Tracking S&P 500 index funds
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Tracking S&P 500 Index Funds

Getting your money's worth?

Alex Frino and David R. Gallagher

> When we buy an actively managed fund, we are like gamblers in Vegas. We know it is likely to be a losing proposition, yet somehow we feel we are getting our money's worth.
>
> —*The Wall Street Journal*, February 27, 2001

The quotation from *The Wall Street Journal* highlights both investors' and gamblers' psychology in their attempt to maximize the returns attributable to their respective activities. Its implication is that both agents are rational with respect to the likely outcome—an acceptance of the economic and statistical laws that ensure the strategy cannot be successful for all participants.

Gruber [1996] highlights the apparent puzzle surrounding the growth in actively managed mutual funds and the direction of significant mutual fund flows into the sector. The Investment Company Institute reports significant growth in U.S. stock mutual funds over the last calendar year. Net new cash flows increased to a record $309 billion as of December 2000, and the vast majority of net new money was allocated to active funds.

This preference in favor of active funds has continued despite considerable empirical evidence indicating active funds do not earn abnormal returns. While Zheng [1999] documents evidence of a "smart money" effect in the short term, in that new money flows predict future performance, in aggregate, active funds with positive new money flows do not beat the market. In addition, despite the documentation of performance

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persistence, Carhart [1997] finds the phenomenon is almost completely attributable to common factors in stock returns and investment expenses rather than superior portfolio management ability.

Investor allocation of capital to active funds appears to make little economic sense, especially when one considers the definition of a benchmark index and the implications an index has for performance measurement. Sharpe [1991] asserts that, on average, active managers cannot better the returns derived from passive investment strategies. The reasoning is that the performance of the index equals the weighted-average return of both active and passive investors before investment expenses. Therefore, by definition active management is a zero-sum game.[1]

Despite the significant attention to active funds in the performance evaluation literature, empirical research evaluating index funds is surprisingly scarce. This is even stranger when one considers that U.S. stock index mutual funds and other index portfolios accounted for more than $1.5 trillion in assets as of December 2000.

Significant growth has occurred in both the proportion of indexed assets invested in diversified U.S. stock funds and the number of index mutual funds available. Lipper Inc. reports that indexed assets represented about 12% of total assets as of December 2000, compared to around 5% in 1995. Morningstar, Inc., tracked 190 index mutual funds as of December 2000, or more than double the number five years ago. Approximately half of these funds (94 funds) track the S&P 500 and are valued in excess of $272 billion.[2]

Indexing also has increased in significance with respect to the growth in exchange-traded funds (ETFs). Since the introduction of the first ETF in 1993 (the Standard & Poor's 500 Depository Receipt (SPDR) or "Spider"), total ETF assets have approximately doubled in the past year to $70 billion as of December 2000.

While the theory and the objectives of an index strategy are both simple and well known, potential difficulties arise for index managers attempting to exactly replicate the returns of the target benchmark. There are a number of factors that are likely to influence the magnitude of index fund tracking error, but the primary source of the problem is that the underlying index is measured as a "paper" portfolio, which assumes transactions may occur at any time without cost. Tracking error in index fund performance is therefore unavoidable, given the presence of market frictions facing index managers. Therefore, the secondary objective for index managers involves managing these constraints so as to minimize divergence in performance from the underlying benchmark index.

Our study highlights the difficulties faced by index funds, examines both the magnitude and variation of tracking error over time for a sample of S&P 500 index mutual funds, and provides a direct performance comparison between index and active mutual funds. Consistent with the empirical evidence, S&P 500 index mutual funds are found to outperform active funds, on average, after expenses in the period examined.

THE CHALLENGE FACING INDEX MANAGERS

Index funds aim to deliver the returns and the risk of the underlying benchmark index. Theoretically, the management of index portfolios is straightforward, requiring investment in all constituent index securities in the exact same proportion as the underlying benchmark (called a "full replication" strategy).[3]

In reality, however, fund managers adopting an indexing approach cannot be guaranteed their portfolios' performance will be identical to the benchmark index. This is because an index represents a mathematical calculation derived from a portfolio of securities that are not subject to the same market frictions faced by index mutual funds. If the composition of the underlying index changes, the index assumes the theoretical portfolio's new weights to each security can be achieved automatically.

Yet, index fund managers cannot make the same assumptions, as physical trading in index stocks will be required in order to realign the portfolio to mimic the underlying benchmark. Market frictions in the management of passive portfolios require minimizing tracking error, the differences in returns between the portfolio and the index, in order not to significantly compromise an index fund's objectives.[4]

Chiang [1998] identifies the main factors driving index fund tracking error as transaction costs, fund cash flows, the treatment of dividends by the index, the volatility of the benchmark, corporate activity, and index composition changes. The liquidity of the underlying index will also have implications for transaction costs and hence the tracking error incurred by index funds (Keim [1999]). Consequently, tracking error in performance will be inherent in the management of index portfolios, leaving index managers with the dual objective of minimizing tracking error in performance as well as minimizing the costs incurred in tracking the index as closely as possible.

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Therefore a trade-off exists between tracking error minimization and transaction costs.

Transaction costs associated with trading in securities markets influence the ability of index mutual funds to replicate the performance of the index. The index itself is calculated as a paper portfolio that assumes transactions can occur instantaneously, in unlimited quantities, and without cost (Perold [1988]). In reality, index funds incur transaction costs that are associated with portfolio implementation, rebalancing, and client capital flows. For example, cash flow movements cause flow-induced trading for open-end index mutual funds, requiring the new cash to be rapidly invested across index securities.[5]

The size and timing of the cash flows, as well as the index manager's use or otherwise of derivative instruments, may also be related to tracking error in performance. Since index funds are required to trade securities in order to mimic the underlying benchmark index, transaction costs (both explicit and implicit) ensure index funds exhibit tracking error. The liquidity of stocks constituting the index also has implications for transaction costs, as full-replication index funds require some proportion of fund assets to be invested in less liquid securities (Keim [1999]).

Tracking error may also be related to changes in the composition of the index. These include index adjustments related to company additions and deletions, share changes, and corporate restructuring. Periodic changes to the index can make it difficult for an index fund to exactly replicate the target benchmark return. Again, additional transaction costs are incurred, as changes in the composition of the index require passive funds to trade index securities in order to realign their portfolios with the new index. Depending on the relative size of the stocks entering and exiting the index (in terms of market capitalization), changes will require a number of odd-lot transactions in order to match the rebalanced index.

The index manager also faces the additional challenge of executing orders at the best possible prices and in such a manner as to minimize the recognition of capital gains tax liabilities to avoid significant erosion of returns. In the case of securities that are subject to corporate restructuring, such as a merger or takeover by another company outside the index, there may be a timing delay between the date the index fund receives the cash settlement and the date the target firm is ultimately removed from the index.

In addition, front-running by risk arbitrageurs (who acquire securities ahead of their inclusion in the index) may also have an undesirable impact (Beneish and Whaley [1996]).

If an index fund is perfectly aligned with the index, index volatility should not result in tracking error, all things equal. When index portfolios do not exactly mirror the benchmark, volatility of the index will induce tracking error for index funds. Indeed, the magnitude of tracking error should be directly related to the extent of volatility of the underlying securities in the index. Dividends may also cause tracking error in performance when there is a timing delay in their receipt as well as the index rules governing the treatment of dividends in the index.

For example, if there is a timing delay between when the index incorporates the dividend (at the ex-dividend date) and the actual receipt of the dividend by the index fund (after the ex-dividend date), tracking error will be unavoidable. In the case of S&P 500 constituent securities, actual receipt of dividends can take as long as several weeks. This may be minimized by index managers through participation in dividend reinvestment plans, but it is generally uncommon for S&P 500 constituent securities to distribute dividends in the form of new securities. When an index assumes that dividends are smoothed, the dividend effect may cause index managers to incur tracking error.

While tracking error will be inherent in index fund performance, investors reasonably expect index fund returns will underperform the underlying index only to the extent of the management fees charged by mutual funds. Indeed, investors may consider index performance net of index fund charges to be a more optimal investment strategy than active management.

There are a number of sound reasons why. First, the overwhelming majority of performance evaluation studies over the last three and a half decades have confirmed the inability of active mutual funds to outperform market indexes (see Elton et al. [1993], Malkiel [1995], and Gruber [1996]).

Second, if active management incurs significantly higher transaction costs in executing the strategy (compared with passive management), then the higher expense ratios charged by active mutual funds will translate into lower after-expenses returns to investors (see Keim and Madhavan [1998]).

In the third instance, the higher turnover exhibited by active funds has a potentially greater effect on future capital gains tax liabilities, which further diminishes after-expense and after-tax performance.

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ANALYSIS OF S&P 500 INDEX FUND TRACKING ERROR

We use a sample of 42 S&P 500 index mutual funds from the Morningstar Principia Pro CD-ROM to measure tracking error.[6] The analysis period spans the five years ending February 1999. The period is limited due to data availability owing to the relative newness of the index mutual fund market.[7] The five-year period maximizes both the number of funds included in the sample and the length of the evaluation horizon.

Morningstar reports total monthly fund returns data (income and capital gains) after expenses. In order to estimate tracking error before expenses, index fund returns are adjusted by reported historical fund expense ratios in order to approximate gross returns.[8]

All S&P 500 index funds are classified by Morningstar as growth-and-income, which is consistent with a passive, style-neutral strategy. Funds under management for the sample grew from $US18 billion in December 1993 to more than $US161 billion at the end of February 1999, representing an approximate nine-fold increase. The two Vanguard index mutual funds included in the sample account for approximately $102 billion of total sample assets indexed to the S&P 500 in February 1999.

Roll [1992], Pope and Yadav [1994], and Larsen and Resnick [1998] identify a number of ways tracking error can be measured. We measure tracking error using three methods. First, tracking error in month t is calculated as the absolute difference in returns of the index portfolio and the benchmark index ($e_{pt} = R_{pt} - R_{bt}$), where the monthly average absolute tracking error over n months ($TE_{1,p}$) is defined as follows:

$$TE_{1,p} = \frac{\sum_{t=1}^{n} |e_p|}{n} \tag{1}$$

An alternative test for tracking error, and the standard methodology used in industry, measures the month-to-month variability (standard deviation) of the difference in returns between the index portfolio and the underlying benchmark index return ($TE_{2,p}$). It is expressed as:[9]

$$TE_{2,p} = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}(e_{pt} - \bar{e}_p)^2} \tag{2}$$

Tracking error may also be quantified as the standard error of the residuals of a returns regression ($TE_{3,p}$). If the return on the index portfolio p is regressed on the return of the benchmark index b, the standard error of the regression equation provides an estimate of tracking error. The model is as follows:

$$R_{pt} = \alpha_i + \beta_i R_{bt} + \varepsilon_{pt} \tag{3}$$

While this method should provide similar results to application of Equation (2), Pope and Yadav [1994] note that if the beta is not exactly equal to one, the regression residuals will differ from $TE_{2,p}$. That is, if the relationship between the index portfolio and benchmark index returns is non-linear, this approach will overstate tracking error.

TESTS FOR SEASONALITY IN INDEX FUND TRACKING ERROR

The financial economics literature has documented the presence of seasonality in both stock returns and market bid-ask spreads, particularly the "January effect." Seasonality in tracking error of S&P 500 index mutual funds would then require identification of the drivers explaining the time variation in tracking error. For example, seasonality may be shown to exist in months when stocks go ex-dividend or in months of abnormal volatility. Seasonality in mean monthly tracking error is tested using the dummy variable OLS regression:

$$|e_{pt}| = \pi_1 + \sum_{t=2}^{12} \pi_i D_{it} + \varepsilon_{pt} \tag{4}$$

where

π_1 = intercept of the regression model measuring the average absolute tracking error in the month of January;
D_{it} = seasonal dummy variable for calendar month i;
i = February, ..., December; and
ε_{pt} = random error term with expected mean of zero.

The dummy variable coefficients indicate the mean difference in index fund tracking error between January and each other month. If tracking error is not significantly different across calendar months, the coefficients on the dummy variables will be close to zero, and the F-statistic

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(measuring the joint significance of the dummy variable coefficients) will be statistically insignificant.

S&P 500 MUTUAL FUND RAW AND RISK-ADJUSTED PERFORMANCE

Mutual fund performance for active mutual funds is evaluated using a raw returns approach (method 1) and three risk-adjusted performance models (methods 2, 3, and 4), which measure returns in excess of the risk-free rate (or return in excess of Treasury bills):

1. The raw returns approach (ignoring risk adjustment in performance) measures the contribution of value added or lost by the fund relative to the S&P 500.
2. The single-index model estimates fund risk-adjusted excess returns (in excess of Treasury bills) using the S&P 500 index as the market portfolio (i.e., Equation (3), where returns are measured in excess of the risk-free rate);
3. In the Elton, Gruber, and Blake [1996a] four-index model:

$$R_{pt} = \alpha_{4p} + \beta_{SPp}R_{SPt} + \beta_{pSL} + R_{SLt} + \beta_{pGV}R_{GVt} + \beta_{pB}R_{Bt} + \varepsilon_{pt} \quad (5)$$

α_4 measures a fund's risk-adjusted excess return with respect to the set of risk factors, defined as the S&P 500 (β_{SP}), two Prudential Bache indexes controlling for market capitalization (β_{SL}) and growth-value strategies (β_{GV}), and a proxy for bond returns (β_B) using the Lehman Brothers Aggregate Bond index.[10] Elton et al. [1993] and Elton, Gruber, and Blake [1996a] advocate the use of additional indexes because of the potential sensitivity of fund performance to the choice of benchmark used. The additional indexes also capture risk characteristics with respect to mutual fund investment style as well as accounting for non-S&P 500 securities that may constitute part of an active fund's portfolio. These additional benchmarks improve the quantification of portfolio risk.

4. A performance attribution model combining the Treynor-Mazuy [1966] market-timing model and Elton-Gruber-Blake [1996a] four-index model decomposes fund performance into security selection (α_{4p}^{SS}) and market-timing (γ_{SP}) components. The TMEGB model is defined as follows for portfolio p:

$$R_{pt} = \alpha_{4p}^{SS} + \beta_{pSP}R_{SPt} + \gamma_{SPp}R_{SPt}^{2} + \beta_{pSL}R_{SLt} + \beta_{pGV}R_{BGVt} + \beta_{pB}R_{Bt} + \varepsilon_{pt} \quad (6)$$

The coefficient on the quadratic term is used to determine the market-timing ability of an active mutual fund. The TMEGB model therefore provides a direct comparison between the security selection performances of index and active mutual funds.

We measure index mutual fund performance using methods 1 and 2 only, as these methods represent the most appropriate performance methodologies with respect to an index fund's investment objectives. S&P 500 index funds attempt to replicate the performance of the S&P 500, and as a consequence do not exhibit style biases. In addition, index funds do not engage in market-timing activities. Therefore, methodologies 3 and 4 are not appropriate performance models for assessment of index fund performance, and are not considered in the analysis.

The performance of active and index mutual funds is evaluated after expenses. We examine active funds classified by Morningstar as large-capitalization, as these funds are the most appropriate for directly comparing active fund performance relative to S&P 500 index funds.[11]

All funds in the sample are required to have continuous performance histories over the particular observation periods. Performance is analyzed using two sample periods; the first evaluation horizon is the eight-year period ending February 1999, and the second is the five-year period ending February 1999. The eight-year period includes a sample of 343 active and 15 index mutual funds, while the five-year period evaluates 607 active and 42 index mutual funds. The shorter five-year period is added in an attempt to include more index funds and hence facilitate performance comparisons against active funds.

Overall, both evaluation periods are somewhat constrained because of the limited number of index mutual funds available in the Morningstar database, but the analysis permits sufficient comparison between active and passive portfolio management.

The analysis takes note of the Morningstar prospectus descriptions, which permits partitioning of funds on

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EXHIBIT 1
S&P 500 INDEX MUTUAL FUND TRACKING ERROR AND RISK-ADJUSTED PERFORMANCE

		Absolute Difference in Returns						Return Differences		S.C.C	S.E.R.	S.I.M. Parameters		
S&P 500 Index Mutual Fund	Mean (TE_1)	SD	Min	Q1	Q2	Q3	Max	Mean*	SD (TE_2)	ρ(1)*	Error (TE_3)	α*	β	R^2
BlackRock Index Equity Instl	0.073	0.058	0.002	0.028	0.057	0.096	0.230	-0.015	0.093	-0.092	0.092	-0.009	0.996	0.999
BlackRock Index Equity Inv A	0.110	0.176	0.002	0.025	0.051	0.116	1.035	-0.014	0.208	-0.087	0.208	-0.004	0.993	0.997
BlackRock Index Equity Svc	0.079	0.060	0.000	0.026	0.078	0.122	0.254	-0.014	0.099	-0.090	0.097	-0.006	0.994	0.999
BT Instl Equity 500 Index	0.048	0.054	0.000	0.006	0.039	0.073	0.331	0.005	0.072	-0.089	0.072	0.009	0.997	1.000
BT Investment Equity 500 Index	0.060	0.060	0.000	0.014	0.039	0.103	0.323	0.005	0.086	-0.086	0.085	0.011	0.996	1.000
California Invmt S&P 500 Index	0.059	0.050	0.004	0.020	0.044	0.094	0.220	0.005	0.078	-0.088	0.075	0.014	0.994	1.000
DFA U.S. Large Company	0.056	0.047	0.002	0.018	0.045	0.083	0.174	0.003	0.073	-0.090	0.071	0.011	0.995	1.000
Dreyfus Basic S&P 500 Stock	0.054	0.068	0.000	0.016	0.036	0.062	0.465	-0.001	0.087	-0.089	0.087	-0.001	1.000	1.000
Dreyfus S&P 500 Index	0.049	0.043	0.001	0.016	0.030	0.085	0.156	-0.002	0.065	-0.089	0.066	-0.001	0.999	1.000
Evergreen Sel Equity Index Is	0.092	0.077	0.002	0.034	0.068	0.136	0.438	-0.012	0.120	-0.081	0.117	-0.001	0.993	0.999
Federated Max-Cap Instl	0.059	0.048	0.001	0.018	0.051	0.081	0.198	-0.003	0.076	-0.092	0.075	0.002	0.996	1.000
Federated Max-Cap Instl Svc	0.059	0.047	0.002	0.022	0.055	0.077	0.223	-0.006	0.076	-0.092	0.075	-0.001	0.997	1.000
Fidelity Spartan Market Index	0.046	0.035	0.001	0.019	0.041	0.064	0.162	0.009	0.058	-0.091	0.058	0.010	0.999	1.000
Fidelity Spartan U.S. Eq Index	0.049	0.037	0.000	0.023	0.040	0.075	0.158	0.002	0.062	-0.091	0.062	0.004	0.999	1.000
First American Equity Index A	0.049	0.037	0.000	0.018	0.040	0.074	0.177	0.005	0.061	-0.092	0.061	0.008	0.998	1.000
First American Equity Index Y	0.049	0.040	0.002	0.019	0.038	0.073	0.158	0.006	0.063	-0.089	0.062	0.012	0.996	1.000
Firstar Equity Index Instl	0.051	0.036	0.005	0.020	0.046	0.076	0.188	0.013	0.061	-0.092	0.062	0.014	1.000	1.000
Galaxy II Large Co Index Ret	0.052	0.041	0.001	0.018	0.045	0.074	0.197	0.004	0.066	-0.090	0.065	0.010	0.996	1.000
Kent Index Equity Instl	0.058	0.042	0.001	0.024	0.052	0.082	0.167	-0.008	0.071	-0.089	0.066	0.002	0.993	1.000
Kent Index Equity Invmt	0.049	0.042	0.000	0.016	0.035	0.072	0.167	-0.009	0.064	-0.090	0.061	-0.001	0.995	1.000
MainStay Equity Index A	0.071	0.054	0.000	0.029	0.065	0.102	0.280	-0.007	0.090	-0.087	0.084	0.005	0.992	1.000
MainStay Inst Indx Eq Inst	0.057	0.046	0.001	0.022	0.050	0.077	0.201	0.009	0.073	-0.088	0.072	0.013	0.997	1.000
MasterWorks S&P 500 Stock	0.060	0.060	0.003	0.024	0.045	0.076	0.366	-0.009	0.085	-0.090	0.085	-0.006	0.998	1.000
Munder Index 500 A	0.052	0.043	0.001	0.014	0.050	0.075	0.192	-0.007	0.067	-0.093	0.067	-0.004	0.998	1.000
Munder Index 500 K	0.051	0.044	0.000	0.019	0.041	0.064	0.190	-0.007	0.068	-0.091	0.067	-0.001	0.996	1.000
Munder Index 500 Y	0.050	0.038	0.002	0.020	0.042	0.078	0.148	-0.004	0.063	-0.090	0.062	0.001	0.997	1.000
Nations Equity-Index Prim A	0.058	0.047	0.001	0.017	0.047	0.089	0.212	0.002	0.076	-0.090	0.072	0.012	0.994	1.000
Northern Instl Equity Index A	0.044	0.038	0.002	0.015	0.031	0.059	0.163	-0.007	0.058	-0.091	0.058	-0.004	0.998	1.000
One Group Equity Index A	0.060	0.049	0.003	0.021	0.052	0.081	0.255	0.000	0.078	-0.087	0.074	0.010	0.993	1.000
One Group Equity Index B	0.070	0.098	0.000	0.021	0.043	0.069	0.517	0.001	0.121	-0.089	0.111	0.018	0.988	0.999

EXHIBIT 1 continued

Pegasus Equity Index A	0.066	0.069	0.001	0.022	0.046	0.108	0.445	0.015	0.095	-0.095	0.094	0.021	0.995	0.999
Pegasus Equity Index I	0.068	0.072	0.001	0.015	0.049	0.104	0.456	0.008	0.099	-0.096	0.098	0.013	0.996	0.999
Prudential Stock Index Z	0.070	0.071	0.003	0.023	0.055	0.083	0.333	0.004	0.100	-0.083	0.094	0.017	0.991	0.999
SEI Index S&P 500 Index E	0.055	0.048	0.000	0.025	0.044	0.074	0.283	0.001	0.074	-0.088	0.074	0.005	0.998	1.000
SSgA S&P 500 Index	0.054	0.053	0.000	0.013	0.030	0.093	0.257	-0.010	0.075	-0.093	0.076	-0.010	1.000	1.000
Stagecoach Equity Index A	0.051	0.039	0.001	0.014	0.043	0.074	0.138	-0.004	0.065	-0.090	0.060	0.005	0.994	1.000
T. Rowe Price Equity Idx 500	0.039	0.035	0.000	0.012	0.028	0.052	0.165	0.012	0.051	-0.090	0.051	0.014	0.999	1.000
Vanguard 500 Index	0.042	0.030	0.002	0.019	0.033	0.067	0.133	0.010	0.051	-0.091	0.051	0.010	1.000	1.000
Vanguard Instl Index	0.045	0.034	0.002	0.019	0.040	0.072	0.155	0.010	0.056	-0.091	0.056	0.010	1.000	1.000
Victory Stock Index	0.103	0.146	0.006	0.034	0.061	0.115	0.860	-0.011	0.097	-0.094	0.179	-0.003	0.996	0.998
Wachovia Equity Index A	0.063	0.060	0.001	0.020	0.050	0.087	0.256	-0.005	0.087	-0.090	0.087	-0.001	0.998	1.000

Tracking error and risk-adjusted returns are expressed in percentage terms per month, where expenses have been added back to index mutual fund returns to approximate gross returns.

* *The returns difference method (TE_2), serial correlation coefficient (S.C.C.), and risk-adjusted excess returns for S&P 500 index funds are all statistically insignificant. The performance results are consistent with expectations of an index investment management strategy, where alpha (α) is statistically indistinguishable from zero before costs and systematic risk (β) is equal to or approximate unity.*

the basis of the portfolio management approach adopted (full replication or non-replication) and the investment strategy adopted by active funds (aggressive growth, growth, growth and income, and income).[12]

The Morningstar data set has the standard survivorship bias problem present in the vast majority of performance evaluation studies, in that funds going out of business are excluded from the data records. Survivorship bias skews the results toward the more successful funds, as there is generally a higher attrition rate among the poor performers.[13]

EMPIRICAL RESULTS

Exhibit 1 documents the degree of tracking error and risk-adjusted performance of index mutual funds in the sample. The cross-sectional average $TE_{1,P}$ is equal to 5.9 basis points per month, ranging between 3.9 and 11.0 basis points per month before expenses. In other words, market frictions induce tracking error in S&P 500 index fund performance.

Tracking error estimates using $TE_{2,P}$ or $TE_{3,P}$ methods, as expected, provide very similar results. The cross-sectional average S&P 500 index mutual fund's tracking error ($TE_{2,P}$) in the sample period is 8.0 basis points per month or 27.6 basis points per year. $TE_{2,P}$ across funds ranges between 5.1 and 20.8 basis points per month, equivalent to 17.7 and 72.1 basis points annualized.[14]

In light of Pope and Yadav's [1994] warning of potential tracking error estimation bias, the serial correlation results (presented in the S.C.C. column) indicate the use of monthly data is not problematical. In terms of the risk-adjusted performance of index mutual funds, all alphas are equal to or very close to zero, and systematic risk (β) is in line with the S&P 500.

In summary, these results demonstrate that tracking error over time is inherent in performance, although the overall performance objectives of index funds are not compromised.

Exhibits 2 and 3 present the results of tracking error variation over time for index funds in the sample. The evidence clearly indicates the presence of a seasonal pattern in S&P 500 index mutual fund tracking. Tracking error is significantly higher in the months of January and May and is lowest in June.

A strong quarterly pattern (troughs) is also evident, suggesting S&P 500 index mutual funds experience improved replication ability in the months of March, June, September, and December. These quarterly troughs are

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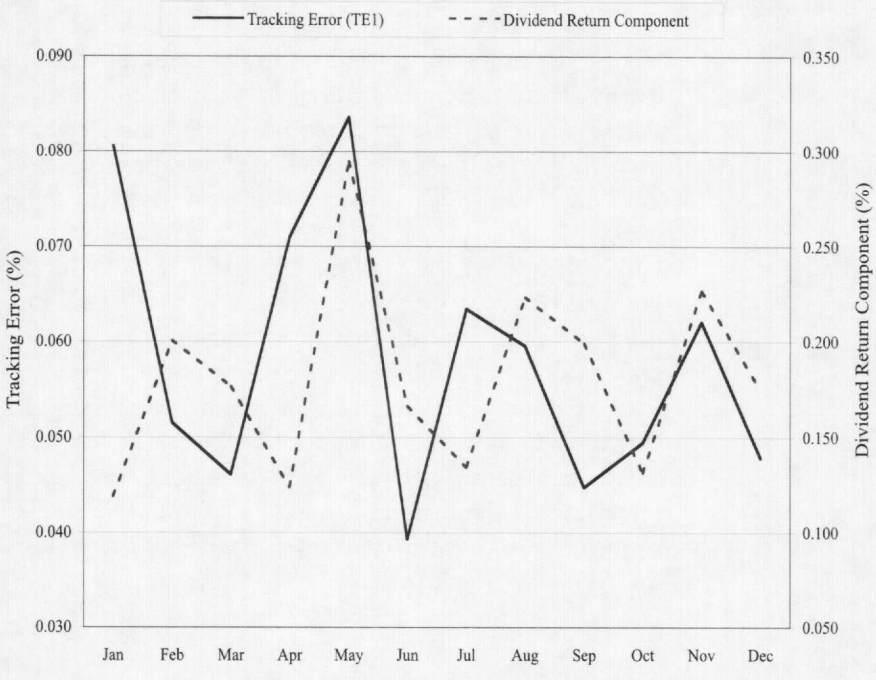
EXHIBIT 2
AVERAGE 1994-1995 S&P 500 INDEX MUTUAL FUND TRACKING ERROR AND DIVIDED COMPONENT RETURN ON S&P 500



followed by sharp reversals in each subsequent month, with the exception of October (although the month of October still exhibits higher tracking error post-September).

Further analysis of individual calendar years (not directly reported here) also appears to support the quarterly seasonal pattern of a trough in tracking error in the months of March through December as well as significantly higher tracking error for index funds in January than in other months.

A number of factors may explain the seasonality phenomenon of tracking error for index mutual funds.[15] A dividend effect may explain the sharp rises in tracking error for S&P 500 index funds immediately following the quarters ending March-June-September-December (although October's reversal is not as dramatic). An evaluation of the return component attributable to dividends over the sample period reveals quarterly peaks for the months preceding the quarter ends, namely, February, May, August, and November. The month of May is particularly pronounced, followed by November, August, and February in that order.

Constituent dividend-paying securities in the S&P 500 are assumed to reinvest dividends at the ex-dividend date, although there is likely to be a time lag between the ex-dividend date and actual receipt of the dividend. Mutual funds may not receive dividend disbursements until several weeks later, and potentially in the month following the ex-dividend date. Timing delays in the receipt of dividends make perfect replication of the S&P 500 unachievable, and consequently tracking error arises.[16]

An empirical examination of the role of dividend payments reveals strong statistical evidence that a dividend effect drives the sharp increases in index mutual fund tracking error. The particularly pronounced dividend effect in May coincides with the month that exhibits the highest dividend component of return encapsulated in the S&P 500 total return index. The Pearson and Spearman correlation coefficients between tracking error ($TE_{1,p}$) and the return attributable to dividends are both positive and statistically significant (ρ = 0.138 and 0.101, respectively, at the 0.01 level).

Exhibit 3 can therefore be interpreted that index mutual fund managers experience tracking error when stocks go ex-dividend, but that improved replication of the S&P 500 is achieved as dividends are received in the following month.

Additional explanations for index mutual fund tracking error may have to do with S&P 500 index changes. These include company additions and deletions as well as quarterly index divisor adjustments required to update all common shares outstanding for constituent S&P 500 stocks.

Standard & Poor's preannounces amendments to the S&P 500, and index changes generally become effective up to five business days after the announcement. While this policy is aimed at easing order imbalances, index managers typically wait until the effective date before portfolio adjustments are made to reflect the new S&P 500. Index additions and deletions are unlikely to follow a consistent seasonal pattern, as amendments are generally not predictable.

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EXHIBIT 3
OLS REGRESSION MODEL EVALUATING SEASONALITY IN S&P 500 INDEX MUTUAL FUND TRACKING ERROR ($TE_{1,p}$)

	Coefficient	T-Statistic
Intercept (January)	0.081	21.71***
February	-0.029	-5.53***
March	-0.034	-6.58***
April	-0.010	-1.82*
May	0.003	0.59
June	-0.041	-7.89***
July	-0.017	-3.27***
August	-0.021	-4.01***
September	-0.036	-6.83***
October	-0.031	-5.94***
November	-0.018	-3.53***
December	-0.033	-6.25***
F-statistic	-	15.07***
DW-statistic	-	1.43

* *Significant at 0.10 level.*

*** *Significant at 0.01 level.*

Theoretically, tracking error may be related to S&P 500 index changes. The extent of tracking error is likely to depend on the relative market capitalization weights of stocks added to or removed from the S&P 500 in the period.

Tracking error for index mutual funds may also be significantly higher in January because of mutual fund flows. Large net cash flows require the index manager to rapidly engage in securities trading to avoid cash drag, or tracking error induced by holding liquid assets and not stocks. Further, tax-related selling in December could also potentially drive the high tracking error recorded in the month of January.[17] More research is warranted with respect to the determinants of tracking error in S&P 500 index fund performance.

Exhibit 4 describes the after-expense performance of active and index mutual funds. As expected, index funds earn significantly negative raw and risk-adjusted excess returns, and the margin of underperformance is roughly equivalent to the average expense ratio. This is consistent with an index fund's performance objective, net of expenses.

EXHIBIT 4
PERFORMANCE COMPARISON BETWEEN ACTIVE AND INDEX S&P 500 MUTUAL FUNDS

	$R_p - R_b$	α_1	α_4	β_{SP}	β_{SL}	β_{GV}	β_B	R^2	α_4^{SS}
Panel A: 8-Year Period									
All Index Funds—Replication	-0.036 ***	-0.031 ***	-	0.996	-	-	-	0.999	-
All Active Funds	-0.198 ***	-0.125 ***	-0.072 ***	0.917	0.161	0.038	0.048	0.884	-0.074 ***
Active—Aggressive Growth #	-0.097	-0.188 ***	-0.032	0.947	0.302	0.367	0.129	0.844	-0.014
Active—Growth	-0.119 ***	-0.120 ***	-0.037 **	0.943	0.176	0.157	0.047	0.876	-0.035 **
Active—Growth and Income	-0.255 ***	-0.149 ***	-0.121 ***	0.920	0.139	-0.055	0.030	0.901	-0.135 ***
Active—Income	-0.311 ***	-0.045 **	-0.052 **	0.824	0.161	-0.208	0.097	0.891	-0.019
Panel B: 5-Year Period									
All Index Funds	-0.035 ***	-0.029 ***	-	0.996	-	-	-	0.999	-
Index—Replication	-0.034 ***	-0.027 ***	-	0.995	-	-	-	0.999	-
Index—Non-Replication	-0.041 ***	-0.036 ***	-	0.997	-	-	-	0.999	-
All Active Funds	-0.355 ***	-0.293 ***	-0.162 ***	0.944	0.131	0.041	-	0.916	-0.170 ***
Active—Aggressive Growth #	-0.115	-0.379 ***	-0.083	1.043	0.219	0.403	-0.040	0.893	-0.112
Active—Growth	-0.300 ***	-0.312 ***	-0.174 ***	0.969	0.121	0.134	-0.066	0.910	-0.178 ***
Active—Growth and Income	-0.389 ***	-0.280 ***	-0.162 ***	0.937	0.134	-0.052	-0.028	0.928	-0.181 ***
Active—Income	-0.555 ***	-0.216 ***	-0.116 ***	0.833	0.155	-0.236	0.023	0.922	-0.105 ***

** *Significant at 0.05 level.*

*** *Significant at 0.01 level.*

\# *Statistical significance affected due to small sample size.*

In the case of index funds, R^2 is the coefficient of determination. For active funds, R^2 represents the adjusted coefficient of determination.

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In terms of performance relative to active funds, Exhibit 4 indicates that index mutual funds outperformed active mutual funds. The most appropriate performance measure for active funds is the Elton-Gruber-Blake [1996a] four-index model and the TMEGB performance attribution model. Systematic risk (β_{SP}) and the growth-value risk factor sensitivities (β_{GV}) are consistent with the investment strategies adopted by active mutual funds.

In terms of risk-adjusted performance, the alphas estimated from the single-index model (α_1) and the four-index model (α_4) both indicate that the average active mutual fund significantly underperforms. While index mutual funds also have significantly negative alpha (α_1), the extent of underperformance is approximately equal to the average expense ratio levied by index mutual funds (2.9 and 3.4 basis points per month for the eight-year and five-year periods, respectively). Interestingly, active funds with growth and income investment objectives (the same investment objective as S&P 500 index funds) record the worst performance of all active funds, a result consistent with Gruber's [1996] findings.

Davis [2001] corroborates our conclusions reported in an analysis of the performance of active equity mutual funds using the Fama-French three-factor model. After controlling for factor sensitivities related to the market portfolio, market capitalization, and the ratio of book-to-market equity (or value/growth tilts), Davis [2001] also documents the inability of active funds to generate significantly positive risk-adjusted excess returns. These findings are consistent across all investment styles.

In terms of the security selection performance of active mutual funds derived from the TMEGB model (α_4^{SS}), additional evidence is presented showing that active funds underperform index funds. While income-oriented active funds in the eight-year period show evidence of risk-adjusted performance after costs approximating the return attributable to an index strategy, income equity funds are found to significantly underperform over the five-year horizon.

The potential influence of survivorship bias can also be observed for the active mutual fund sample by comparing the average eight-year and five-year risk-adjusted excess returns. Active funds over the eight-year period outperformed the sample of active funds in the five-year period, indicating the likelihood of positive bias in fund alphas represented in the eight-year sample period (or that fund alphas shifted to the right of the distribution).

CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

This study highlights the reasons tracking error is inherent in index fund performance. It evaluates the extent of S&P 500 index fund tracking error and compares active fund index and mutual fund performance.

Index funds experience difficulties replicating the returns of the target index because index managers face market frictions compared to an index that has no frictions and is calculated on the basis of holding a paper portfolio of index securities. There is seasonality in S&P 500 index mutual fund tracking error; tracking error is significantly higher in the months of January and May, and there is a seasonal trough in the quarters ending March-June-September-December.

Statistical evidence indicates that tracking error is both positively and significantly correlated with the dividend payments arising from constituent S&P 500 securities. There are also likely to be other determinants that explain tracking error variation, including the size and timing of adjustments to the S&P 500 index divisor.

The results of this study as to the performance of active mutual funds are consistent with the evidence in the literature. Active funds on average significantly underperform passive benchmarks. S&P 500 index mutual funds, on the basis of this research, earned higher risk-adjusted excess returns after expenses than large-capitalization-oriented active mutual funds in the period examined. One may therefore conclude that the S&P 500 is consistent with capital market efficiency.

These findings strongly suggest no economic benefit accrues to the average investor using actively managed equity mutual funds.

ENDNOTES

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[1]If index assets as a proportion of the total index increase, the average active investor must still earn the return on the underlying index, all things equal, so that active management remains a zero-sum game. The assumption is that active and passive investors select stocks from the same basket of securities; the only difference is their relative weighting.

[2]Another specific example of the growth in indexing is the total assets invested in the Vanguard 500 Index Fund. The Vanguard 500 grew from around $2 billion to over $100 billion in the period 1990-2000 to become the second-largest U.S. mutual fund.

[3]Alternative approaches to full replication involve either stratified sampling and optimization portfolio strategies. Stratified sampling and optimized portfolios are non-replication strategies designed to mimic the index through investment in a *subset* of index securities, while at the same time ensuring that the portfolio has similar risk and return characteristics as the index (e.g., risk attributes pertaining to size, industry, and dividend yield). The portfolio techniques index managers use will depend in part on the liquidity of the underlying index. S&P 500 index mutual funds predominantly adopt a full-replication approach.

[4]Tracking error is also commonly expressed in terms of the volatility (standard deviation) of return differences between the fund and the index (see Roll [1992]).

[5]Transaction costs for index mutual funds include both explicit costs (brokerage and taxes) and implicit costs (market impact and market bid-ask spreads). Opportunity costs are not a factor for index funds, as passive funds do not engage in information-motivated trading (see Keim and Madhavan [1998]).

[6]The Morningstar data set has the standard survivorship bias problem of the vast majority of performance evaluation studies. Performance records of funds ceasing to exist typically are removed from the database, as subscribing clients would find historical records of prior funds irrelevant. The survivorship bias for index mutual funds is expected to be slight for two reasons: 1) the limited evaluation period arising from the relative infancy of the index mutual fund market, and 2) by virtue of the strategy employed by index funds.

[7]While the Vanguard 500 index mutual fund was the first passively managed product offered to investors in 1976, the availability of these types of funds was extremely limited until the 1990s. The sample period both maximizes the number of funds included in the sample as well as provides a reasonable performance horizon for analysis. The criteria for inclusion of index mutual funds in the sample requires availability of 60 continuous months of performance data in the five-year period. Gruber's [1996] evaluation of index fund performance is similarly constrained because of the relatively short performance histories of index funds. Gruber's evaluation period for index mutual funds is the five years 1990-1994.

[8]Morningstar, Inc., reports returns after expenses (management fees, administration and 12b-1 fees, and other asset-based costs), but excluding brokerage costs. Morningstar reports that mutual fund expense ratios are accrued on a daily basis, ensuring minimal daily effects to a fund's net asset value (NAV).

[9]Roll [1992] notes that if an index fund consistently outperforms the index by x% per month, use of this method will result in zero tracking error. The converse is also the case. Pope and Yadav [1994] also warn of potential estimation bias in tracking error arising from the use of high-frequency data (i.e., daily or weekly data). They show that negative serial correlation in tracking error can bias the estimate of tracking error upward. The use of less frequent data (i.e., monthly) does not lead to significantly negative serial correlation in our analysis.

[10]Our bond factor does not account for high-yield bonds. The four-factor model has similar proxies (albeit with an additional factor) as the Fama-French three-factor model.

[11]Morningstar classifies equity mutual funds according to a fund's self-reported investment objective (aggressive growth, growth, growth and income, income) and according to investment style. First Morningstar ranks funds on the basis of market capitalization and valuation relative to the S&P 500 index. Investment style is then classified into a three-by-three matrix, with market capitalization on the vertical axis and valuation on the horizontal axis. Market capitalization is dichotomized into large, medium, and small, and the valuation category is split into value, growth, and blend (blend is a combination of value and growth).

The first criterion for inclusion in our sample requires equity funds to be classified as large-capitalization. All S&P 500 index funds are categorized as large-blend, so it is most appropriate that active funds are also selected from the large-cap category; active funds in the large-cap category are more likely to hold a greater proportion of S&P 500 stocks in their portfolios.

Second, each active fund's investment objective is evaluated to determine the appropriateness of applying the S&P 500 index as a performance benchmark. Third, active funds are eliminated when there are security selection limitations (such as if a fund is required to meet ethical and/or environmental criteria).

[12]The majority of S&P 500 index mutual funds in our sample employ a full-replication approach, which is not surprising, as stocks constituting the S&P 500 are highly liquid.

[13]See Brown et al. [1992] and Elton, Gruber, and Blake [1996b].

[14]Consistent with Pope and Yadav [1994], the annualized TE_2 metric is calculated by multiplying the standard deviation (employing monthly data) by $\sqrt{12}$.

[15]Exhibit 1 indicates that some index funds exhibited abnormal or extreme monthly absolute tracking errors in the period. Our seasonality analysis excludes an extremely small number of observations for three funds to help ensure seasonality was not significantly influenced by such outliers.

[16]The dividend component of returns is measured as the arithmetic difference between the S&P 500 composite index accounting for dividend and capital value changes (total return index) and capital value changes only (price index).

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[17]Index managers not permitted to use derivatives may use S&P 500 SPDRs, an exchange-traded security listed on the American Stock Exchange, to equitize cash and improve index tracking.

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