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Tracking S&P 500 Index Funds

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ABSTRACT

Index funds have grown significantly over the past decade, however empirical research concerning these passive investment offerings is surprisingly scarce in the literature. While the 'theory' and objectives of an index strategy are both simple and well known, potential difficulties arise for index managers attempting to replicate the returns of the target benchmark. The source of the problem is due to the underlying index being measured as a 'paper' portfolio and the implication that simple duplication is achievable without cost. However in reality, tracking error in index fund performance is unavoidable due to the existence of market frictions. This paper highlights the difficulties faced by index funds, examines both the magnitude and variation of tracking error over time for S&P 500 index mutual funds and provides a direct performance comparison between index and active mutual funds. This research documents S&P 500 index funds, on average, outperformed active funds after expenses over the sample period.

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INTRODUCTION

"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

This recent quote from *The Wall Street Journal* highlights both investors' and gamblers' psychology in their attempt to maximize the returns attributable to their respective activities. However, the implication of this statement 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. Indeed, Gruber [1996] highlights the apparent 'puzzle' surrounding the growth in actively managed mutual funds, where investors have directed significant mutual fund flows into the sector. In addition, the Investment Company Institute reported significant growth in U.S. stock mutual funds over the last calendar year. Net new cash flows increased to a record $309 billion as at December 2000, with the vast majority of net new money allocated to active funds. This preference in favour of active funds has continued despite the large volume of empirical evidence indicating active funds do not earn abnormal returns. While Zheng [1999] documents evidence of a 'smart-money' effect in the short-term, where new money flows predict future performance, in aggregate active funds with positive new money flows do not beat the market. In addition, despite performance persistence being well documented in the literature, Carhart [1997] finds the phenomenon is almost completely attributable to common factors in stock returns and investment expenses rather than superior portfolio management ability.

The rationale behind the average investor allocating 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. William F. Sharpe [1991] asserts in the 'Arithmetic of Active Management' that on average, active managers cannot outperform 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 received by active funds in the performance evaluation literature, empirical research evaluating index funds is surprisingly scarce. This is even more perplexing when one considers U.S. stock-index mutual funds and other index portfolios accounted for more than $1.5 trillion in assets at 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. reported that indexed assets represented about 12 percent of total assets at December 2000, compared to around 5 percent in 1995. In terms of index mutual fund offerings, Morningstar Inc. tracked 190 index mutual funds at 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 at December 2000.

While the 'theory' and 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 which are likely to influence the magnitude of index fund tracking error, however the primary source of the problem is due to the underlying index being 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 existence of market frictions facing index managers. Therefore, the secondary objective for index managers involves managing these constraints so as to minimize the divergence in performance from the underlying benchmark index.

This 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 (known as a 'full replication' strategy).[3] However in reality, fund managers adopting an indexing approach cannot be guaranteed their portfolios' performance will be identical to the benchmark index. This is due to the fact that 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. However, index fund managers cannot make the same assumptions, as physical trading in index stocks will be required in order to re-align the portfolio to mimic the underlying benchmark. Market frictions in the management of passive portfolios ensure that tracking error, measuring the differences in returns between the portfolio and the index, must be minimized in order that an index fund's objectives are not significantly compromised.[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. 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.[5] 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. 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 comprising 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. Periodical 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 re-align 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 which minimizes the crystallization of capital gains tax liabilities to avoid significant erosion of returns. In the case of securities which are subject to corporate restructuring, such as a merger or takeover by another company outside the index, a timing delay may exist between the date when the index fund receives the cash

settlement and 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, *ceteris paribus*, index volatility should not result in tracking error. However, where 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 comprising the index. Dividends may also cause tracking error in performance where 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 'dividend effect' may be minimized by index managers through participation in dividend reinvestment plans, however it is generally uncommon for S&P 500 constituent securities to distribute dividends in the form of new securities. Where an index assumes that dividends are 'smoothed', the dividend effect may cause index managers to incur tracking error in their performance.

While tracking error will be inherent in index fund performance, investors reasonably expect index fund returns will only underperform the underlying index by a similar magnitude to 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 this philosophy may exist. Firstly, the overwhelming majority of performance evaluation studies over the last three-and-a-half decades have confirmed empirically the inability of active mutual funds to outperform market indices (for example, Elton *et al.* [1993], Malkiel [1995] and Gruber [1996]). Secondly, 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 larger affect on future capital gains tax liabilities, which further diminishes after expenses and after tax performance.

ANALYSIS OF S&P 500 INDEX FUND TRACKING ERROR

The study uses a sample of 42 S&P 500 index mutual funds contained on the *Morningstar Principia Pro* CD-ROM in measuring tracking error.[6] The analysis period spans the five years to February 1999, and while relatively short, is limited due to data availability arising from the relative infancy of the index mutual fund market.[7] The five-year time-frame 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, the index fund returns have been adjusted with reference to the reported historical fund expenses ratios in order to approximate gross returns.[8] All S&P 500 index funds are classified by Morningstar as exhibiting a growth-and-income prospectus objective, which is consistent with a passive, style-neutral strategy. Funds under management for the sample grew from $US18.0 billion as at December 1993 to more than $US161 billion as at 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 at February 1999.

Roll [1992], Pope and Yadav [1994] and Larsen and Resnick [1998] identify a number of ways in which tracking error can be measured. In this study, tracking error is measured using three methods. First, tracking error in month t is calculated as the absolute difference in returns of the index portfolio and 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:

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

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 ($TE_{2,p}$) and 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:

$$R_{pt} = \alpha_i + \beta_i R_{bt} + \varepsilon_{pt} \quad (3)$$

While this method should provide similar results to (2), Pope and Yadav [1994] note that if the beta is not exactly equal to one, then 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, then this approach will overstate tracking error.

TESTS FOR SEASONALITY IN INDEX FUND TRACKING ERROR

This study evaluates the potential existence of seasonality in index fund tracking error. The financial economics literature has documented the existence of seasonality in both stock returns and market bid-ask spreads, particularly the infamous 'January effect'. The existence of 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 where stocks go ex-dividend or in months of abnormal volatility. Seasonality in mean monthly tracking error is tested using the following dummy variable OLS regression:

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

Where:

π_1 = the intercept of the regression model measuring the average absolute tracking error in month of January;

D_{it} = seasonal dummy variable for calendar month *i;*

i = February,…, December;

ε_{it} = 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 respective 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 (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 A) and three risk-adjusted performance models (methods B, C and D) where returns are measured in excess of the risk free rate (or return in excess of T-bills). These methodologies are described below:

(A) The raw returns approach (ignoring risk adjustment in performance), which measures the contribution of value added or lost by the fund relative to the S&P 500;

(B) The single index model, where fund risk-adjusted excess returns (in excess of Treasury bills) are estimated 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);

(C) The Elton, Gruber and Blake [1996a] four-index model:

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

where 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 indices 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 *et al.* [1996a] advocate the use of additional indices due to potential sensitivity of fund performance to the choice of benchmark used. The additional indices also capture risk characteristics with respect to mutual fund investment style as well as accounting for non-S&P 500 securities that may comprise part of an active fund's portfolio. These additional benchmarks improve the quantification of portfolio risk.

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

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

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.

Index mutual fund performance is measured using methods A and B 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 C and D are not appropriate performance models with which to assess index fund performance and are not considered in the analysis.

The performance of active and index mutual funds are evaluated after expenses. The study evaluates active funds classified by Morningstar within the large-capitalization category, as these funds are the most appropriate in directly comparing active fund performance relative to S&P 500 index funds.[11] All funds comprising the sample were required to have continuous performance histories over the respective observation periods. Performance is analyzed using two sample periods; the first evaluation horizon is the 8-year period to February 1999 and the second period is the 5-years to February 1999. The 8-year horizon contains a sample of 343 active and 15 index mutual funds while the 5-year sample evaluates 607 active and 42 index mutual funds. The shorter 5-year period was performed in an attempt to increase the sample of index funds and hence aid performance comparisons against active funds. Overall, both evaluation periods are somewhat constrained due to the limited number of index mutual funds available in the Morningstar database, however the analysis permits sufficient comparison between active and passive portfolio management.

The analysis was also performed with reference to the Morningstar prospectus descriptions over time which permitted funds to be partitioned on 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, income).[12]

The Morningstar data set has the standard survivorship-bias problem contained in the vast majority of performance evaluation studies, where funds ceasing 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 magnitude of tracking error and risk-adjusted performance of index mutual funds comprising the sample. The cross-sectional average $TE_{1,p}$ is equal to 5.9 basis points per month and is in the range of 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 annum. $TE_{2,p}$ 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 problematic. 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 tracking error over

time is inherent in performance, however, the overall performance objectives of index funds are not compromised.

<<INSERT EXHIBIT 1 ABOUT HERE>>

Exhibits 2A and 2B presents 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 lowest in June. The existence of a strong quarterly pattern (trough) 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 followed by sharp reversals in each of the subsequent months, 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 in this study) also appears to support the quarterly seasonal pattern of a trough in tracking error in the months of March to December as well as significantly higher tracking error for index funds in January compared with other months.

EXHIBIT 2A – DUMMY VARIABLE 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

<<INSERT EXHIBIT 2B ABOUT HERE>>

There are a number of factors that may explain the seasonality phenomenon of tracking error for index mutual funds.[15] In particular, 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.[16] The month of May is particularly pronounced, followed by November, August and February respectively. Constituent dividend-paying securities in the S&P 500 are assumed to reinvest dividends at the ex-dividend date, however 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 makes perfect replication of the S&P 500 unachievable, and consequently tracking error arises.

An empirical examination of the role of dividend payments reveals strong statistical evidence of a dividend effect driving the sharp increases in index mutual fund tracking error. The dividend effect is particularly pronounced in May. This coincides with the same month exhibiting 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 2B can therefore be interpreted as index mutual fund managers experiencing tracking error when stocks go ex-dividend, however 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 be related to 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 pre-announces 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. Theoretically, tracking error may be related to S&P 500 index changes. The magnitude of tracking error is likely to be dependent on the relative market capitalization weights of stocks added or removed from the S&P 500 in the period.

Tracking error for index mutual funds may also be significantly higher in January due to 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, the existence of tax-related selling in December could also potentially drive the high tracking error recorded in the month of January.[17] Indeed, further research is warranted with respect to the determinants of tracking error in S&P 500 index fund performance.

Exhibit 3 presents the after expenses performance of active and index mutual funds. As expected, index funds earn significantly negative raw and risk-adjusted excess returns, where 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. In terms of performance comparison relative to active funds, Exhibit 3 indicates 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 the average active mutual fund significantly underperforms. While index mutual funds also have significantly negative alpha (α_1), the magnitude 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 8-year and 5-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, and this result is consistent with Gruber's [1996] findings. Davis' [2001] recent study corroborates the conclusions reported in this paper, where the performance of active equity mutual funds was evaluated with respect to the Fama-French three-factor model.[18] 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 were consistent across all investment styles.

<<INSERT EXHIBIT 3 ABOUT HERE>>

In terms of the security selection performance of active mutual funds derived from the TMEGB model (α_4^{SS}), additional evidence is presented showing active funds underperform index funds. While income-oriented active funds in the 8-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 5-year horizon. The potential influence of survivorship bias can also be observed for the active mutual fund sample by comparing the average 8-year and 5-year risk-adjusted excess returns. Active funds over the 8-year period outperformed the sample of active funds comprising the 5-year period, indicating the likelihood of positive bias in fund alphas (or fund alphas having shifted to the right of the distribution) represented in the 8-year sample period.

CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

This study highlights the reasons why tracking error is inherent in index fund performance, empirically evaluates the magnitude of S&P 500 index fund tracking error and compares the performance of active funds relative to index mutual funds. Index funds experience difficulties replicating the returns of the target index due to market frictions faced by index managers compared with an index that has no frictions and is calculated on the basis of holding a 'paper' portfolio of index securities. Seasonality in S&P 500 index mutual fund tracking error is demonstrated, where tracking error is significantly higher in the months of January and May, together with a seasonal trough in the quarters ending March-June-September-December. Statistical evidence indicates 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. Future research is already well under way with respect to tracking error determinants and the existence of seasonality.

The results of this study concerning the performance of active mutual funds are consistent with the evidence presented 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 the S&P 500 is consistent with capital market efficiency. These findings strongly suggest an absence of economic benefit accruing to the average investor utilizing actively managed equity mutual funds.

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

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.

S&P 500 Index Mutual Fund	Absolute Difference in Returns							Return Differences		S.C.C.	S.E.R.	S.I.M. Parameters		
	Mean	SD	Min	Q1	Q2	Q3	Max	Mean*	SD	ρ (1)*	Error	α*	β	R^2
	(TE_1)								*(TE_2)*		*(TE_3)*			
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 Idx	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 Idx	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 Idx 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 Idx	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 Idx	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 Indx 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 Indx 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 Idx 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
One Group Equity Index I	0.057	0.049	0.005	0.021	0.044	0.081	0.252	0.003	0.075	-0.085	0.067	0.016	0.991	1.000
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

* 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 the 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 approximates unity.

EXHIBIT 2B – AVERAGE S&P 500 INDEX MUTUAL FUND TRACKING ERROR (TE_1) AND AVERAGE DIVIDEND COMPONENT RETURN ON THE S&P 500 OVER CALENDAR MONTHS: 1994 – 1999 (IN PERCENTAGE TERMS PER MONTH)

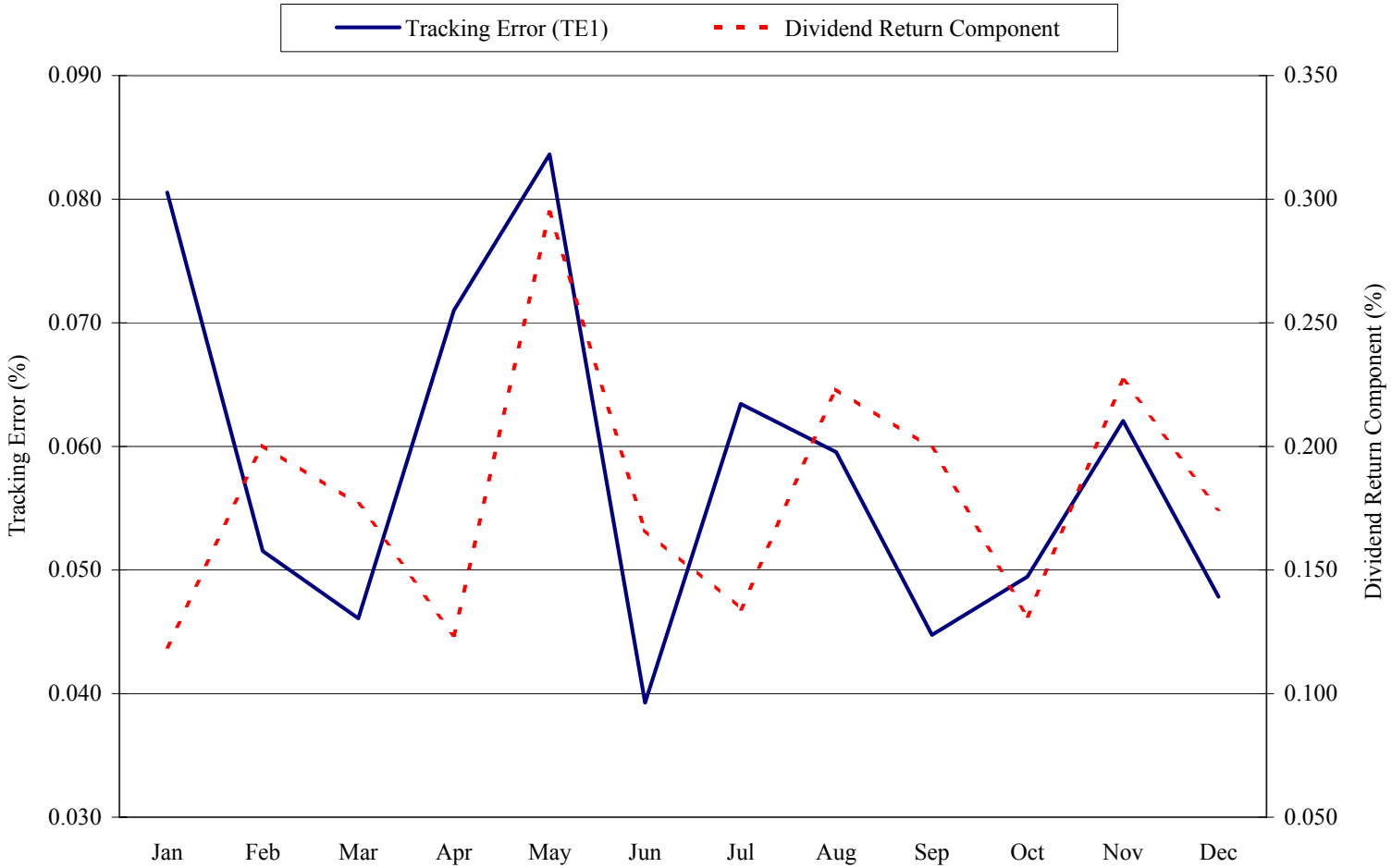

EXHIBIT 3 – PERFORMANCE COMPARISON BETWEEN ACTIVE AND INDEX S&P 500 MUTUAL FUNDS

Returns are expressed in percentage terms per month after expenses.

	$R_p - R_b$	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	-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	-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	-0.044	0.916	-0.170 ***
Active - Aggressive	-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	-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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END NOTES

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[1] If index assets as a proportion of the total index increases, *ceteris paribus*, the average active investor must still earn the return on the underlying index, such that active management remains a zero sum

game. The assumption is active and passive investors select stocks from the same basket of securities, with the only difference being 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 on the other hand 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 technique employed by index managers will in part be dependent upon 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 non-existent 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 contained in the vast majority of performance evaluation studies. Funds ceasing to exist typically have their performance records removed from the database, as subscribing clients would find historical records of prior funds irrelevant. However, in terms of survivorship bias for index mutual funds, the bias is expected to be small 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 1990's. The sample period adopted both maximized the number of funds included in the sample as well as providing a providing reasonable performance horizon for analysis. The criteria for inclusion of index mutual funds in the sample required availability of 60 continuous months of performance data in the 5-year period. Gruber's [1996] evaluation of index fund performance was similarly constrained due to index funds having relatively short performance histories. Gruber's evaluation period for index mutual funds was the five years 1990-1994.

[8] Morningstar Inc. reports returns after expenses, which account for management fees, administration and 12b-1 fees and other asset-based costs, but excludes 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, however, that if an index fund consistently outperforms the index by x percent per month, then the 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 upwards the estimate of tracking error. The use of less frequent data (i.e. monthly) does not lead to significantly negative serial correlation in our analysis.

[10] See Elton *et al.* [1996a] for an extensive description of the market capitalization, growth-value and bond indices used in their model. Our bond factor did not account for high-yield bonds. The four-index model has similar proxies (albeit with an additional factor) to the Fama-French three-factor model.

[11] Morningstar classifies equity mutual funds on the basis of a fund's self-reported investment objective (aggressive growth, growth, growth and income, income) and according to investment style. In terms of investment style, 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 where market capitalization is represented 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' (where blend is a combination of value and growth). The first criteria for inclusion in the sample required equity funds to be classified within the large-capitalization category. All S&P 500 index funds are categorized within Morningstar's large-blend category, hence it is most appropriate that active funds are also selected from the large-cap category. This is due to active funds in the large-cap category being more likely to hold a larger proportion of S&P 500 stocks in their portfolios. Second, each active fund's investment objective was evaluated to determine the appropriateness of applying the S&P 500 Index as a performance benchmark. Third, active funds were

removed where security selection limitations existed (for example, if the fund was 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 comprising the S&P 500 are highly liquid.

[13] See Brown, Goetzmann, Ibbotson and Ross [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 excluded 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).

[17] Index managers not permitted to use derivatives may use S&P 500 'Spiders', an exchange-traded security listed on AMEX, to equitize cash and improve index tracking.

[18] We thank the anonymous referee for drawing our attention to this paper after our study was submitted for review in August 2000. This research contributes to the literature by providing a direct performance comparison between active and index mutual funds.