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Fundamental Indexation

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A trillion-dollar industry is based on investing in or benchmarking to capitalization-weighted indexes, even though the finance literature rejects the mean–variance efficiency of such indexes. This study investigates whether stock market indexes based on an array of cap-indifferent measures of company size are more mean–variance efficient than those based on market cap. These "Fundamental" indexes were found to deliver consistent, significant benefits relative to standard cap-weighted indexes. The true importance of the difference may have been best noted by Benjamin Graham: In the short run, the market is a voting machine, but in the long run, it is a weighing machine.

The capital asset pricing model (CAPM) says that the "market portfolio" is mean–variance optimal. Although the model is predicated on an array of assumptions, most of which are arguably not accurate, it leads to the conclusion that a passive investor/manager can do no better than holding a market portfolio. The finance industry, with considerable inspiration and perspiration from Markowitz (1952, 1959), Sharpe (1965), and many others, has translated that investment advice into trillions of dollars invested in or benchmarked to capitalization-weighted market indexes such as the S&P 500 Index or the Russell 1000 Index.

Many academic papers, however, have rejected the idea that cap-weighted indexes are good CAPM market proxies, which is equivalent to rejecting the mean–variance efficiency of those indexes.[1] It also suggests that more efficient indexes exist. The effort to identify a better index may be moot, however, if *ex ante* identification is impossible or if cap-weighted equity market indexes are *almost* optimal.[2]

The *ex ante* construction of a mean–variance-efficient portfolio is a difficult problem; forecasting expected stock returns and their covariance matrix for thousands of stocks, which is necessary for applying Markowitz's mean–variance portfolio construction, is intellectually challenging and resource intensive. This is precisely why CAPM remains so powerful: If one can find the "market" portfolio, one simultaneously identifies a mean–variance-optimal portfolio.

The investment industry and countless MBA programs have promoted the belief that cap-weighted equity market indexes are *sufficiently* representative of the CAPM market portfolio to be nearly mean–variance efficient. If we accept this simplifying assumption, we reduce the complicated problem of optimal portfolio construction to essentially buying and holding a cap-weighted index. We demonstrate in this article that investors can do much better than cap-weighted market indexes: We provide "Fundamental" equity market indexes that deliver superior mean–variance performance.[3]

We constructed indexes that use gross revenue, equity book value, gross sales, gross dividends, cash flow, and total employment as weights. If capitalization is a "Wall Street" definition of the size of an enterprise, these characteristics are clearly "Main Street" measures. When a merger is announced, the *Wall Street Journal* may cite the combined capitalization but the *New York Post* will focus on the combined sales or total employment. We show that the fundamentals-weighted, non-capitalization-based indexes consistently provide higher returns and lower risks than the traditional cap-weighted equity market indexes while retaining many of the benefits of traditional indexing.

Merits of Cap-Weighted and Other Indexes

Pension funds and endowments use investment portfolios indexed to the S&P 500 or Russell 1000

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Note: A patent is currently pending for the construction and management of indexes based on objective noncapitalization measures of company size.

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for many reasons other than the presumed mean–variance efficiency of these indexes. Whatever its shortcomings, capitalization weighting as the basis for these portfolios has many benefits that any alternative should largely preserve:

- Capitalization weighting is a passive strategy requiring little trading; therefore, indexing to a cap-weighted index incurs far lower trading costs and fees than active management. Cap-weighted portfolios automatically rebalance as security prices fluctuate. Apart from the impact of stock buybacks and secondary equity offerings, the only rebalancing cost associated with executing this strategy is the cost of replacing a constituent security in the portfolio. The cap-weighted indexes require material adjustment only when new companies become large enough to merit inclusion in an index or when others disappear through merger, failure, or relative changes in capitalization, collectively referred to as "reconstitution." Such changes are not insignificant. A study of changes in the composition of the S&P 500 (Blume and Edelen 2003) found that nearly half, 235 companies, had been replaced between 1995 and 2000.
- A cap-weighted index provides a convenient way to participate in the broad equity market. Capitalization weighting seeks to assign the greatest weights to the largest companies. These companies are typically among the largest as also measured by metrics of size other than capitalization—including sales, book value, cash flow, dividends, and total employment.
- Market capitalization is highly correlated with trading liquidity, so cap weighting tends to emphasize the more heavily traded stocks, thereby reducing portfolio transaction costs.
- Because market capitalization is also highly correlated with investment capacity, cap weighting tends to emphasize the stocks with greater investment capacities, thus allowing the use of passive indexing on an immense scale by large pension funds and institutions.[4]

In constructing our Fundamental indexes, we sought to retain the many benefits of cap weighting for the passive investor. Most alternative measures of company size—such as book value, cash flow, sales, revenues, dividends, or employment—are highly correlated with capitalization and liquidity, which means that the Fundamental indexes are also primarily concentrated in the large-cap stocks and preserve the liquidity and capacity benefits of traditional cap-weighted indexes. In addition, these Fundamental indexes typically have volatilities that are substantially identical to those of conventional cap-weighted indexes, and their CAPM betas and correlations average, respectively, 0.95 and 0.96. Therefore, market characteristics that investors have traditionally gained exposure to by holding cap-weighted market indexes are equally accessible with Fundamental indexes.

Maintaining low turnover is the most challenging aspect in the construction of Fundamental indexes. In addition to the usual reconstitution, a certain amount of rebalancing is needed for Fundamental indexes. If a stock price goes up 10 percent, its capitalization also goes up 10 percent and the weight of that stock in the Fundamental index will at some interval need to be rebalanced to its Fundamental weight in that index. If the rebalancing periods are too long, the difference between the policy weights and actual portfolio weights becomes so large that some of the suspected negative attributes associated with cap weighting may be reintroduced. We based the Fundamental index strategies described here on annual rebalancing as of 1 January. The resulting turnover only modestly exceeded the turnover for cap-weighted indexes. Because the Fundamental indexes are concentrated in large, liquid companies, the relatively low rebalancing turnover translates into rebalancing costs that are nearly as low as those for a cap-weighted strategy.[5]

The genesis of our non-cap-weighted market indexes was our concern that market capitalization is a particularly volatile way to measure a company's size or its true fair value. If so, cap weighting may lead to suboptimal portfolio return characteristics because prices are too noisy relative to fundamentals. Mathematically, cap weighting assuredly gives additional weight to stocks that are currently overpriced relative to their (unknowable) discounted future cash flows (the true fair value) and reduces weights in stocks that are currently trading below that true fair value (see Hsu 2004 and Treynor 2005) for different derivations of this result). This mismatch leads to a natural performance drag in cap-weighted and other price-weighted portfolios.

Equal weighting, which is obviously not price weighting, is a much studied alternative to cap weighting. Its disadvantage is that it does not preserve the benefits of cap weighting. It lacks the liquidity and capacity found in traditional market indexes, and its return characteristics are not representative of the *aggregate* equity market. Furthermore, equal weighting has logical inconsistencies: For instance, an equal-weighted portfolio containing the Russell 1000 stocks gives as much weight to the 1000th largest company as to the largest company but gives no weight whatsoever to the 1001st largest company.

Fundamental Indexes: Construction

Adopting Fundamental Indexation is more than simply changing the basis for weighting the stocks in an index. For instance, if we simply reweight the stocks in the S&P 500 or the Russell 1000 by book value, we miss a large number of companies with substantial book value that are trading at a low price-to-book ratio. We end up with a portfolio concentrated most heavily in stocks that are large in both capitalization and book value.

To avoid this problem, we ranked all companies by each metric, then selected the 1,000 largest by each metric. Each of these 1,000 largest was included in the index at its relative metric weight to create the Fundamental index for that metric. The measures of company size we used are as follows:

- book value (Book),
- trailing five-year average cash flow (Cash Flow),
- trailing five-year average revenue (Revenue),
- trailing five-year average gross sales (Sales),
- trailing five-year average gross dividends (Dividends), and
- total employment (Employment).[6]

We also examined a composite that equally weighted four of the fundamental metrics of size. This composite Fundamental index (Composite index) excluded employment because that information is not always available, and it excluded revenues because sales and revenues are very similar concepts and performers. The four metrics used in the Composite index are widely available in most countries, so the Composite index can be easily applied globally—even in emerging markets.

The sample period was selected to cover as long a history as possible with data from the Compustat database. Although Compustat has data extending back to the 1950s, the number of companies prior to 1962 that had sufficient five-year data for our purposes is far less than 1,000.

Financial statement data are from the Compustat database. Stock price information is from the CRSP database and was linked to the corresponding Compustat entries by using the CRSP/Compustat merged list. The roster of selected stocks and the portfolio weights for 1 January of any year were generated by using only data available on the last trading day of the prior year. In most cases, this process meant using data that were lagged by at least one quarter. Each index was rebalanced on the last trading day of each year on the basis of end-of-day prices. We held this portfolio until the end of the next year, at which point we used the most recent company financial information to calculate the following year's index weights.

We rebalanced an index only once a year, on the last trading day of the year, for two reasons. First, the financial data available through Compustat are available only on an annual basis for the earliest years of our study. Second, when we tried monthly, quarterly, and semiannual rebalancing, we increased index turnover but found no appreciable return advantage over annual rebalancing.

Note that we did not adjust for trading costs in the index construction, which is consistent with the practice of providers of commercial cap-weighted indexes and with most academic research. The actual trading cost would be difficult to know with any precision, but we did examine the impact of a 1 percent (each way) trading cost. Reciprocally, we measured how large the trading cost would have to be to completely eliminate the alpha generated by each Fundamental index relative to cap-weighted indexes.

We offer results for six Fundamental indexes based on individual measures and for the Composite index. In constructing the Composite, to get the composite weights, we combined, in equal proportions, the weights each company would have in the four Fundamental indexes (Book, Cash Flow, Sales, and Dividends). We then selected the top 1,000 companies by composite weight and weighted each by this composite weight.

The treatment of dividends as a metric requires some explanation. The dividend metric excluded all companies that did not distribute dividends.[7] We recognized that nonpayment of dividends may not be a sign of weak/small cash flows, however, because many non-dividend-paying companies choose not to pay out dividends for tax reasons.[8] Therefore, in the Composite index, we treated non-dividend-paying companies differently from the way we treated low-dividend-paying companies. When a company was not paying dividends, we used the average of the remaining three size metrics instead of the full four size metrics.

For the Fundamental indexes, only book value and employment were single-year metrics; we used trailing five-year averages wherever substantial volatility in the index weights would result from using year-to-year data. The five-year averaging reduced rebalancing turnover. When fewer than five years of data were available, we averaged the years of data that were available. When we tested the mean return, volatility, and equity market beta for similar indexes constructed with single-year cash flow or revenue, we found that the results were not materially different from the results for using trailing five-year data but portfolio turnover was substantially higher.[9]

Because none of our measures of size rely on price, none captured the current market valuations of perceived growth opportunities of the companies. So, young companies and fast-growing companies were underrepresented in the Fundamental indexes relative to their weights in cap-weighted indexes.

Ex ante, it might seem that these indexes, which deemphasize growth characteristics, would produce lower absolute returns and lower risk than cap-weighted indexes because growth companies usually have the higher market beta risk and correspondingly (in theory) higher expected returns. We show later that lower absolute returns did not result.

For benchmarking purposes, we also constructed a 1,000-stock cap-weighted index by using the same construction method used for the Fundamental indexes. Although it bears a close resemblance to the Russell 1000, it is not identical. The construction of this "Reference" cap-weighed portfolio allowed us to make direct comparisons between it and the Fundamental indexes that were uncomplicated by questions of float, market impact, subjective selections, and so forth.[10]

Relative Performance of Fundamental Indexation

Table 1 shows the return attributes of the Fundamental indexes, the Reference cap-weighted portfolio, and the S&P 500 for the 43 years from 1962 through 2004. We later show results decade-by-decade and for different economic and market environments within the 43 years. The historical portfolio results were not adjusted for any transaction costs associated with maintaining the strategy; we examine the issue of turnover and trading costs separately.

The Fundamental indexes exhibit volatility and beta similar to those of the cap-weighted Reference portfolio and the S&P 500, except for the dividend-weighted index, which, as might be expected, had significantly lower return volatility and CAPM beta. The dividend-weighted index is dominated by mature companies with less risk and lower perceived growth prospects than the whole group of companies. Even so, perhaps surprisingly, it outpaced the higher-risk conventional cap-weighted indexes in returns.

The returns produced by the Fundamental indexes are, on average, 1.97 percentage points higher than the S&P 500 and 2.15 pps higher than the Reference portfolio. The highest performing of the Fundamental indexes (Sales) outpaced the Reference portfolio by 2.56 pps a year. The Composite index rivaled the performance of the average Fundamental index, even though it excluded two of the best single-metric Fundamental indexes. Although we did not include this comparison in the tables, most of these indexes also outpaced both the equal-weighted S&P 500 and the equal-weighted CRSP universe, with lower risk. The excess returns were significant and had an average *t*-statistic of about 3.09; the Composite index came in even higher with a *t*-statistic of 3.26.

As shown in **Table 2**, once we adjusted for the slightly lower beta of the Fundamental indexes, the average CAPM alpha rose to 2.37 percent with a *t*-statistic of 3.41; the Composite index again, despite excluding two of the best single-metric indexes, delivered an even more impressive alpha of 2.44 percent with a *t*-statistic of 3.87. The information ratio is above 0.50 for the best indexes.[11] The Composite index information ratio is 0.60 on a beta-adjusted basis.[12]

Over the investment period of 43 years, the return advantages compounded to ending values that are typically well above twice that of the ending value for the Reference portfolio. Only the Book index and Dividends index failed to double the cumulative return of the cap-weighted indexes.

Table 1. Return Characteristics of Alternative Indexing Metrics, 1962–2004

Portfolio/Index	Ending Value of $1	Geometric Return	Volatility	Sharpe Ratio	Excess Return vs. Reference	Tracking Error vs. Reference	Information Ratio	*t*-Statistic for Excess Return
S&P 500	$ 73.98	10.53%	15.1%	0.315	0.18 pps	1.52%	0.12	0.76
Reference	68.95	10.35	15.2	0.301	—	—	—	—
Book	136.22	12.11	14.9	0.426	1.76	3.54	0.50	3.22
Income	165.21	12.61	14.9	0.459	2.26	3.94	0.57	3.72
Revenue	182.05	12.87	15.9	0.448	2.52	5.03	0.50	3.25
Sales	184.95	12.91	15.8	0.452	2.56	4.93	0.52	3.36
Dividends	131.37	12.01	13.6	0.458	1.66	5.33	0.31	2.02
Employment	156.83	12.48	15.9	0.423	2.13	4.64	0.46	2.98
Composite	156.54	12.47	14.7	0.455	2.12	4.21	0.50	3.26
Average (ex Composite)	$159.44	12.50%	15.2%	0.444	2.15 pps	4.57%	0.47	3.09

Table 2. CAPM Characteristics of Alternative Indexing Metrics, 1962–2004

Portfolio/Index	Ending Value of $1	Geometric Return	Correlation with Reference	CAPM Beta vs. Reference	Excess Return vs. Reference	CAPM Alpha vs. Reference	Information Ratio of Alpha	*t*-Statistic for CAPM Alpha
S&P 500	$ 73.98	10.53%	100%	0.99	0.18 pps	0.23%	0.16	1.00
Reference	68.95	10.35	—	—	—	—	—	—
Book	136.22	12.11	97	0.95	1.76	1.98	0.57	3.71
Income	165.21	12.61	97	0.95	2.26	2.51	0.65	4.21
Revenue	182.05	12.87	95	0.99	2.52	2.57	0.51	3.32
Sales	184.95	12.91	95	0.99	2.56	2.63	0.53	3.46
Dividends	131.37	12.01	94	0.84	1.66	2.39	0.49	3.17
Employment	156.83	12.48	96	1.00	2.13	2.15	0.46	3.00
Composite	156.54	12.47	96	0.93	2.12	2.44	0.60	3.87
Average (ex Composite)	$159.44	12.50%	96%	0.95	2.15 pps	2.37%	0.53	3.41

Portfolio Liquidity

In **Table 3**, we present liquidity/capacity characteristics of the Fundamental indexes. In conjunction with the information on annual portfolio turnover, this information allowed us to assess the impact of transaction costs on the excess returns of the Fundamental indexes.

There are several useful ways to gauge liquidity. We measured the relative capacity of each Fundamental index by dividing the fundamentals-weighted average capitalization of that index by the cap-weighted average capitalization of the Reference portfolio. This "CAP ratio" measure helped us assess the investment capacity of each index. A CAP ratio of 0.66 for the Composite index suggests that the weighted-average capitalization of the companies in the Composite index is two-thirds as large as that of the Reference portfolio. A possible inference is that the aggregate amount of money that can be benchmarked to or invested in the Composite index is approximately two-thirds the amount that could be benchmarked to or invested in the Reference portfolio.

In addition, we examined the average dollar trading volume of the Fundamental indexes and the average number of trading days required to trade a billion-dollar portfolio. For these two measures, we used only the data from 1993 through 2003 in order to report numbers that are relevant to the current environment. These two metrics suggest that, apart from the Employment index, the Fundamental indexes have liquidity that is more than half that of the Reference portfolio. Given that more than $1 trillion is passively managed in some variant of cap-weighted index portfolios, this finding does not seem to be a serious constraint.[13]

We also measured the concentration of the portfolio in the large-cap stocks by examining the fraction of the total index capitalization that belonged to the top 100 stocks by metric weight in each index. Table 3 shows these concentration ratios to be similar for all the indexes, including the Reference portfolio. Most are between 51 percent and 57 percent, nearly identical to the 55 percent concentration ratio for the cap-weighted Reference portfolio.

Table 3. Liquidity Characteristics of Alternative Indexing Metrics, 1962–2004

Portfolio/Index	Ending Value of $1	CAP Ratio	Concentration Ratio	Weighted $ Trading Volume[a] (millions)	Weighted Trading Days[a]	Turnover	Excess Return at 1% Trade Cost	Trade Cost for No Excess Return
Reference	$ 68.95	1.00	55.06%	$191	0.9	6.30%	—	—
Book	136.22	0.64	51.46	134	1.5	13.20	1.62%	12.73%
Income	165.21	0.65	57.06	126	1.3	12.14	2.14	19.34
Revenue	182.05	0.55	54.66	105	2.0	14.15	2.36	16.05
Sales	184.95	0.54	52.48	99	1.7	13.41	2.42	17.99
Dividends	131.37	0.71	61.99	110	1.6	11.10	1.56	17.27
Employment	156.83	0.38	42.76	70	9.3	14.56	1.96	12.89
Composite	156.54	0.66	51.76	102	1.5	10.55	2.03	24.93
Average (ex Composite)	$159.44	0.58	53.40%	$107	2.9	13.09%	2.01%	16.04%

[a]Information for 1962–2003.

Table 3 also shows average annual index turnover. Recall that the indexes were reconstituted and rebalanced once a year at the end of the year. Observe that the Reference portfolio has lower turnover than the others. This result is expected because virtually the entire turnover in this portfolio arises from reconstitution. The Fundamental indexes, in contrast, must adjust the index holdings also to (1) reflect the deviation in the index weights from the beginning-of-year policy weights and (2) reflect changes in prices. These changes increase turnover from the 6.3 percent for the Reference portfolio to an average of 13.1 percent for the Fundamental indexes. The Composite index produced a surprisingly modest average of 10.6 percent.

The pertinent issue in measuring turnover is the erosion of any excess return relative to the cap-weighted index because of transaction costs. When we assumed a 2 percent round-trip transaction cost (including transaction fees and price impact), the excess return fell from an average of 2.15 percent to 2.01 percent. To completely erode the excess return would require a one-way transaction cost greater than 16 percent for each trade, and a 24.9 percent transaction cost each way would be needed to eliminate the alpha of the lower-turnover Composite index.

Outliers and Market Environment

We report here a series of tests of the robustness of our findings. From a mean–variance perspective, the Fundamental indexes appear to be superior to cap-weighted market indexes. In the results of skewness and kurtosis tests reported in **Table 4**, we show that, on average, skewness was similar to that of the cap-weighted indexes and kurtosis was slightly higher, which suggests modestly more outliers in the historical returns of the Fundamental indexes. The Fundamental indexes were slightly more exposed to extreme one-month and three-month events than a cap-weighted market index would have been.

The pattern for various indexes in Table 4 is interesting. For the Dividends index compared with the cap-weighted index, the return for the worst month ("Minimum Monthly Return") was sharply higher but the return for the best month ("Maximum Monthly Return") was not degraded. For the Employment, Revenue, and Sales indexes, however, the range between best and worst months is wider than for other indexes. The observed extreme events across all of the indexes do not appear to be large enough to account for the high excess return for the Fundamental indexes. Indeed, the extremes are dampened in the Composite index, so it outperformed the Reference portfolio *and* the S&P 500 for their best and worst month and quarter.

Furthermore, the broad dispersion between best and worst did not carry through to spans longer than a quarter. The 12-month results, with one exception, favored all the Fundamental indexes over the Reference portfolio: Best outcome was better and worst outcome was better. The exception is the low-beta Dividends index, which lagged the best 12-month span for the cap-weighted indexes.

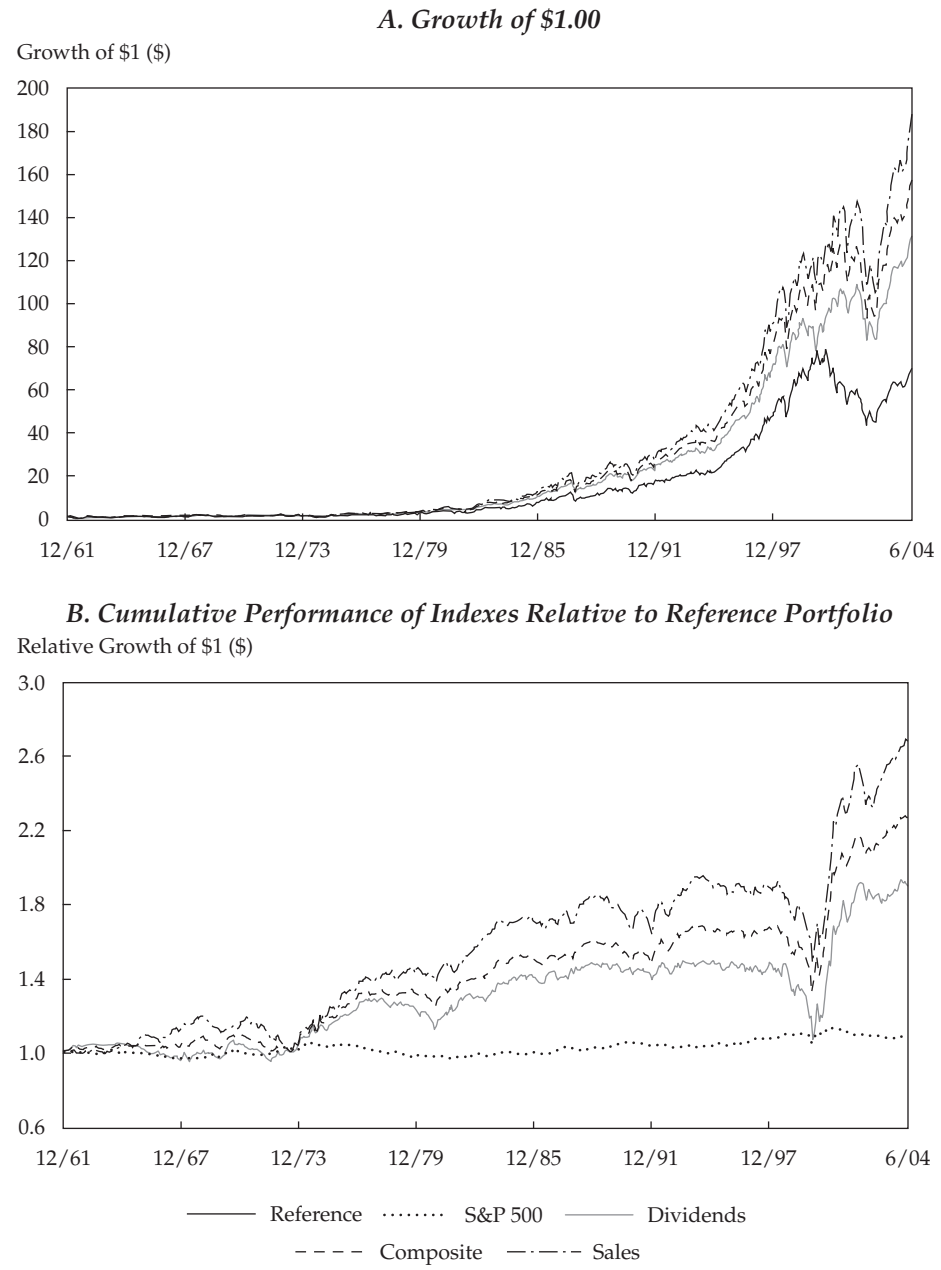
How Robust Are the Findings?

If the goal of earning higher returns with lower risk is the *raison d'être* for the finance community, the evidence for indexing to these Fundamental indexes is convincing. **Figure 1** vividly demonstrates the superior performance of the Fundamental indexes. Panel A shows the cumulative growth of a $1 investment in the Reference portfolio, the Composite index, the top-performing (Sales) index, and the bottom-performing (Dividends) index.[14] Panel B shows the cumulative

Table 4. Outlier Risks of Alternative Indexing Metrics, 1962–2004

Portfolio/Index	Skewness	Excess Kurtosis	Maximum Monthly Return	Minimum Monthly Return	Maximum 3-Month Return	Minimum 3-Month Return	Maximum Trailing 12-Month Return	Minimum Trailing 12-Month Return
S&P 500	–0.32	1.79	17.0%	–21.7%	21.7%	–29.7%	61.6%	–39.0%
Reference	–0.36	1.69	17.5	–21.3	27.0	–28.8	62.4	–41.0
Book	–0.30	1.94	17.9	–21.3	27.2	–28.3	62.8	–32.9
Income	–0.30	2.01	18.4	–21.0	28.0	–28.7	64.6	–34.3
Revenue	–0.33	2.36	21.3	–23.3	33.1	–30.7	72.9	–33.9
Sales	–0.33	2.38	21.2	–23.3	33.1	–30.7	72.8	–33.9
Dividends	–0.23	2.00	17.8	–19.1	25.8	–26.3	58.8	–32.7
Employment	–0.36	2.45	21.3	–23.5	32.2	–29.4	69.7	–36.8
Composite	–0.29	2.11	18.9	–21.2	27.8	–28.5	64.4	–33.4
Average (ex Composite)	–0.31	2.19	19.7%	–21.9%	29.9%	–29.0%	66.9%	–34.1%

Figure 1. Wealth Accumulation: Various Indexation Metrics, 1962–2004



Note: Dates as of December each year.

wealth relative to the Reference portfolio of the S&P 500 as well as the Composite index, the top-performing index according to this measure (Sales), and the bottom-performing (Dividends) index.

Note in Panel B that the S&P 500 closely tracked the Reference portfolio in this period except during the technology/media/telecommunications (TMT) bubble toward the end of the sample period. The Fundamental indexes did not keep pace with the cap-weighted indexes in times of large-cap high-multiple bull markets (the Nifty Fifty age of 1972, the TMT bubble of 1998–1999, and to a lesser extent, the TMT-dominated rallies of 1980 and 1989–1991). Such markets are characterized by narrow high-multiple leadership, which leaves the "average stock" far behind. The Fundamental indexes did keep pace with the cap-weighted indexes in average bull markets.

Table 5 presents the performance of the cap-weighted and Fundamental indexes in various decades. The Fundamental indexes beat the

Table 5. Return Characteristics of Alternative Indexing Metrics by Decade, 1962–2004

Portfolio/Index	1/62–12/69	1/70–12/79	1/80–12/89	1/90–12/99	1/00–12/04
A. Geometric return					
S&P 500	6.58%	5.86%	17.71%	18.57%	–2.15%
Reference	6.80	5.90	17.00	17.94	–1.73
Book	6.94	8.72	18.29	17.09	5.84
Income	7.04	8.64	19.04	17.65	7.60
Revenue	8.26	8.67	19.32	16.99	8.38
Sales	8.26	8.70	19.47	16.84	8.66
Dividends	6.37	8.48	19.15	15.42	7.98
Employment	9.94	8.69	17.74	15.65	7.82
Composite	7.13	8.63	19.04	16.95	7.59
Average (ex Composite)	7.80%	8.65%	18.83%	16.61%	7.71%
B. Value added relative to Reference portfolio					
S&P 500	–0.22 pps	–0.05 pps	0.71 pps	0.63 pps	–0.43 pps
Reference	—	—	—	—	—
Book	0.13	2.81	1.29	–0.85	7.57
Income	0.23	2.73	2.04	–0.29	9.33
Revenue	1.46	2.77	2.32	–0.95	10.10
Sales	1.46	2.79	2.47	–1.10	10.39
Dividends	–0.44	2.57	2.15	–2.52	9.71
Employment	3.14	2.78	0.74	–2.29	9.55
Composite	0.33	2.73	2.04	–1.00	9.32
Average (ex Composite)	1.00 pps	2.74 pps	1.84 pps	–1.33 pps	9.44 pps
C. Annualized standard deviation of returns					
S&P 500	12.38%	16.11%	16.56%	13.55%	17.98%
Reference	12.61	16.62	16.40	13.46	18.07
Book	12.40	16.58	15.61	13.22	18.18
Income	12.27	16.55	15.81	13.52	17.63
Revenue	13.38	18.23	16.59	13.96	18.22
Sales	13.38	18.21	16.60	13.64	18.15
Dividends	11.80	15.47	14.45	11.95	15.27
Employment	12.88	18.63	16.50	13.75	18.56
Composite	12.43	16.63	15.56	12.99	17.22
Average (ex Composite)	12.69%	17.28%	15.93%	13.34%	17.67%
D. Sharpe ratio					
S&P 500	0.19	–0.03	0.53	1.01	0.27
Reference	0.20	–0.03	0.49	0.97	–0.24
Book	0.22	0.14	0.60	0.93	0.17
Income	0.23	0.14	0.64	0.95	0.28
Revenue	0.30	0.13	0.63	0.87	0.31
Sales	0.30	0.13	0.64	0.88	0.33
Dividends	0.18	0.14	0.71	0.89	0.35
Employment	0.44	0.12	0.53	0.79	0.28
Composite	0.23	0.14	0.65	0.93	0.28
Average (ex Composite)	0.28	0.13	0.62	0.88	0.28

cap-weighted indexes, often by a wide margin, in four of the five spans. The only shortfall was in the 1990s, and even during the 1990s, the Composite index was ahead of the Reference portfolio until the end of May 1999, just 10 months before the bubble burst. This decade was dominated by "mega-cap" companies, fueled in part by a massive flow of investment assets into cap-weighted index funds—in short, a decade in which anything other than the largest companies lagged. Comparing any of the Fundamental indexes with the S&P 500 in that decade is an apples-to-oranges comparison.

Even in such a comparison, the Composite index held a lead relative to the Reference portfolio until the last eight months of the decade. Then, as the TMT bubble burst, the Fundamental indexes pulled ahead by an average of 9.44 pps a year for January 2000 through December 2004.

Table 6 shows the performance of the indexes in the recessionary and expansionary phases of the business cycle as defined by the National Bureau of Economic Research. The excess returns were particularly strong in the recessionary phases of the business cycle; they averaged 4.13 percent a year versus 1.80 percent a year during expansions. Still, value was added during expansions as well as recessions.

In **Table 7**, we show the performance in bear and bull markets, where a bull market is defined simplistically (and *ex post*) by a 20 percent rally from the previous low and a bear market, by a 20 percent decline from the previous high. The Fundamental indexes outperformed by an average 6.40 pps a year in bear markets and a still-respectable 0.55 pps a year in bull markets. Given the value bias of the Fundamental indexes, the superior performance in bear markets is not surprising, but the indexes also matched the cap-weighted indexes in the typical bull market, despite the growth bias of the cap-weighted indexes.

Table 8 shows the performance in rising-interest-rate and falling-interest-rate regimes, where a rising-rate regime is defined (simplistically and *ex post*) by the U.S. 90-day T-bill yield rising more than 20 percent from the previous low and a falling-rate regime is defined by the T-bill yield falling more than 20 percent since the previous high. The Fundamental indexes outperformed the Reference portfolio by an average of 2.54 pps a year in falling-interest-rate environments and 1.87 pps a year in rising-interest-rate environments.

Table 6. Return Characteristics of Alternative Indexing Metrics in NBER Business Cycles, 1962–2004

	Expansions			Recessions		
Portfolio/Index	Geometric Return	Volatility	Sharpe Ratio	Geometric Return	Volatility	Sharpe Ratio
S&P 500	11.75%	14.13%	0.45	3.15%	20.34%	–0.25
Reference	11.66	14.13	0.44	2.46	20.90	–0.28
Book	13.19	13.89	0.56	5.51	20.13	–0.13
Income	13.60	13.94	0.59	6.55	20.03	–0.08
Revenue	13.82	14.74	0.57	7.03	21.75	–0.05
Sales	13.84	14.67	0.58	7.24	21.62	–0.05
Dividends	12.70	12.75	0.57	7.74	18.36	–0.03
Employment	13.63	14.61	0.56	5.49	22.24	–0.12
Composite	13.40	13.75	0.58	6.77	19.93	–0.07
Average (ex Composite)	13.46%	14.10%	0.57	6.59%	20.69%	–0.08

Table 7. Return Characteristics of Alternative Indexing Metrics in Bull and Bear Markets, 1962–2004

	Bull Markets			Bear Markets		
Portfolio/Index	Geometric Return	Volatility	Sharpe Ratio	Geometric Return	Volatility	Sharpe Ratio
S&P 500	20.81%	13.62%	1.21	–24.02%	16.49%	–1.89
Reference	20.89	13.56	1.22	–24.89	17.01	–1.89
Book	21.20	13.51	1.25	–19.30	16.77	–1.58
Income	21.63	13.64	1.27	–18.62	16.49	–1.56
Revenue	22.24	14.46	1.24	–19.36	17.90	–1.48
Sales	22.27	14.38	1.25	–19.30	17.85	–1.48
Dividends	19.68	12.63	1.21	–15.27	14.84	–1.51
Employment	21.62	14.34	1.20	–19.08	18.43	–1.42
Composite	21.26	13.48	1.25	–18.09	16.37	–1.54
Average (ex Composite)	21.44%	13.83%	1.23	–18.49%	17.05%	–1.51

Table 8. Return Characteristics of Alternative Indexing Metrics in Rising- and Falling-Interest-Rate Regimes, 1962–2004

	Falling Rates			Rising Rates		
Portfolio/Index	Geometric Return	Volatility	Sharpe Ratio	Geometric Return	Volatility	Sharpe Ratio
S&P 500	18.05%	16.31%	0.75	5.08%	13.99%	–0.05
Reference	18.13	16.31	0.76	4.73	14.19	–0.07
Book	19.81	16.04	0.87	6.53	13.78	0.06
Income	20.94	16.04	0.94	6.61	13.80	0.06
Revenue	20.99	16.84	0.90	7.00	14.91	0.08
Sales	21.02	16.74	0.91	7.06	14.86	0.09
Dividends	20.38	14.47	1.01	5.99	12.75	0.02
Employment	20.87	17.13	0.88	6.44	14.62	0.05
Composite	20.56	15.74	0.94	6.63	13.75	0.06
Average (ex Composite)	20.67%	16.21%	0.92	6.60%	14.12%	0.06

Tables 4 through 8 address the concern that the excess returns of the Fundamental indexes are driven by exposure to macroeconomic risks that are not captured fully by the CAPM model. These tables suggest that weighting by the Main Street definitions of the size of a company is surprisingly robust in improving on the mean–variance efficiency of cap-weighted indexes.

Panel A of **Table 9** compares the correlations of the Fundamental indexes and the cap-weighted indexes with an array of asset-class returns. The results are, for the most part, surprisingly bland: The Fundamental indexes have largely the same correlations that the cap-weighted indexes do with this assortment of assets. The notable exception is that the Fundamental indexes are more

Table 9. Correlations of Indexes with Major Asset Classes, 1988–2004

Portfolio/Index	S&P 500	Hedged EAFE[a]	Wilshire REIT	Lehman Aggregate U.S. Bond	Lehman U.S. TIPS[b]	Merrill U.S. High-Yield B–BB	JP Morgan Unhedged Non-U.S. Bonds	JP Morgan Emerging Markets Bonds	Dow Jones AIG Commodity
A. Correlation of index returns									
S&P 500	1.00	0.54	0.30	0.20	–0.22	0.49	0.01	0.54	–0.05
Reference	0.99	0.54	0.31	0.19	–0.22	0.51	0.01	0.55	–0.04
Book	0.96	0.52	0.41	0.19	–0.18	0.52	–0.01	0.54	–0.01
Income	0.95	0.51	0.42	0.21	–0.16	0.53	–0.02	0.55	–0.03
Revenue	0.92	0.50	0.46	0.17	–0.15	0.56	–0.04	0.52	–0.03
Sales	0.92	0.51	0.46	0.16	–0.15	0.56	–0.03	0.52	–0.02
Dividends	0.90	0.45	0.42	0.25	–0.13	0.48	0.03	0.50	–0.03
Employment	0.93	0.51	0.46	0.18	–0.15	0.55	–0.02	0.55	0.01
Composite	0.94	0.50	0.43	0.20	–0.16	0.53	–0.01	0.53	–0.02
Average (ex Composite)	0.93	0.50	0.44	0.19	–0.16	0.53	–0.02	0.53	–0.02
B. Correlation of index value added over Reference portfolio									
S&P 500	0.12	0.01	–0.08	0.09	0.03	–0.11	0.05	–0.06	–0.07
Reference	—	—	—	—	—	—	—	—	—
Book	–0.17	–0.12	0.32	–0.03	0.12	0.00	–0.06	–0.05	0.09
Income	–0.17	–0.13	0.28	0.02	0.16	0.02	–0.06	–0.03	0.04
Revenue	–0.14	–0.08	0.36	–0.05	0.15	0.12	–0.11	–0.07	0.03
Sales	–0.17	–0.08	0.37	–0.08	0.15	0.10	–0.09	–0.09	0.05
Dividends	–0.44	–0.31	0.10	0.05	0.19	–0.20	0.03	–0.23	0.03
Employment	–0.14	–0.09	0.44	–0.04	0.17	0.13	–0.06	–0.02	0.15
Composite	–0.26	–0.18	0.26	–0.01	0.16	–0.03	–0.05	–0.12	0.05
Average (ex Composite)	–0.21	–0.13	0.31	–0.02	0.16	0.03	–0.06	–0.08	0.06

[a]Europe/Australasia/Far East Index.
[b]From February 1997; U.S. TIPS did not previously exist. TIPS is the short name commonly given to Treasury Inflation-Indexed Securities.

strongly correlated than the cap-weighted indexes with the Wilshire REIT Index. All correlations larger than 0.11 are statistically significant at the 90 percent level in a two-tailed test; a correlation of 0.18 or above is significant at the 99 percent level.[15] Accordingly, most of these correlations are highly significant.

Panel B of Table 9 goes a step farther than Panel A: It examines the correlation of the value added for the various indexes, net of the return for the Reference portfolio, with an array of asset classes. Here, we found differences that may be more interesting than those shown in Panel A, although these results often lack statistical significance. The value added by the S&P 500 apparently outpaced that of the Reference portfolio when the stock market was rising, the broad U.S. bond market was rising (i.e., interest rates were falling), and high-yield bonds, emerging market bonds, and REITS were performing badly. The Fundamental indexes reveal mostly the opposite characteristics, performing best when U.S. and non-U.S. stocks were falling and REITS were rising. Curiously, the Fundamental indexes generally performed well when high-yield bonds were rising but emerging market bonds were falling. Also, they tended to perform well when TIPS were rising (i.e., real interest rates were falling). Most of these results are not surprising, but, apart from the S&P, REIT, and TIPS correlations, most are also not statistically significant.

Intuition for Fundamental Indexes

We believe the performance of these Fundamental indexes is largely free of data mining. Our selection of size metrics was intuitive; the metrics were not selected *ex post* on the basis of results. Nor was the composite constructed by "cherry picking" the best metrics; we chose the obvious ones—measures that are readily available worldwide. For example, although we also examined reported and operating earnings, both raw and smoothed, we have not shown those results in tables here because cash flow is slightly less subject to manipulation and global accounting differences than earnings.[16] We used no subjective stock selection or weighting decisions in the indexes' construction, and the portfolios were not fine-tuned in any way. For the Composite index, we did not optimize the weighting of the constituent measures in any way.

Even so, we acknowledge that our research may be subject to at least two criticisms:

- Part of the motivation for this research is that the authors lived through the 1962–2004 period; we experienced bubbles in which cap weighting caused severe destruction of investor wealth, which contributed to our concern about the efficacy of cap-weighted indexation.
- The fundamental metrics of size all implicitly introduce a value bias into the indexes, which has been amply documented as possibly the result of market inefficiencies or as priced risk factors. (Reciprocally, it can be argued that cap-weighted indexes have a growth bias.)

To explore the second point, we compared a list of the largest companies by capitalization (the Reference portfolio) as of the end of 2004 with the largest as measured by the Composite index. **Table 10** shows the results. With few exceptions, the stocks on both of these lists are intuitive and unsurprising. What is also evident is that the cap-weighted list has a marked bias, relative to the Composite index, in favor of high-multiple stocks with strong perceived growth opportunities. Whether this growth bias will prove profitable in the future is not known, but it has not proven profitable in the past.

Although the top three stocks on both indexes are the same, albeit in a different order, few aspects of the Fundamental indexes more starkly highlight the difference with cap-weighted indexes than the fourth largest companies on the two lists. Microsoft is unequivocally an important part of today's—and tomorrow's—economy, and its weight in the cap-weighted portfolio is 2.0 percent. Its place accords with the market's view of future profits. In the Composite index, where companies are weighted in accordance with the current scale of an enterprise in today's economy, Microsoft occupies 11th place, with a more modest 1.3 percent of the index. From the perspective of Main Street, Wal-Mart occupies a larger share of the economy; it pays larger dividends, earns larger profits, and includes more of the nation's capital stock (book value) than Microsoft. Wal-Mart also accounts for more of our consumption basket (sales) and employs more people, although this last metric was not included in the Composite index. Accordingly, the Composite index weights Wal-Mart 4th, at 1.6 percent of today's economy, even though it ranks 13th in capitalization.

Of course these index weights do not suggest that Microsoft is overvalued or that Wal-Mart is undervalued. The weights merely indicate that Microsoft's scale in the *current* economy is smaller than Wal-Mart's current scale. Empirically, the volatility associated with the shifting perceptions of *future* scale for individual companies creates a performance drag on the cap-weighted indexes. Wall Street is making the judgment that Wal-Mart will be 45 percent smaller in the future economy than Microsoft, but Fundamental indexing (Main Street) pegs Wal-Mart as 25 percent larger in the current

Table 10. Largest by Capitalization and by Fundamental Composite, 31 December 2004

20 Largest by Reference Portfolio	Weight in Index	20 Largest by Fundamental Composite	Weight in Index
General Electric	3.19%	ExxonMobil	2.763%
ExxonMobil	2.75	Citigroup	2.482
Citigroup	2.05	General Electric	2.455
Microsoft	2.03	Wal-Mart Stores	1.610
Pfizer	1.70	Fannie Mae[a]	1.492
Bank of America	1.58	Bank of America	1.485
Johnson & Johnson	1.56	SBC Communications	1.468
International Business Machines	1.37	ChevronTexaco	1.377
American International	1.24	General Motors	1.335
Intel	1.24	American International Group	1.311
Procter & Gamble	1.18	Microsoft	1.310
JPMorgan Chase & Co.	1.15	Ford Motor	1.232
Wal-Mart Stores	1.12	Verizon Communications	1.220
Cisco Systems	1.08	JP Morgan Chase & Co.	1.189
Altria Group	1.03	Altria Group	1.14 0
Verizon Communications	0.93	Pfizer	1.003
ChevronTexaco	0.93	Merck & Co.	0.947
Dell	0.88	Morgan Stanley	0.935
Wells Fargo & Co.	0.87	International Business Machines	0.913
Home Depot Inc.	0.79	Wells Fargo & Co.	0.845

[a]Federal National Mortgage Association.

economy than Microsoft. That is a big gap; the market's perception that Microsoft will be larger in the future than it is today may or may not prove true.

Figure 2 illustrates the stability of the sector allocations of the Fundamental indexes over time.[17] The cap-weighted index (Panel A) has reacted strongly to shifting investor preferences, with a huge spike and collapse in the allocation to energy in the early 1980s and in the allocation to technology stocks in 1998–2001. In contrast, the Fundamental indexes closely reflect the steady evolution of the economy at large, with a gradual change in sector allocations in response to the shifting composition of the economy.

Performance Attribution

The excess return of the Fundamental indexes we observed is consistent with the hypothesis that stock prices are inefficient, but the incremental performance is also consistent with explanations not based on price inefficiency. We explore here the possible reasons behind the performance of the Fundamental indexes and provide evidence supporting both views.

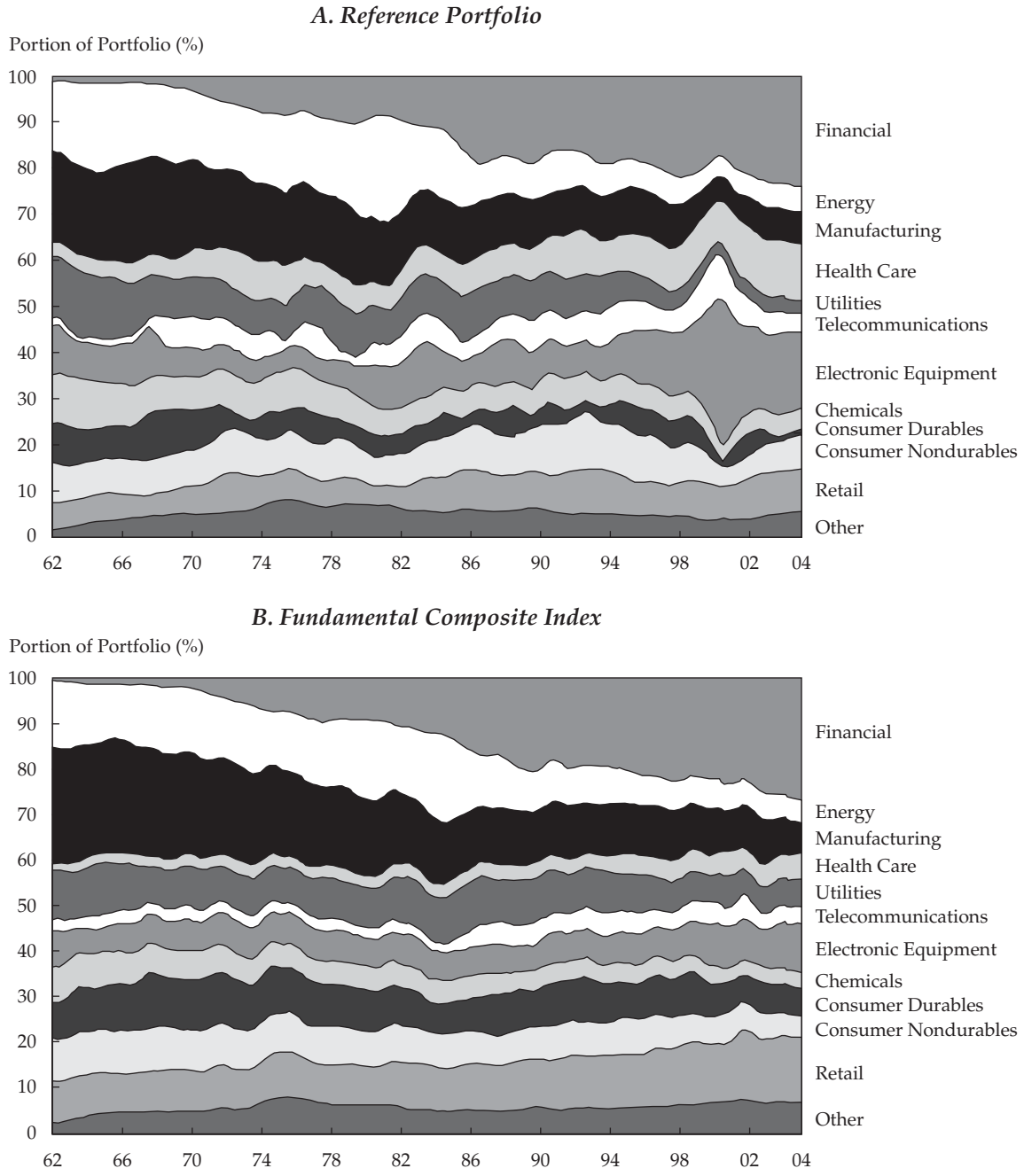
Table 2 shows that the CAPM betas and correlations for the Fundamental indexes averaged 0.95 and 0.96; the notable outlier is Dividends, which had an average beta of 0.84. Adjusted for beta risk, the average excess return for the Fundamental indexes increases from 2.15 pps to 2.37 pps a year. The *t*-statistics are significant for all the Fundamental indexes, approaching 4.0 for the Composite index. How does one explain these alphas?

Much of the work on explaining the Fundamental index alphas builds on existing knowledge: Alphas have been used repeatedly in the academic literature to reject (1) the S&P 500 as a good market proxy, (2) the link between noise in asset pricing and the factor returns observed for value and size, (3) the CAPM's single-factor framework, and (4) price efficiency.

Many theoretical reasons have been given for why the S&P 500 and other cap-weighted indexes do not proxy well for the "true" equity market portfolio, so our identification of a better equity market index is not surprising. That cap-weighted indexes fall short of proxying the market is a defensible interpretation of our empirical results, but it does not provide an *ex ante* reason to believe these Fundamental indexes are a better proxy for the true CAPM market portfolio than is, for example, the S&P 500.

Hsu demonstrated that cap-weighted portfolios suffer from a return drag if prices are noisy relative to movements in company fundamentals. Treynor shows that random pricing errors lead to

Figure 2. Sector Weightings
(12-month centered moving average, 1962–2004)



a *negative alpha* for any price-weighted or cap-weighted portfolio relative to a price-indifferent portfolio, such as the Fundamental indexes (or equal weighting).

Portfolio managers like to believe that observed superior performance is alpha and is driven by price inefficiency, but they recognize that any assumption of price inefficiency is significantly difficult to defend. We understand this point and do not wish to overstate our case. Many practitioners and academics do believe, however, that the extraordinary run-up in share valuations and the subsequent crash of 1998–2002 was a bubble; this experience adds support to the contention that price fluctuations sometimes do not reflect changes in company fundamentals.

What if the assumption of price inefficiency is true? After all, Fischer Black famously observed that the markets are far more efficient when viewed from the banks of the Charles than from the banks

of the Hudson. Price inefficiency need not immediately suggest easy money. Suppose we merely know that some companies are overvalued and others are undervalued. We have no simple way to trade away this idiosyncratic noise in prices because we do not know which stock is currently overvalued and which stock is undervalued.

Any price deviation from "true fair value" implies, however, that cap weighting will overweight *all* currently overpriced stocks and underweight *all* undervalued ones. An overreliance on overpriced stocks and underreliance on underpriced stocks leads to lower risk-adjusted performance relative to hypothetical fair value–weighted strategies—and probably also relative to strategies that randomize these errors. The size metrics that we explored are valuation indifferent and, therefore, will not be subject to this bias or the corresponding performance drag in cap-weighted indexes. Admittedly, they could introduce other (potentially more costly) biases, but we found no evidence of that in the data.

The literature on stock return predictability in which price-related ratios, such as dividend yield and earnings yield, appear to forecast next-period stock returns is also consistent with price inefficiency.[18] This evidence of return predictability is a stronger form of price inefficiency than simply idiosyncratic price noise because the pattern of price deviation in the studies is systematic (e.g., high-P/E stocks have a greater tendency to underperform) and because there are obvious strategies to profit from the inefficiency.[19] Return predictability suggests a systematic inefficiency that can be exploited by using companies' financial ratios as trading signals. The Fundamental indexes implicitly condition on company financial ratios through their annual reconstitution and reweighting, which allows these indexes to benefit from the documented predictive relationships between dividend yields and other value measures of future stock returns.

Although the construction of the Fundamental indexes systematically underweights growth stocks relative to a cap-weighted portfolio, a better way to state what is going on is that the cap-weighted Wall Street indexes systematically overweight growth stocks relative to a Main Street Fundamental index. A Fama–French three-factor regression shows that the Fundamental indexes have exposure to the value factor and, to a lesser extent, the size factor. Accordingly, the Fundamental indexes, net of the effects of the value and size factors, earned an estimated alpha of –0.1 percent. Three observations are noteworthy here. First, we were not seeking Fama–French "alpha"; this approach is a passive method with no stock selection. Second, most value indexes earn an estimated Fama–French alpha of –1.5 percent *or worse,* meaning that their CAPM alphas could be far higher if they were better constructed. No existing indexes that we are familiar with earn as much value added relative to capitalization weighting as the Fundamental indexes or avoid a large negative Fama–French alpha in the process. Finally, we question whether the returns on the Fama–French factors create the alpha for Fundamental Indexation or whether they are themselves generated by the same negative-alpha driver that cuts returns on the cap-weighted indexes. One can adopt the interpretation that the value premium is an anomaly and is a pure alpha because of a systematic price inefficiency.[20]

The cap-weighted index underperformance is positively related to the size of the price deviation, whether that deviation is idiosyncratic or systematic (see Hsu). Table 5 provides a powerful illustration in the data showing that the cap-weighted market portfolio underperformed the Fundamental indexes in the current decade—after high-tech share prices began to revert to a level of normalcy relative to their fundamentals—by an average of 9.44 pps.

The observed excess returns could also be attributed to hidden risk exposures rather than return anomalies from price inefficiency. Underweighting growth stocks relative to a cap-weighted index may expose the Fundamental indexes to more risks, such as economywide liquidity or distress risk, than a cap-weighted index is exposed to. Although the history of stock returns we analyzed does not provide support for this view (except, weakly, in the worst single month for a few of the Fundamental indexes), the proposition that hidden risk factors are behind the performance is conceivable.

These explanations are not mutually exclusive. That is, the superior performance of the Fundamental indexes may be attributable in part to market mispricing and in part to the index taking on additional hidden risk exposure. A common denominator in all three explanations, however, should be kept in mind: In any but the simplest CAPM definition of alpha, this value added is attributable more to a structural negative return bias from cap-weighted or price-weighted indexes than to any positive alpha from Fundamental Indexation.

We remain agnostic as to the true driver of the Fundamental indexes' excess return over the cap-weighted indexes; we simply recognize that they outperformed significantly and with some consistency across diverse market and economic environments. Our research suggests little reason to believe that this pattern will not continue.[21]

Conclusion

We have described a group of fundamentals-based market portfolios whose construction method is based on selection and weighting with metrics of company size other than cap weighting. These size measures include book value, revenues, dividends, and others. The resulting portfolios outperformed the S&P 500 by an average of 1.97 pps a year over the 43-year span tested. The performance was robust across time, across phases of the business cycle, across bear and bull stock markets, and across rising- and falling-interest-rate regimes. Our work suggests that indexes constructed using Main Street measures of company size are significantly better than the cap-weighted Wall Street indexes.

The excess return of the Fundamental index portfolios over the S&P 500 could arise from (1) superior market portfolio construction, (2) price inefficiency, (3) additional exposure to distress risk, or (4) a mixture of the three. Whether the superior performance is driven by better market index construction, by pure CAPM alpha (driven by a structural negative return bias in cap-weighted portfolios), or by beta exposure to additional risk, historically, the Fundamental indexes are materially more mean–variance efficient than standard cap-weighted indexes.

We believe these results are not mere accidents of history but are likely to persist into the future. The mean–variance superiority of the Fundamental indexes is robust and significant. We offered our interpretations of the results and explained why the results should not be dismissed as active management anomalies or the product of data mining or data snooping.

We are pursuing additional research related to Fundamental Indexation in numerous directions that are beyond the scope of this article. A particularly worthy question is whether the Fundamental indexes have a value bias relative to the cap-weighted indexes—or whether the cap-weighted indexes have a growth bias relative to the "average company" (the Fundamental indexes). Other areas include performance in comparison with the "next 2,000 stocks" (roughly equivalent to the Russell 2000), performance outside the United States, performance in comparison with active managers, why the Fundamental indexes sharply outpace the cap-weighted indexes in bear markets but not bull markets, risk premium implications, the superior performance we have found for the Fundamental indexes in relation to conventional value indexes, and the role of mean reversion in the Fundamental indexes' performance.

We find it refreshing that Main Street indexing outperforms Wall Street indexing. When the popular press describes mergers and other corporate actions, the size of the companies is generally described in revenues, profits, employees, or other Main Street measures. The true significance of the difference between these two forms of viewing the stock market may have been best noted by Benjamin Graham: In the short run, the market is a voting machine, but in the long run, it is a weighing machine.

We are indebted to George Keane and Marty Leibowitz for sowing the seeds for this research in many discussions about improved ways to manage passive portfolios. We also appreciate the valued feedback and suggestions of Peter Bernstein, Burton Malkiel, Harry Markowitz, and Jack Treynor, with additional help from Cliff Asness, Michael Brennan, Bob Greer, Philip Halpern, Bing Han, Max Moroz, Richard Roll, Glenn Swartz, and Ashley Wang. Special thanks go to Yuzhao Zhang for assistance with CRSP/Compustat data issues.

Notes

1. The CAPM market portfolio should theoretically be a portfolio that includes all assets in positive net supply, including all financial instruments backed by physical assets as well as nontraded capital assets. Thus, the true market portfolio should include (at least) U.S. and international stocks plus corporate bonds, commodities, real estate, and human capital. Thus, a globally diversified all-asset portfolio is closer to being mean–variance efficient than is a diversified stock portfolio. Mayers (1976) was the first to point out that the CAPM market portfolio should include all assets in positive net supply and, therefore, the equity market portfolio cannot be a reasonable proxy for it. Traditional CAPM tests using a cap-weighted equity market portfolio have found the CAPM relationship to not hold, which represents either a rejection of the equity market portfolio as the CAPM portfolio or a rejection of the mean–variance optimality of the market portfolio. Stambaugh (1982) extended Mayers' idea and tested the CAPM with a market portfolio that included nonequity asset classes; the result was improved success over traditional CAPM tests. Roll and Ross (1994, p. 101) stated ". . . it is well known that a positive and exact cross-sectional relation between ex ante expected returns and betas must hold if the market index against which betas are computed lies on the positively sloped segment of the mean–variance efficient frontier. Not finding a positive cross-sectional relation suggests that the index proxies used in empirical testing are not ex ante mean–variance efficient." See Roll (1977) and Ross (1977) for excellent reviews of this topic. Papers that rejected the efficiency of various cap-weighted market indexes include Ross (1978), Gibbons (1982), Jobson and Korkie (1982), Shanken (1985), Kandel and Stambaugh (1987), Gibbons, Ross, and Shanken (1989), Zhou (1991), and MacKinlay and Richardson (1991).

2. Roll and Ross suggested that the standard cap-weighted market indexes may be located within 22 bps below the true market index in mean–variance space.
3. We are not the first to explore weighting by fundamental factors, although none of these works came to our attention before our research was completed. Goldman Sachs managed an earnings-weighted S&P 500 Index during the early 1990s, as did Global Wealth Allocation from 1999 to 2003. Barclays Global Investors recently introduced a dividend-weighted strategy. Paul Wood manages an earnings-weighted 100 (out of the S&P 500) strategy (see Wood and Evans 2003). All of these strategies, however, use as a company universe an existing cap-weighted index. Each strategy, therefore, requires that companies be large in both capitalization *and* the other selected metric of size. None of the organizations have published a theoretical basis for the success of their strategies.
4. A cap-weighted index has the added intellectual satisfaction of macro consistency. All investors can hold a cap-weighted portfolio without violating market clearing. The alternative indexes we propose would not be market-clearing portfolios. But the CAPM is predicated on an array of simplifying assumptions that are not factually correct; these assumptions have been repeatedly shown to invalidate the mean–variance efficiency of that market-clearing portfolio. Accordingly, investors seeking better indexes have little reason to care greatly about the market-clearing property.
5. Turnover is surprisingly high on the most widely used "passive" indexes. For example, the widely respected Frank Russell Company makes available data on "annual index portfolio turnover," which is defined as "the percentage of an index fund that must be 'traded out' at reconstitution to maintain an exact replication of the index in the Russell 1000, which represents 92 percent of all domestic equity market value." Russell states that this turnover has averaged 9.2 percent a year during the 1983–2000 period. The Russell 3000, which represents 98 percent of all domestic market value, has averaged 9.0 percent turnover.
6. We are indebted to Burton Malkiel for suggesting that we test this measure of company size. In addition to the number of employees, we also looked at dollar payroll, with results nearly identical to those for number of employees.
7. Empirical studies have shown that zero-yield stocks outpace low-yield stocks with some regularity. Yet, even though zero-yield stocks were excluded from the Dividends index while low-yield stocks were not, the index still handily outpaced the traditional cap-weighted indexes in the long run, with markedly lower risk.
8. These companies tend either to be fast growing enough for shareholders to accept a policy of 100 percent earnings retention or struggling enough to have canceled the dividend and be marked down in price as a consequence. See Arnott (1988).
9. The differences in annual returns between the indexes that used five-year trailing average statistics versus one-year trailing statistics were within ±10 bps, whereas turnover increased uniformly by more than 2 percentage points.
10. The Russell indexes are weighted by float, not aggregate capitalization, and are rebalanced annually at midyear.
11. The information ratio is the value added divided by the standard deviation of value added (or the "tracking error").
12. Given that Warren Buffett's lifetime information ratio is about 0.70, we found this result to be very satisfactory, particularly for a process that is not seeking alpha.
13. We found also (not shown in Table 3) that the Fundamental indexes have roughly twice the liquidity and half the turnover of an equally weighted portfolio of the Reference index holdings.
14. By each metric, Revenue nearly duplicates Sales performance. Results for every Fundamental index are available from the authors or online at www.researchaffiliates.com/index.
15. The required significance data for TIPS (Treasury Inflation-Indexed Securities) correlations, because of the limited history of TIPS, are 0.18 for the 90 percent level and 0.29 for the 99 percent level.
16. The results for earnings were nearly identical to the results for the Cash Flow index.
17. We used stocks of the merged Compustat/CRSP database grouped by the 12 S&P industrial sector groupings.
18. See Blume (1980); Campbell and Shiller (1988); Fama (1990); Chen, Grundy, and Stambaugh (1990); Hodrick (1992); Campbell and Hamao (1992); Goetzmann and Jorion (1993, 1995); Fama and French (1992,1995); Lamont (1998); Barberis (2000); Arnott and Asness (2003). Cochrane (1999) contains an excellent review of return predictability. The particular return predictabilities explored in most academic general equilibrium models are not related to price inefficiencies but are related to time-varying risk premiums.
19. See Bansal, Dahlquist, and Harvey (2004) for a trading strategy based on the literature of return predictability to enhance buy-and-hold portfolio returns.
20. This stance is not as controversial as it might seem. The academic finance literature has still not reached a consensus on the source of the value premium, and journals continue to publish general equilibrium models demonstrating how the Fama–French value factor may be a proxy for an underlying risk factor. Little convincing evidence is available, however, on the value factor proxying a macroeconomic risk factor. In contrast, the most popular interpretations of the value factor as a systematic distress-risk factor have failed to identify economywide distress scenarios that coincided with price collapses in value stocks. The finance literature on return anomalies, and on systematic market inefficiencies driven by behavioral biases, certainly lends support to the interpretation that Fundamental indexes capture the value premium as pure alpha.
21. For example, the capitalization ratios of the Fundamental indexes are currently well within normal ranges, which suggests that the excess return is not merely a function of a 42-year revaluation of the Fundamental Indexation metrics.

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