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Is Index Performance Achievable?: An Analysis of Australian Equity Index Funds.

This paper examines the performance of index equity funds in Australia. Despite the significant growth in index funds since 1976, when the first index mutual fund was launched in the U.S., research on their performance is sparse in the US and non-existent in Australia. This study documents the existence of significant tracking error for Australian index funds. For example, the magnitude of the difference between index fund returns and index returns averages between 7.4 and 22.3 basis points per month across index funds operating for more than 5 years. However, there is little evidence of bias in tracking error implying that these funds neither systematically outperform or underperform their benchmark on a before cost basis. Further analysis documents that the magnitude of tracking error is related to fund cash flows, market volatility, transaction costs and index replication strategies used by the manager.

Key words: Benchmark index; Index fund; Tracking error; Investment performance

Literature based on U.S. markets widely confirms the inability of active mutual funds to outperform passive benchmarks or indices such as the S&P 500 (Jensen 1968, Grinblatt and Titman 1989b, Elton, Gruber, Das and Hlavka 1993, Malkiel 1995, Gruber 1996, Carhart 1997 and Edelen 1999). The findings of Australian studies are consistent with the U.S. evidence (Bird, Chin and McCrae 1983, Robson 1986, Hallahan and Faff 1999, Sawicki and Ong 2000). Unlike active funds, which aim to *outperform* their benchmark index, passive or index funds aim to *replicate* the performance of the benchmark. While prior research on the performance of active investment funds is extensive, there exists a critical gap in the literature with respect to the performance of passive funds. Such literature is limited to Gruber (1996) and Frino and Gallagher (2001).[1] Gruber (1996) examines the performance of a sample of U.S. index funds between 1 January, 1990 and 30 December, 1994, and documents that they underperform the index by approximately 0.202 percent per annum on an after-cost and risk-adjusted basis. Frino and Gallagher (2001) extend the analysis to a

sample of 42 U.S. index equity funds between 1 March, 1994 and 28 February, 1999, and documents that they underperform the index by approximately 0.29 percent per annum on an after-cost and risk-adjusted basis, and the magnitude of the difference between index fund performance and their benchmark averages between 0.039 and 0.110 percent per month before costs. The main objective of this study is to extend previous research by documenting the performance of Australian equity index funds.

Since the aim of index funds is to replicate the performance of an index, then the difference between the return on a benchmark index and return on an index funds' portfolio (or *tracking error*) can be used to evaluate their performance. Tracking error in the performance of index funds is likely to arise from the difficulties inherent in management of passive portfolios. Theoretically, the management of an index portfolio is straightforward, requiring passive fund managers to hold each constituent index security in the same proportion to the benchmark (known as a 'full replication' strategy). In reality, index funds will experience considerable difficulty in replicating the target index, because the index represents a mathematical calculation that does not take into account market frictions. For example, index funds must physically transact in index securities in order to replicate the returns of the benchmark thereby incurring transaction costs and imparting price pressure. However, the calculation underlying the index assumes costless re-balancing may occur at any time at prevailing market prices. Chiang (1998) identifies that transaction costs, index composition changes, corporate activity, fund cash flows, index volatility and the reinvestment of dividends are the main factors which give rise to tracking error in index fund performance. The existence of these factors is the main motivation for the research reported in this paper. The primary aim of this research is to document the magnitude of tracking error in the returns generated by Australian equity index funds as a consequence of

these factors. This research also extends previous US based research by assessing the significance of these factors in explaining the magnitude of tracking error.

In the U.S. the first index mutual fund was launched in 1976 by Vanguard Group Inc., however it has only been in the last decade that indexing has grown significantly (Gruber 1996; Frino and Gallagher 2001). In Australia, indexing has also grown substantially in terms of the size of funds under management. The amount of assets passively managed by Australian institutions as at September 2000 was reported by Rainmaker Information to be around $A75.9 billion, or 11 percent of the Australian investment management industry [Rainmaker Information, 2000]. In addition, an April 2000 survey by one the Australian superannuation industry's journals, *Superfunds*, reported total assets indexed was around $A57.4 billion, representing an increase of 42 percent since the previous year.[2] The research reported in this paper is therefore also motivated by the significance and growth of index funds in Australia.

While the primary aim of this study is to provide an understanding of the difficulties and performance of a new and growing type of investment fund *per se*, the analysis also provides evidence relevant to two other issues in the funds management performance evaluation literature. To date, the literature documents that active funds do not outperform appropriate benchmark indices, and suggests passive funds represent an appropriate alternative (eg. Malkiel, 1995; Elton Gruber and Blake, 1996). However, this argument implies that index funds are able to achieve their performance objectives. Given the difficulties faced by index funds, and the likelihood of tracking error, this study provides new evidence relevant to assessing the merits of an active versus passive investment strategy. The performance evaluation literature also identifies the importance of employing appropriate benchmark indices in the evaluation of fund performance. For example, Elton et al.

(1993) show Ippolito's (1989) findings of superior performance for active U.S. mutual funds is attributable to an incorrectly specified benchmark. If index funds exhibit significant tracking error, then this implies that replication of index returns is problematic. This in turn may cast doubt on the appropriateness of an index as a technical benchmark in performance evaluation. The results of this study are also relevant to this issue. The following section discusses the difficulties faced by passive fund managers in achieving their objective (index returns), and identifies a number of variables that are likely to be related to tracking error in passive fund performance.

THEORY

The objective of a passive or index fund is to replicate the return on a benchmark index. This is typically achieved by holding a portion of the theoretical portfolio of securities underlying the benchmark index, or some other portfolio that mimics the returns on the index. An index is an arithmetic calculation measuring changes in the value of a group of securities within a particular asset class. The calculation of an index ignores market frictions in the sense that when the security weights within the index change, the index implicitly assumes that re-balancing of securities to reflect the new market weights can occur costlessly, instantaneously, and at prevailing market prices. However, index funds face a number of market frictions in attempting to mimic the index portfolio, or more specifically, returns on the index. These frictions can ultimately result in tracking error. Chiang (1998) identifies that transaction costs, client related cash flows, the treatment of dividends by the index, the volatility of the benchmark and changes in the composition of the index may all contribute to tracking error. Tracking error may also differ across index funds as a

consequence of the portfolio strategy adopted in attempting to replicate the performance of the index. Each of these factors is discussed below.

Explicit costs associated with trading in securities markets, including brokerage fees and stamp duty, can influence the ability of passive funds to replicate index performance. The index itself is calculated as a 'paper' portfolio, which assumes transactions can occur costlessly (see Perold, 1988). In reality, passive funds incur explicit costs associated with transactions relating to client capital flows. For example, cash flow movements cause flow-induced trading for passive funds, requiring new cash to be invested across index securities or part of the portfolio to be liquidated. Apart from cashflow induced trading, index funds also trade regularly for a variety of other reasons, associated with strategy implementation. Because index funds are required to trade, explicit transaction costs are incurred. These costs erode the value of the index fund by the amount of the explicit costs and lead to tracking error in performance measured after management expenses.[3] Funds also incur implicit transaction costs in trading, including bid-ask spreads and the price impact of trading (Perold and Sirri 1994). These will also cause tracking error in performance measured before management expenses. Transactions by passive funds can cause temporary demand and supply imbalances, which implies that they are not able to trade instantaneously at prevailing market prices (Chan and Lakonishok 1993, Perold and Sirri, 1994). Overall, this implies that client related cashflow movements and the implicit costs of trading, such as bid ask spreads, are likely to be related to the magnitude of tracking error.

Another factor likely to be related to tracking error is the volatility of the underlying benchmark index. If the composition and weighting of stocks held by an index fund perfectly match those of the index, changes in the value of the index fund portfolio should match changes in the benchmark index. However, at any point in

time, the composition of the portfolio of a passive fund is unlikely to be perfectly aligned with the index portfolio for a number of reasons. For example, most index fund managers are likely to use some form of proxy portfolio because the smaller, less liquid, stocks in the underlying index are more difficult to acquire. Other funds explicitly aim to hold an imperfect proxy portfolio with the objective of minimising the costs of assembling a portfolio to track the underlying index. New client cash inflows may also take time to be invested in the funds' desired portfolio, especially those involving less liquid stocks. As a result, unsystematic movements in the stocks underlying an index that are not in a passive fund managers portfolio will result in tracking error. Similarly, unsystematic movements in the overweight stocks in a fund managers portfolio relative to the index portfolio will also cause tracking error. Consequently, higher benchmark index volatility is likely to be associated with higher tracking error.

Tracking error can also arise from dividends paid by stocks in the index. When a listed company in an index goes ex-dividend, the index effectively assumes that the dividend is re-invested in the stock from which it is derived on the ex-dividend date. However, investors (including passive funds) experience a significant time delay, which normally extends into weeks, in receiving cash in relation to a dividend. As a consequence, tracking error can occur for two reasons. First, there are transaction costs associated with re-investing the dividends once received, and these erode the value of the passive funds portfolio. In contrast, the index assumes that the proceeds from the dividend payment are re-invested costlessly at the prevailing market price. Second, the fund manager must wait for receipt of cash in relation to dividends prior to being able to re-invest it. Hence, there is likely to be a positive relationship between the level of dividends paid by stocks in an index and passive fund tracking error.

Tracking error may also be related to changes in the composition of the benchmark index. These include periodical index adjustments related to company additions and deletions, capitalisation changes and corporate restructuring. Fund managers may need to trade in order to adjust their portfolios to properly track the index following such changes. Transaction costs are also incurred in this trading which can also increase tracking error. Depending on the relative size of the stocks entering and exiting the index (in terms of market capitalization), these changes may also require a number of costly 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 that minimizes the crystallization of capital gains tax liabilities to avoid significant erosion of returns. In the case of corporate corporate restructuring, tracking error can also arise when index securities are involved in a merger or takeover by another company outside the index (Chiang 1998). For example, a timing delay may exist between the date on which the index fund receives the cash settlement and the date when the target firm is removed from the index. Periodical changes to the index can also make it difficult (and costly) for a passive fund to replicate the benchmark index.[4] Beneish and Whaley (1996) and Chiang (1998) identify that 'front-running' by market participants, who acquire index securities ahead of their inclusion in a benchmark, can have an undesirable impact on index funds.[5] Ultimately, changes in the composition of the index require passive funds to trade, which can result in transaction costs and tracking error. Overall, changes in the composition of the index are also expected to cause tracking error.

The magnitude of tracking error may differ across index managers depending on the portfolio management approach used to replicate returns on the index. The different approaches can be classified into 'full replication', 'stratified sampling' and

'optimisation' strategies.[6] Full replication strategies require that index funds hold *all* securities in the basket index in the same proportion as represented in the index. Stratified sampling and optimised 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 the portfolio has similar risk and return characteristics as the index.[7] Non-replication strategies aim to minimise transaction costs compared with full replication strategies, however, the trade-off is potentially higher tracking error arising from the performance of excluded securities which comprise the underlying index (Olma 1998). Optimised portfolios are constructed using highly quantitative, multi-factor risk models aimed at minimising tracking error through an understanding of the covariance between factors driving asset returns (Liu, Sheikh and Stefek 1998, and Olma 1998). The expectation, *ceteris paribus*, is that tracking error will be systematically lower for full replication index funds compared with non-replication index funds.

The theoretical discussion above implies tracking error is likely to be related to cash flows and implicit transaction costs, index volatility, dividend distributions, changes in the composition of the benchmark index and the portfolio management strategy adopted by index managers. This paper empirically documents the magnitude of tracking error experienced by index funds, as well as assessing the significance of these factors in explaining the magnitude of tracking error.

DATA

This research analyses the tracking error of all Australian equity index fund managers with at least one index fund benchmarked to the All Ordinaries Accumulation Index over the period July 1989 to March 1999. The monthly Australian equity index fund returns were initially obtained from asset consultant William M. Mercer Pty Ltd. and

were subsequently checked against the returns supplied directly by the investment managers.[8] Performance of the funds includes both income returns and capital changes. The investment objective of the seven pure index funds examined involves replicating the performance of the All Ordinaries Accumulation Index. The investment managers also provided monthly cash flow data, fund size data and information concerning the portfolio strategy adopted by the fund (i.e. full replication, stratified sampling and optimisation). The Securities Industry Research Centre of Asia-Pacific (SIRCA) provided market bid-ask quote data for all stocks listed on the Australian Stock Exchange, as well as a database of stocks included and excluded from the All Ordinaries Index over the period evaluated.

There are seven index funds examined in this study. Of these, three use full replication portfolio management strategies and the remaining four passive funds use stratified sampling and/or optimisation methods in order to mimic index returns. The combined assets of the index funds in this study is approximately $A5.0 billion as at 31 March 1999. The study is free of survivorship bias.[9]

METHOD

The performance evaluation literature has predominantly evaluated the risk-adjusted performance of actively managed funds in assessing their ability to outperform market indices. The three classical performance evaluation techniques typically employed by prior studies have involved the Sharpe Ratio (1966), Jensen Measure (1968) and Treynor Index (1965). These approaches are consistent with attempting to determine whether active funds meet their investment objective, which is to *outperform* the benchmark. Index fund strategies differ to actively managed funds in that passive

funds aim to *replicate* the return and risk of the underlying benchmark index (Keim 1999). If an index manager is unable to perfectly replicate the returns on a benchmark index (i.e. it experiences tracking error), then this is *prima facie* evidence that an index fund is not meeting its investment objective. Roll (1992) also argues that the level of tracking error in performance is an important criterion for assessing fund managers (both active and passive) performance. This is because the variability of a fund's differential returns provides the performance analyst with a level of statistical confidence that the manager's investment process has been implemented successfully. For these reasons, this paper investigates the ability of index funds to exactly mirror the performance of the underlying index to which they are benchmarked – their tracking error.

Measures of the Magnitude of Tracking Error

Tracking error represents the extent to which the performance of a fund differs from the underlying benchmark index (Roll, 1992). Pope and Yadav (1994) identify a number of different ways tracking error may be measured. These are (1) the average of the absolute difference in returns between the fund and index, (2) the standard deviation of return differences between the fund and index, and (3) the standard error of a regression of fund returns on benchmark returns. All of these measures are applied in this study.

Tracking error measured as the average absolute difference in returns ($TE_{1,p}$) is calculated as follows:

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

where:

$e_{pt} = R_{pt} - R_{bt}$

R_{pt} = the return of index portfolio p in period t;

R_{bt} = the return of the benchmark index b in period t; and

n = the number of observations in the period.

This definition of tracking error provides a measure of the extent to which the returns on portfolio p differ from the returns on the underlying benchmark index b over the sample period. This definition treats any deviation in returns (outperformance or underperformance of the index portfolio) as tracking error.

Tracking error measured as the standard deviation of return differences between the fund and index is measured as follows:

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

It is important to note, however, if an index fund consistently underperforms the index by x percent per month, then the use of this method will result in zero tracking error over the period (Roll 1992). The converse is also the case and would provide different conclusions concerning tracking error relative to ($TE_{1,p}$). The well-known market model can also be used to generate an estimate of tracking error ($TE_{3,p}$). If the returns on the index funds portfolio p are regressed on the returns on the benchmark index b, as follows:

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

the standard error of the regression equation (the volatility of residuals (ε_{pt}) around the regression line) represents an estimate of tracking error. While this method should provide similar results to (2), Pope and Yadav (1994) identify that if the beta of a portfolio is not exactly equal to one, then the regression residuals will differ from the tracking error metric $TE_{2,p}$. If the relationship between the two sets of returns is non-linear, then this approach will overstate tracking error.[10]

Measures of Bias in Tracking Error

The tracking error metrics above are concerned with the *efficiency* with which funds are able to track the All Ordinaries Accumulation Index, however, they do not indicate if there is a *bias* in performance. That is, they do not determine whether passive funds systematically underperform (or indeed outperform) the index. This paper assesses whether there is any bias in the performance of passive funds using two measures. First, the variance or standard deviation statistic is a traditional measure of the efficiency of an estimate, while the expected or mean value can be used to assess bias (Gujarati, 1995, p. 781). Analogously, in addition to examining the standard deviation of return differences ($TE_{2,p}$) to assess the efficiency of passive fund performance in tracking the index, the average difference in the return on the index fund and return on the index is examined to assess bias. Second, given that the objective of pure index funds is to mimic the performance of the All Ordinaries Accumulation Index, the coefficient α in the market model (equation 3) is expected to be zero and $\beta = 1$. Hence, the significance of the α coefficient is also examined for evidence of bias in tracking error.

Determinants of Tracking Error

The theory section identifies cash flows, transaction costs, index volatility, dividends, changes to the composition of the index and the index replication strategy employed by index equity funds (i.e. full replication and non-replication approach) as potential determinants of tracking error. To test the significance of these variables in explaining tracking error, the following model is estimated:

$$\left|e_{pt}\right| = \alpha_i + \beta_1 CF_{pt} + \beta_2 SPR_t + \beta_3 VOL_t + \beta_4 DIV_{pt} + \beta_5 INOUT_t + D_6 FR_{pt} + \varepsilon_{it} \qquad (5)$$

where $\left|e_{pt}\right|$ is the absolute value of tracking error in period *t* for fund *p*, CF represents the absolute value of the funds net monthly cash flow scaled by the index fund's size (or normalised cash flow as per Gruber 1996) and SPR is the market capitalisation-weighted and time-weighted average bid-ask spread across securities in the index in percent (see McInish and Wood, 1992). VOL measures the volatility of the All Ordinaries Index and DIV is the dividend yield of securities comprising the index.[11] INOUT measures the percentage market capitalisation of stocks included and excluded from the All Ordinaries Index each month.[12] FR is a dummy variable taking on a value of 1 if observation *t* is drawn from a full replication fund, otherwise 0.

RESULTS

The tracking error and risk-adjusted performance of index equity managers evaluated in this study are reported in Table 1 together with a number of other descriptive statistics. Panel A of Table 1 reports the magnitude of tracking error for the entire sample period available for each fund. Based on $TE_{1,p}$ the magnitude of monthly

tracking error ranges from an average of 0.03 percent to 0.242 percent across funds. There is also evidence of considerable variability in tracking error for each fund through time. For example, tracking error for fund VI ranges between 0.001 percent and 1.069 percent across months. Given that differences in average tracking error are likely to be driven by time specific factors, the tracking error metrics in Panel A are not strictly comparable across funds because of the differences in sample periods. Panel B reports tracking error metrics for the 4 funds with 60 months (5 years) of continuous data to March 1999. The magnitude of monthly tracking error based on $TE_{1,p}$ still exhibits considerable variability across funds ranging from an average of 0.074 percent for fund III to 0.223 percent for fund VI. Monthly tracking error based on $TE_{2,p}$ is similar in magnitude ranging from ranging from 0.097 percent for fund III to 0.285 percent over the funds with 60 months of continuous data in Panel B. Finally, measures of tracking error based on $TE_{3,p}$ are almost identical to those based on $TE_{2,p}$.

While the magnitude of the tracking error documented in Table 1 is small, a number of observations can be drawn. First, Frino and Gallagher (2001) find that the tracking error for a sample of US index funds averages between 0.039 and 0.110 percent per month. The comparable figures for Australian Index funds documented in this paper are substantially higher, ranging between 0.074 and 0.224. Hence, passive funds in Australia appear to have greater difficulty in achieving index returns. This reflects, in part, the higher cost of trading the underlying portfolio of stocks in Australia.[13] Second, a recent survey of Australian pooled index equity funds suggests that management fees range from approximately 0.005 percent to 0.017 percent per month (William M. Mercer, 1999). Hence, the tracking error documented in this study, which is an implicit cost of investing in index funds, is many times greater than the explicit cost charged by the fund manager to investors (i.e. the management fee).

Third, the average magnitude of the monthly movement in the All Ordinaries Accumulation Index over the five-year period examined in this study was 2.93 percent. Hence, tracking error ranging between 0.074 and 0.223 ($TE_{1,p}$) represents between 2.5 percent and 7.6 percent, respectively, of the average magnitude of the movement in the benchmark.

TABLE 1

INDEX EQUITY FUNDS - TRACKING ERROR AND RISK ADJUSTED PERFORMANCE

Fund	Strategy	N	Absolute Difference in Returns							Differences in Returns			Market Model Parameters				
			Mean	SD	Min	Q1	Q2	Q3	Max	Mean	*t*-stat	SD	S.E. Reg.	α	*t*-stat	β	R^2
			$(TE_{1,p})$									$(TE_{2,p})$	$(TE_{3,p})$				
*Panel A: All Index Funds Since Inception to March 1999 (Monthly Data)**																	
I	FR	10	0.030	0.024	0.003	0.010	0.026	0.052	0.071	-0.002	-0.18	0.040	0.041	-0.001	-0.05	0.998	1.000
II	FR	117	0.120	0.113	0.000	0.046	0.104	0.163	0.781	0.006	0.36	0.165	0.167	0.006	0.37	1.000	0.998
III	FR	80	0.112	0.122	0.001	0.030	0.076	0.152	0.797	-0.023	-1.24	0.164	0.165	-0.025	-1.35	1.004	0.998
IV	O,S	36	0.122	0.122	0.000	0.036	0.086	0.173	0.556	0.036	1.27	0.170	0.172	0.034	1.16	1.003	0.998
V	O,S	60	0.103	0.094	0.003	0.039	0.085	0.135	0.480	0.017	0.96	0.139	0.137	0.014	0.79	1.006	0.999
VI	O	63	0.242	0.205	0.001	0.079	0.210	0.374	1.069	0.000	-0.01	0.319	0.315	0.007	0.17	0.982	0.993
VII	O	21	0.104	0.111	0.001	0.042	0.071	0.157	0.466	0.018	0.53	0.153	0.157	0.019	0.55	0.997	0.999
*Panel B: 5 Years to March 1999 (Monthly Data)**																	
II	FR	60	0.099	0.087	0.000	0.047	0.077	0.142	0.455	-0.016	-0.91	0.132	0.128	-0.011	-0.64	0.991	0.999
III	FR	60	0.074	0.063	0.001	0.028	0.065	0.103	0.267	-0.012	-0.96	0.097	0.095	-0.009	-0.73	0.994	0.999
V	O,S	60	0.103	0.094	0.003	0.039	0.085	0.134	0.480	0.017	0.96	0.139	0.137	0.014	0.79	1.006	0.999
VI	O	60	0.223	0.175	0.001	0.078	0.170	0.368	0.648	0.012	0.34	0.285	0.285	0.017	0.46	0.990	0.994

* Panels A and B document tracking error metrics for All Ordinaries Accumulation Index funds. Index funds are partitioned on the basis of portfolio strategy adopted in replicating the performance of the index where FR = full replication, S = stratified sampling and O = optimisation. Panel A reports tracking error metrics from the inception of index funds to March 1999 using monthly data. Panel B documents tracking error for index funds with continuous 5-year performance history to March 1999 using monthly data. All metrics are expressed in percentage terms. N represents the number of observations for each index fund used in the analysis.

While there is evidence of significant tracking error in Table 1, there is no evidence of significant bias in performance. For example, the mean difference in returns documented in Table 1 are negligible, and not significant based on standard *t* tests. Further, the estimated α coefficients are also negligible in magnitude and not significant for any of the funds or sample periods. This confirms that passive funds neither systematically outperformed or underperformed the All Ordinaries Accumulation Index over the sample period. In turn, this implies that investors with a long-term investment horizon will achieve investment returns that are similar to index returns. However, investors with shorter investment horizons (eg. 1 month) are likely to experience significant under or overperformance relative to the index.

Table 2 reports the results of regression analysis testing the significance of the determinants of tracking error. All *t* statistics are adjusted for heteroskedasticity and autocorrelation using procedures developed by Newey and West (1987). The *F* statistic tests the joint significant of coefficients, and is significant at the 0.001 level. This confirms that the overall model is significant.

. Consistent with expectations, the table documents the coefficients on CF, SPR and VOL are all positive and statistically significant. This confirms that tracking error is positively and significantly related to fund cashflows, the cost of trading stocks in the index portfolio and the volatility of the benchmark. While the coefficients on DIV and INOUT are both positive, as expected, they are not statistically significant. Hence, dividend payments and the entry and exit of stocks in the index are not significantly related to tracking error. One explanation for the insignificance of dividend payments may lie in the use of dividend re-investment plans. Dividend re-investment plans (DRPs) allow investors to elect to receive stock to the value of the dividends paid in place of cash dividends. DRPs can be used by fund managers to eliminate the costs of re-investing the dividends in the index

portfolio, as well as differences in the actual time between day the dividend is paid and re-invested and that assumed in constructing the index. In Australia, index managers are likely to elect to use DRP's where possible to minimise tracking error in performance.

TABLE 2

DETERMINANTS OF TRACKING ERROR IN INDEX FUND PERFORMANCE

Variable	**Coefficient**	***t*-stat**
Intercept	0.034	1.28
CF	0.005	1.76*
SPR	0.147	2.14**
VOL	0.034	1.68*
DIV	0.028	0.77
INOUT	0.005	0.61
FR	-0.045	-2.94***
R^2 Adjusted	0.089	
F-statistic	3.67***	
Condition Index	6.316	

* significant at 0.10 level
** significant at 0.05 level
*** significant at 0.01 level
t-statistics have been adjusted for heteroskedasticity and autocorrelation using the Newey-West (1987b) method.
The coefficients are expressed in percentage terms (i.e. 10^2)

Apart from suggesting that index funds experience significant (but unbiased) and time-varying tracking error *per se*, the results above also have at least two other implications. First, in relation to the merits of an active versus passive investment strategy. The result that passive funds perform in line with the benchmark over a long term period on a *before expenses* basis implies that they necessarily systematically underperform their benchmark on an *after expenses* basis. In contrast, previous research has found that although active funds do not outperform the benchmark index, they perform roughly in line with the benchmark on an *after expenses* basis. For example, Sawicki and Ong (2000) report an alpha for a sample of active Australian equity funds comparable with the index funds examined in this study. The alpha is

close to zero and statistically insignificant.[14] Consistent with Gruber (1996) we interpret this as evidence that passive funds are not necessarily an unambiguous alternative to active funds. Second, the results also have implications for the appropriateness of an index as a technical benchmark for measuring the performance of active funds. The finding that passive fund performance is unbiased over the long term implies that the benchmark is achievable, and hence appropriate for use in performance assessment over a long sample period. However, the tracking error experienced by passive funds over short term periods (i.e. one month) casts doubt over the use of the technical benchmark in performance evaluation over short time intervals.[15] The results imply that underperformance/overperformance in any month may simply be a function of a fund managers exposure to the factors that cause tracking error in the performance of passive funds, and cannot be attributed to the skill of a particular manager. Perhaps a more appropriate benchmark of performance over shorter periods is the performance of a comparable passive fund.

CONCLUSION

This is the first Australian study to examine the ability of Australian equity index funds to exactly mimic the underlying All Ordinaries Accumulation Index, and the first study to provide evidence on the determinants of tracking error in passive fund performance. This study confirms that Australian equity index funds do indeed exhibit tracking error in their performance, and there is considerable variability in performance both across funds and through time. The magnitude of tracking error is significantly related to fund cashflows, the cost of trading stocks in the index portfolio, the volatility of the benchmark and the investment strategy used by the fund manager. This tracking error reflects the difficulties facing index equity managers in

approximating the performance of a frictionless index, and represent an additional risk to investors in passive funds.

While this paper provides evidence of tracking error in index fund performance, there is little evidence of a bias in fund performance over the sample period. This implies that investors who engage the services of index managers with long investment horizons ultimately achieve returns that are commensurate with those of the All Ordinaries Accumulation Index before expenses.

The results reported in this paper also have implications for the debate on whether passive funds represent a better investment than active funds, and the appropriateness of an index as a benchmark in performance evaluation. First, a comparison of results to previous research on active funds (eg. Sawicki and Ong, 2000) suggests, after taking into account costs, that passive funds are not necessarily a superior alternative to active funds. Second, the results also imply that while the All Ordinaries Index is a suitable for estimating performance over a long sample period, the degree of tracking error experienced by passive funds on a monthly basis casts doubt on the appropriateness of using an index as a benchmark for assessing performance over short-term periods.

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[1] While evidence on the performance of index funds is limited to Gruber (1996) and Frino and Gallagher (2001), Sinquefield (1991) and Keim (1999) examine the design of small-capitalisation index funds, while Horan (1998) examines the types of fund assets likely to use index investment products.

[2] *Superfunds*, August 2000, Volume 239, pp13-18. The percentage increase in the year to 1999 was 65 percent, and 90 percent of all indexed assets were invested in the Australian and international equity asset classes.

[3] Management expenses cover costs incurred by the fund manager associated with custodian services, trading and administration. They also include the profit earned by the fund manager.

[4] The ASX rules governing the inclusion and exclusion of securities from the All Ordinaries Index are made with regard to a stock's liquidity and market capitalisation. Full replication funds may experience increased difficulties as a result of index changes, given that smaller capitalised securities have a higher probability of not meeting the All Ordinaries Index liquidity rules

[5] For example in the U.S. from October 1989, Standard and Poor's pre-announced changes to the S&P 500 Index, where the index change became effective five days after the announcement. This amendment was designed to provide index funds with greater ease in acquiring the new securities ahead of their inclusion in the index. However, because index funds rebalance portfolios on the day the change becomes effective, this allows risk arbitrageurs the opportunity to sell the stock to index funds at a premium. The Australian Stock Exchange (ASX), in a similar manner to Standard and Poor's, pre-announces changes to the All Ordinaries Index, however the length of time between the announcement of the change and the actual index amendment depends on the size of the stock.

[6] Olma (1998) suggests that the choice of portfolio management technique used to replicate the returns of an index is influenced by the liquidity of the constituent securities comprising that index.

[7] These characteristics include size, industry and dividend yield and other risk attributes such as those identified by BARRA.

[8] Other fund managers were also surveyed to ensure that the Mercer database included all managers offering passive equity funds. The Australian index fund market is particularly small compared with the universe of active equity managers that exist in Australia. In order to evaluate each manager's performance, we collected data for each manager's first Australian equity index fund. This ensures the maximum evaluation period possible. While some managers have more than one index portfolio, the approach used in this paper provides a representation of each index manager's ability to replicate the All Ordinaries Accumulation Index. Enhanced index funds and 'quant' funds were excluded from the analysis as they do not represent pure index strategies.

[9] The Mercer database covering wholesale funds includes both surviving and non-surviving funds. For the index fund category, no funds ceased to exist. Correspondence with the portfolio managers concerning their competitors and discussions with William M. Mercer Pty. Ltd. indicated that this study includes the population of Australian equity index fund managers over the period examined. The infancy of the passive funds market also helps to mitigate problems of survivorship. However, given the study uses only one fund for each manager, the study may have selection bias.

[10] In addition to the market model, the parameters of the Capital Asset Pricing Model were also estimated. The parameters for the CAPM were virtually identical to those reported for the market model.

[11] DIV is measured as the difference in returns of the All Ordinaries Accumulation Index and All Ordinaries Price Index. Volatility was measured using the standard deviation of daily returns for the All Ordinaries Price Index each month. Alternative measures of volatility, including the Parkinson (1980) estimator (also outlined in Wiggins 1991) were also evaluated, however these methods also provided consistent findings.

[12] The ASX amends the All Ordinaries Index at the close of trading each month. This could be inferred as the change occurring at *t-1*. However the change affects the market in period *t*.

[13]For example, Aitken and Frino (1996) estimate that the average bid-ask spread of the largest 429 stocks listed on the ASX in the second half of 1992 averaged 4.4 percent, while Jang and Venkatesh (1991) estimate that the average bid ask spread of all stocks trading on the NYSE averaged 1.4 percent in an earlier sample period.

[14] The most comparable result for active funds relative to the sample of passive funds examined in this study is the performance of NPST Australian Equities reported in Table 2 of Sawicki and Ong (2000). Lines 7 and 8 of Panel A in Table 2 report the results for active funds where performance estimates are based on before tax (and after expense) returns and a traditional Jensen model.

[15] Asset consultants regularly compare the performance of specific active funds on a monthly basis and draw conclusions regarding changes in their performance (eg. performance surveys).