Decomposing Fundamental Indexation

Equity / Price percentile to modify market-capitalization weights. The second fundamental portfolio, FI (Composite), averages the fundamental weight implied by book equity and five-year average revenues, operating income before depreciation and dividends. Tilt (Composite) uses the average percentile ranks of the four fundamentals scaled by the price to construct the multiplier.\(^{10}\) All portfolios in Exhibit 4 are rebalanced once a year at the end of April.

We also consider an additional portfolio, Tilt (Value / ROE / Asset Growth | Momentum), that combines multiple independent quantitative factors using the modified index portfolio construction approach. We first take the average percentile rank of the three slower signals, Value (Book Equity/Price), Profitability (ROE), and Asset Growth to form the multiplier.\(^{11}\) Similar to an approach explored in Fisher, Shah and Titman [2015], we condition trades motivated by changes in the multiplier using our faster signal, momentum. Specifically, if the multiplier increases from one year to the next we only use the new multiplier if the momentum percentile rank is greater than 0.5, and instead use the old multiplier if the momentum signal is unfavorable. Similarly, if the multiplier decreases, we use the new multiplier if the momentum percentile rank is less than 0.5. In this way, the momentum signal reduces the turnover of our modified market index.
Exhibit 4. Fundamental index and Modified Market-Index portfolios from May 1975–December 2014. Market index is a capitalization-weighted portfolio of all stocks in the eligible universe. FI (Book Equity) is a fundamental indexed portfolio that weights stocks by book equity. Tilt (Book Equity) is a modified market index portfolio that gives greater-than-market capitalization weight to stocks that have higher Book Equity / Price. FI (Composite) is a fundamental index portfolio that weights stocks by book equity, cash flows, sales and dividends. Tilt (Composite) is a modified market index portfolio that gives greater-than-market capitalization weight to stocks that have higher Book Equity / Price, Cash Flow / Price, Sales / Price or Dividends / Price. The portfolios are rebalanced once a year at the end of April. Tilt (Value/ROE/Asset Growth | Mom>50%) is a modified market index portfolio that gives greater weight to stocks that have higher Book Equity / Price, Return on Equity and low Asset Growth, but only updates the multiplier depending on the momentum signal. Panel A reports results for small capitalization stock portfolios; Panel B reports results for large capitalization stock portfolios.

### Panel A. Small Capitalization Stocks

<table>
<thead>
<tr>
<th></th>
<th>Compound Return</th>
<th>Arithmetic Return</th>
<th>Standard Deviation</th>
<th>Turnover</th>
<th>Tracking Error</th>
<th>Information Ratio</th>
<th>HML</th>
<th>4-Factor Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Index</td>
<td>13.29%</td>
<td>14.81%</td>
<td>21.07%</td>
<td>23%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FI (Book Equity)</td>
<td>15.48%</td>
<td>16.51%</td>
<td>19.96%</td>
<td>43%</td>
<td>4.55%</td>
<td>0.37</td>
<td>0.46</td>
<td>-0.01%</td>
</tr>
<tr>
<td>Tilt (Book Equity)</td>
<td>16.19%</td>
<td>17.07%</td>
<td>19.67%</td>
<td>40%</td>
<td>3.58%</td>
<td>0.63</td>
<td>0.40</td>
<td>0.03%</td>
</tr>
<tr>
<td>FI (Composite)</td>
<td>16.50%</td>
<td>17.39%</td>
<td>19.90%</td>
<td>43%</td>
<td>6.16%</td>
<td>0.42</td>
<td>0.56</td>
<td>0.04%</td>
</tr>
<tr>
<td>Tilt (Composite)</td>
<td>16.44%</td>
<td>17.24%</td>
<td>19.38%</td>
<td>38%</td>
<td>4.19%</td>
<td>0.58</td>
<td>0.43</td>
<td>0.04%</td>
</tr>
<tr>
<td>Tilt (Value/ROE/Asset Growth</td>
<td>16.82%</td>
<td>17.63%</td>
<td>19.71%</td>
<td>32%</td>
<td>3.33%</td>
<td>0.85</td>
<td>0.37</td>
<td>0.08%</td>
</tr>
</tbody>
</table>

### Panel B. Large Capitalization Stocks

<table>
<thead>
<tr>
<th></th>
<th>Compound Return</th>
<th>Arithmetic Return</th>
<th>Standard Deviation</th>
<th>Turnover</th>
<th>Tracking Error</th>
<th>Information Ratio</th>
<th>HML</th>
<th>4-Factor Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Index</td>
<td>11.72%</td>
<td>12.28%</td>
<td>15.08%</td>
<td>8%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FI (Book Equity)</td>
<td>12.56%</td>
<td>12.99%</td>
<td>14.71%</td>
<td>22%</td>
<td>3.60%</td>
<td>0.20</td>
<td>0.29</td>
<td>0.01%</td>
</tr>
<tr>
<td>Tilt (Book Equity)</td>
<td>12.85%</td>
<td>13.27%</td>
<td>14.88%</td>
<td>22%</td>
<td>3.04%</td>
<td>0.32</td>
<td>0.26</td>
<td>0.00%</td>
</tr>
<tr>
<td>FI (Composite)</td>
<td>13.16%</td>
<td>13.49%</td>
<td>14.49%</td>
<td>21%</td>
<td>3.95%</td>
<td>0.30</td>
<td>0.31</td>
<td>0.05%</td>
</tr>
<tr>
<td>Tilt (Composite)</td>
<td>13.06%</td>
<td>13.40%</td>
<td>14.52%</td>
<td>20%</td>
<td>3.03%</td>
<td>0.37</td>
<td>0.26</td>
<td>0.02%</td>
</tr>
<tr>
<td>Tilt (Value/ROE/Asset Growth</td>
<td>13.21%</td>
<td>13.50%</td>
<td>14.26%</td>
<td>17%</td>
<td>2.66%</td>
<td>0.46</td>
<td>0.21</td>
<td>0.06%</td>
</tr>
</tbody>
</table>

Exhibit 4 reports returns, standard deviations, turnover, tracking error, information ratios and 4-factor alphas associated with various back-tested investment strategies over the period May 1975 to December 2014. Panel A displays results for small capitalization stocks. We find the small book equity fundamental index portfolio has average annualized compound returns of 15.48%, 2.19% higher than the small market index (the value-weighted portfolio of all small cap stocks), with 1% less volatility. In this paper, all of the strategies we consider have broad market exposure, with different weighting schemes.
that have an impact on portfolio performance. For that reason, we measure risk-adjusted performance using the information ratio (difference in average arithmetic return divided by tracking error) instead of the Sharpe ratio.

The tracking error of this portfolio relative to the small market index is 4.55%, which produces an information ratio of 0.37. The third row of Panel A presents results for the tilted modified index portfolio, which has a 99.5% correlation with the fundamental indexed book equity portfolio. The mimicking portfolio generates slightly higher annualized compound returns and lower volatility with 1% less tracking error.

The reduction in tracking error leads to higher information ratios for the Tilted portfolios when compared to the Fundamental Index portfolios and requires some explanation. A large stock with a very low (high) Fundamental-to-Price ratio will have a much smaller (larger) weight in the Fundamental index portfolio relative to the Tilt portfolio.

As of June 2014, Procter & Gamble and Amazon have similar market capitalizations, but the book equity of Procter & Gamble is close to seven times as large as that of Amazon. Thus, the fundamental index portfolio assigns Procter & Gamble seven times the weight of Amazon, while the tilted portfolio recognizes that both stocks have similar market capitalizations and assigns weights that are more similar. Since the relation between expected returns and Fundamental-to-Price ratios such as Book-to-Market is better explained by a log-linear model than a linear model, the large underweight for Amazon due to its low relative price ratio creates substantially more tracking error but does not meaningfully increase expected returns.¹²

The fourth row examines the fundamental index portfolio formed on book equity and five-year average revenues, operating income before depreciation and dividends. This portfolio has an average annualized compound return of 16.50%, which is 3.21% higher than the small market index and more than 1% higher than the book equity fundamental index portfolio. Despite the increase in average returns, the information ratio of the composite fundamental index portfolio is 0.42, which is only slightly higher than the book equity fundamental index portfolio. The tracking error for this portfolio is higher than for the other investment strategies we consider because of its larger weight deviations.
relative to the index that arise from extreme levels of revenues, dividends and operating income before depreciation. The analogous modified composite market index, Tilt (Composite), has a 99.0% correlation with the composite fundamental index with an information ratio that is 38% higher because of its lower tracking error.

We find high levels of value exposure (HML) for all four portfolios that we analyze, with value exposure being slightly higher for the fundamental index portfolios when compared to the modified market index portfolios. The 4-factor alphas are close to zero, suggesting that these portfolios’ excess returns are explained by systematic exposures to market, size, value, and momentum factors. The turnover in all of the small capitalization portfolios is quite high, ranging from 23% for the small index portfolio to between 32% and 43% for the others. The higher turnover arises because of the relatively large stocks, which have high weights in these portfolios, migrating from the small capitalization portfolio to the large capitalization portfolio.

For large capitalization portfolios analyzed in Panel B, our results mirror the small capitalization portfolios examined in Panel A, except that the information ratios are lower, despite lower tracking error, because of the lower value premium for large capitalization stocks. We still find the modified market index composite portfolio has close to 1% lower tracking error relative to the fundamental index composite portfolio, producing higher risk-adjusted performance.

Up to now we have shown that a modified market index strategy that tilts towards price-scaled fundamental variables produces expected returns that are similar to those of fundamental indexes, but with lower tracking error. We now consider how the strategy can be improved by incorporating information from multiple firm characteristics. Specifically, we consider a modified index strategy that uses momentum, profitability (ROE), and asset growth, in addition to value (Book Equity/Price) information. This portfolio is reported in the last row of each panel. The Tilt (Value/ROE/Asset Growth | Momentum) portfolio has slightly higher average returns, lower volatility, tracking error and turnover when compared to any of the other size-respective fundamental index or modified index portfolios. The information ratio for the strategy that utilizes multiple firm
characteristics relative to the respective composite fundamental index portfolio is more than twice as high when implemented in the small capitalization universe, and 50% larger when implemented in the large capitalization universe. The higher information ratios are a result of including non-price scaled factors that explain expected returns, which improve portfolio diversification.

**Conclusion**

Fundamental indexed portfolios provide a low cost way to capture the value premium by over-weighting high Fundamental/Price stocks. As we show in this paper, there are alternative low turnover portfolios that more efficiently capture the value premium. An important drawback of fundamental index strategies is that they ignore information from other non-price scaled firm characteristics. While these types of information can generate increased turnover and increased risk in active portfolio strategies, the information can also be used to create semi-passive portfolios with even less turnover and lower tracking error when compared to the fundamental indexed portfolio. These improvements relative to fundamental indexed portfolios are especially relevant for small capitalization portfolios.

**References**


Decomposing Fundamental Indexation


Decomposing Fundamental Indexation


Decomposing Fundamental Indexation

1Contact author. The views expressed here are those of the authors and not necessarily those of any affiliated institution. We thank Andrew Tanzer and the Gerstein Fisher Investment Strategy Group for their helpful comments and suggestions.
2Our decomposition of excess returns associated with a fundamental index strategy is somewhat similar to the concept of greater portfolio yield leading to a value bias explored in Kaplan (2008).
3Chow, Hsu, Kalesnik and Little (2011) find insignificant positive 4-factor alphas for a simulated fundamental index strategy using a similar time period (1964 – 2009) as Blitz and Swinkels (2008).
4Chen, Chen and Bassett (2007) propose that a strategy that uses smoothed capitalization weights or weights based on the median historical index weight produces economically similar increases in returns over the market index. Our paper takes a different approach by evaluating performance of the modified market index relative to the fundamental index by examining tracking error, turnover and value exposure in addition to return and volatility metrics.
5If the delisting return for a stock is non-missing, the delisting return is added a stock’s monthly return.
6If shareholders’ equity is missing, we substitute common equity. If common equity and shareholders’ equity are both missing, the difference between assets and liabilities less minority interest is selected. We set to zero the following balance sheet items, if missing: preferred stock, minority interest and deferred taxes.
7We have two major deviations from the fundamental-indexing portfolio construction methodology outlined in Arnott, Hsu and Moore (2006). First, we rebalance the portfolio at the end of April instead of the end of December. Second, we analyze results for the top 1,000 stocks based on market capitalization at the end of April, not the top 1,000 stocks based on each fundamental. We believe that this is a more sensible formulation, since we are able to isolate and focus on portfolio construction (the weighting scheme is the proposed main benefit of fundamental indexes) from security selection. Similar to Arnott, Hsu and Moore (2006), when book equity, cash flows or sales are zero or negative, we set weight for that metric to zero. When dividends are missing, we average over the remaining three insights.
8Size ranking based on market capitalization at the end of April 2014.
9A stock’s percentile rank reflects the percentage of stocks in the universe that has the same or lower average Fundamental-to-Price (or other stock-level characteristic).
10We try when possible to follow the fundamental indexation methodology. When dividends are zero or missing, we average the percentile rank for the remaining three fundamentals divided by price.
11Asset growth is defined as the percentage annual change in total assets. ROE is defined as revenues minus cost of goods sold, minus selling, general, and administrative expenses, minus interest expense all divided by book equity. These definitions largely match Fama and French (2015). We re-rank the average percentile rank of the three slow signals so that the stock with the lowest average percentile rank receives a multiplier of 0 and the stock with the highest average percentile rank receives a multiplier of 2 (larger stocks relative to the universe) or 4 (smaller stocks relative to the universe).