Journal Of Financial And Strategic Decisions
Volume 8 Number 3 Fall 1995

PITFALLS IN USING THE S&P BOGEY FOR FINANCIAL ANALYSIS AND PORTFOLIO MANAGEMENT

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Abstract

The S&P 500 Index is a benchmark that is widely accepted and used though much maligned. In this study we add a chapter to the index's detractors by investigating and revealing an industry bias built-in to the index. By the nature of the construction of the S&P there exists sectoral imbalances. By constructing 'S&P Comparable' indexes we establish first that such an industry bias does exist and then we probe deeper to find the sectors that are favored or disfavored. We find that the problem is not insevere and neither does it go away with time.

INTRODUCTION

The S&P 500 is one of the most widely used stock indexes and, invariably, the return of the S&P 500 is included in reports that summarize the performance of institutional money managers. Some portfolio managers use it as their primary "bogey" or benchmark for performance. Other equity managers, who may use different indexes for benchmarks, still use it as a quick reference common denominator or yard stick of performance.

The firms included in the S&P 500 are large in size. Inherently, some industries are mainly populated by large firms (e.g., petro-chemicals, auto manufacturing) while others are characterized by smaller sized firms (e.g., textile, furniture). Hence, constructing a portfolio composed of large firms may not only induce a large firm bias but also a non-random industry bias. The problems associated with benchmark construction have been studied. For example Fridson [1992] considers the effects of high-yield indexes while Bailey [1992] notes some of the issues concerning the validity of benchmarks. Gould [1991] considers the impact of weighting procedures in the construction of indexes. In this study, the particular nature of the industry bias, as well as the size bias in the S&P and problems associated with them are established.

The consequences of a biased benchmark is especially painful when it is used to evaluate the performance of portfolio managers. The risk of such consequences is even greater for managers who may specialize in certain industries or sectors and whose performance may be understated or overstated due to the built-in industry bias in the benchmark itself. Another undesirable outcome is potential if managers make investment decisions of asset allocation, stock selection or risk management based on the benchmark since such decisions will be suboptimal or even erroneous. Although the S&P 500 is an invaluable tool in the management of portfolios, our study indicates there are substantial risks in dependence on a biased index. Biases in benchmarks and performance evaluation are also addressed by Allen [1991] and Feinstein [1990].

Over the years, several writers have criticized the S&P 500 on a number of points. Roll [1977, 1978, 1980, 1981] raised concerns about this index because: 1) it, like all other conceptual stock indices, is not "the" true market index; 2) the lack of a "true" or "optimized" index introduces benchmark error into performance evaluations; and 3) the S&P 500 is not a market value weighted index as suggested by CAPM theory. Nagorniak [1982] and Etzioni [1992] conclude that benchmarks are easy to "game" against and that it may not be appropriate

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We thank two anonymous referees for their very helpful comments.

to use any benchmark in evaluating a portfolio manager's individual security or industry selection skills without first considering the benchmark quality to the portfolio that is evaluated. The main problem with a biased benchmark is the problem of inefficiency. From the theory of finance we understand that the benchmark portfolio (e.g. the market) must be an efficient portfolio composed of risky securities. Thus, if the benchmark is not an appropriate proxy for the true market portfolio then decisions on risk and return will be erroneously made; since risk-return decisions are fundamental to many other related financial decisions, the errors will be transformed widely. Hence, the need for well-constructed benchmarks.

This paper expands on prior research and provides further indictments against the S&P 500. The S&P 500's tilt towards large capitalization stocks has been well documented (see, for example, Haugen and Baker [1991], Collins and Fabozzi [1990], Banz [1981], Blume and Stambaugh [1983], Chan et al. [1985], Christie and Hertzel [1981], Keim [1983], Reinganum [1981] and Roll [1981]). These authors note that the risk (betas) measures of small firms may be understated. Other authors (see, for example, Dumas and Sengupta [1991], Sengupta [1990] and Gibbons, Ross and Shanken [1989]) have questioned the efficiency of index portfolios. Multi (industry)-index models too have been studied extensively (see, for example, Cohen and Pogue [1967], Elton and Gruber [1970], Farrell [1974], Fertuck [1975] and King [1966]), but the industry-bias in the S&P and its effects have not been investigated.

We first reveal the nature of the industry and size bias by constructing for comparison three 'S&P comparable' indexes. After establishing the nature, we investigate deeper the extent of the bias by comparing industry groups to the S&P. This latter comparison allows us to segregate the sectoral departures built into the S&P which, in turn, can provide the necessary guidelines for the proper use of the benchmark. The first section of this paper describes the data and methodology used to construct the 'comparable' indexes while section two illustrates the nature of the biases. Section three explores the sectoral imbalance built into the S&P and section four concludes.

DATA AND METHODOLOGY

The data used in the construction of the indexes were extracted from the financial data of the 7,200 firms included in the Compustat tapes. Since the main purpose of this study is to critically evaluate the S&P 500 index, constructing indexes strictly comparable to the S&P index was integral to this study. We constructed three indexes and calculated monthly returns on those indexes for the period 1972-1990. The Compustat tape for 1991 contains monthly financial data for 7,200 firms over the previous 20 year period. The limitation from data in our study is an extension of the limitation of data available in the Compustat tapes. For a more complete description on the Compustat tapes, see McElreath and Wiggins [1984]. These indexes were created so that at the beginning of each month, the values of each index was exactly equal to the S&P's market value. Note that the Compustat tapes specially code the firms included in the S&P 500. Any additions and deletions from the index is updated monthly as are stock splits, stock dividends, treasury stocks and new stock issues. This provision allows a monthly reconstruction of the index from the data included in the tapes. The following is a detailed description of the steps involved in the construction of the indexes.

Step I: Determination Of The Inputs Of The S&P Index

The S&P index is constructed as follows:

$$S\&P\,500\,Index = \frac{Aggregate\,Market\,Value\,(S\&P\,MV)}{Base\,Market\,Value} \times 10 = \frac{\sum_{i=1}^{500} P_i Q_i}{Base\,PQ} \times 10$$

where P_i = price per share, Q_i = # of shares outstanding, for the i^{th} S&P 500 firm. The Base Market Value (BMV) is the $\Sigma P_0 Q_0$ (1941-1943), an average value for all the industry groups and is computed for the period 1941-1943[1]. As the base period value is relatively constant, the index number (the S&P index) reflects only fluctuations in current market value. In this relative form an index number attains its maximum usefulness for statistical purposes. At the beginning and end of each month, the aggregate market value of the S&P index (S&P MV) was determined

from all the firms included in the index. Using the S&P index value, the BMV at the beginning and end of each month was then derived.

Step II: Calculation Of Industry Aggregates

We determined the following at *the beginning of each month*:

a) The Total Market Value (TMV) for all the firms on the Compustat tapes (7,200 firms) as:

$$TMV = \sum_{i=1}^{7200} P_i \times Q_i$$

where P = price per share, Q = # of shares outstanding.

b) The Aggregate Market Value (IMV) for 270 industry groups (3-digit SIC code).

$$IMV_j = \sum_{i=1}^{n} P_i \times Q_i; \quad j = 1, ..., 270$$

where n = # of firms in each 3-digit SIC industry group.

c) The Industry Weights, x_j:

$x_j = IMV_j/TMV$

d) The Representative Industry Value (RIV):

$RIV_j = x_j \times$ S&P MV

such that $\Sigma_j RIV_j$ = S&P MV, j = 1,.., 270.

Step III: Construction Of Industry Value-Weighted Indexes.

a) Large Firm Index: At the beginning of each month the market values for firms in each industry group was sorted by size. Starting with the largest firm, the market values of the firms were summed until the aggregate exactly equaled the RIV for the industry. Within this scheme of construction, it was necessary to use a fraction of the last firm included in the index such that the aggregate market value of the firms in the large-firm index exactly equalled the RIV of that industry. For a more detailed description of the construction of the large, random and small firm index, see Appendix. Using the Base Market Value (BMV) of the S&P index and using a construct similar to the S&P index, an index is derived for the large-firm index. Thus, this index allowed comparison with the S&P index and provided a measure of the extent of industry-wise large-firm bias inherent in using the largest capitalization stocks. This comparison is valid since each industry is represented in the index in proportion to its share in the total market value, only the largest capitalization firms are included in the index and the Base Market Value and constant are identical to the S&P.

b) Small Firm Index: This index was built similarly to the large firm index except that the firms included in the index are the smallest firms in each industry group. This index, along with the large firm index, provides a comprehensive measure of the large firm bias in the S&P index.

c) Random Index: This index was constructed similarly to the other two indexes, but the firms included from each industry group were chosen randomly, by a random number generator. As in the other two indexes, the number of firms representing each industry group depended on the RIV of each group though, ex ante, we may expect the number of firms in the random index to be lesser than the small firm index; by design the random index

could include firms of all sizes. Since an industry bias in the S&P is essentially non-random, this index provides a measure of the extent of non-randomness in the S&P index.

Step IV: Returns And Other Calculations.

Using market values from the end of each month, index values were recalculated at the end of each month. Again, for comparisons, each end-of-month index value was calculated using the constant and the BMV of the S&P 500. Such a scheme ensured the validity of the comparisons. The percentage returns for the indexes were then computed from the index values at the beginning and end of each month. The returns took into consideration that indexes contain fractions of one firm in each index in every month. For a detailed numerical example of the index construction and measurement of returns see Appendix. By utilizing the three "S&P comparable" indexes, we now compare and contrast these different indexes and very quickly discover some of the problems inherent in the use of the S&P 500 index.

S&P 500 PROBLEM AREAS

The market value of the S&P 500 firms (S&P MV) constitutes a very consistent seventy percent (small variance) of the total market value (TMV) of the 7,200 firms, in each month. We can appreciate the largeness of the firms included in the S&P when we note that 6.9 percent of the firms (500/7,200) constitute seventy percent of the total value. Moreover, these large firms have grown larger over the years as the TMV itself has increased over the years of the study. Figure 1 charts the number of firms required by each of the constructed indexes to equal in value the S&P MV, while Table 1 enumerates the same results.

There are a few interesting points to note from Table 1 and Figure 1. First, the number of small or randomly chosen firms required to replicate the S&P MV has monotonically increased over the years. In 1972, only 1,597 firms were required by the small index and 1,215 firms by the random index to replicate the S&P MV. In 1990, 5,366 and 3,184 firms, respectively, were required for replication. This indicates that the firms included in the S&P index themselves have grown significantly over the time period. It should be noted that the requirements of a firm to be included in the Compustat Tapes have not changed significantly over the same time period. Second, the number of firms required by the large cap index to replicate the S&P MV fluctuates considerably during the study period (1972-1990). Since the large cap index allows us to establish the existence of a size and industry-bias, the fluctuations in the replication number of firms may imply that the bias itself may fluctuate. This may, therefore, pose a problem if adjustments are to be made.

Table 2 shows the mean monthly and the annualized returns for each of the indexes over the entire period. Note that the small index has the highest return, while the S&P and the random indexes have approximately equal returns. The large index shows the lowest return for the entire period. The small firm index returns have the largest variance while the S&P 500 has the smallest variance. The risk-returns of the indexes are fairly consistent with other tabulations, including Ibbotson and Sinquefield [1982] and with data published by the U.S. Department of Commerce in their Survey of Current Business series as well as the data published in the CRSP tapes.

Table 3 shows the mean and standard deviations of monthly returns on each of the indexes. We observe that the index mean returns were similar for each index (and higher than returns for the entire period) and that the S&P index return was the smallest of the four indexes. Table 4 shows the result of correlation analysis between index returns. It should be noted that correlation analysis is a test of the closeness of association between different series. The high correlations reported in Table 4 are expected, *a priori*. Each of the indexes represent 70% of the Total Market Value and hence, market-wide movements would similarly affect all indexes. Moreover, the smallest correlations are between the small firm index returns and both the large firm and S&P index returns. This result is not unexpected either because of the size difference of component firms in the indexes.

SECTORAL TESTS

From the discussion so far we conclude that there may exist a serious size and industry bias in the S&P index, and a biased benchmark is detrimental in evaluating either the performance of managers or even the performance

of industry sectors. Therefore, to extend the analysis we try to establish the specifics of this bias, i.e. for which industries does the S&P significantly depart as a benchmark, the nature of these departures over time, etc. However, it is not feasible for comparison to include 270 different industry groupings but rather to aggregate the firms under a broader framework. We aggregated the 7200 firms into 28 industry groups using the broad headings from the compustat SIC listings guide as a basis for segregation. The summary statistics of the market value for each of the 28 groups are shown in Tables 5A and 5B. The results in these tables for both absolute and changes in market value were computed for the period 1981-1990.

For every S&P firm there are on average 14 firms in an industry. While the S&P does not have a single firm in group 1, its firms in group 18 are nearly 33 times greater than the size of average firms in this group. In 8 of the 28 groups, S&P firms are greater than the size of an average 14 firms in that sector. From the correlations between industry and S&P market value over the time period we can observe how stable this size relationship has been. In 19 of the 28 groups, the correlation in absolute market value is greater than 0.80. Earlier, in Figure 1 and Table 1 we observed that the number of firms needed to construct the large firm index fluctuated in relation to the S&P. The correlations below 0.80 in absolute value indicate the possibility of sectoral accounting of such fluctuations. Further, the correlation in changes in market value (returns) between all firms in an industry and the S&P firms in that industry are significantly smaller than those for absolute market values. This indicates that the developments in a sector may lead or lag the developments in large firms in those sectors. In sum, the results in Table 5A reveal the direction of the bias and the direction for further investigation.

In Table 5B we extend the comparison to include time patterns. We observe that for each year the correlation between industry and S&P in mean market values is around 0.80 whereas the correlation in the mean changes in market value is significantly lower. This reinforces the observation from Table 5A that general changes in firms in an industry may not be related in time to the changes in the large firms in that industry. The pairwise T-statistic for changes in market value shows significant differences (99%) in how the value of S&P firms in an industry group changed as compared to all the firms in that industry for the years 1982, 1983, 1987 and 1988. The overall difference (pairwise over 252 observations, i.e. 28 groups for 9 years) is also significant at the 95% level. In general we observe that changes in value for S&P firms, by industries, have not reflected very well the changes in value for all firms in those industrial sectors.

Table 6 shows the results from a variance analysis (ANOVA) test of the data; the results are a composite of the results in Tables 5A and 5B. The ANOVA procedure allows us to observe whether changes in market values are dependent on the industries' firms may belong to and whether this dependence persists in time. The procedure also allows us to measure (F-statistic) the strength of any dependence that may exist. The F-test also allows us to statistically qualify our observations. In the ANOVA test we use F-statistics to determine how significant the differences were between market values over the time period under study. The analysis is conducted in each case for both absolute and change in market values.

The model F-statistic denotes the significance in the relationship between the dependent variable (market value) and the independent variables (industry, year). In Table 6 we observe from the significant statistics that the market value of all firms in an industry is significantly different for sectors, i.e., some sectors are much bigger than others or that the industry bias is built into market values. Further, the overall market value of sectors change in different ways in time. For S&P firms, large firm market values are different by sectors as well but on the whole (model) these differences are not so significant. On the other hand, changes in value for S&P firms show a very different picture. These results indicate that all large firms changed in value over the time period significantly but similarly.

So far the observations from Table 5A, 5B and 6 have further clarified the nature of the industry and size bias. One point that is strongly indicated is that the largest firms are in a world of their own; their differences with their universe is of extreme magnitude. Therefore, we seek to explore deeper into the particulars of these differences. We begin with a scatterplot (Figure 2) of the mean market values of S&P firms and all firms by industry group. From the figure we observe that:

a) The industry groups which contain the smallest of the 500 S&P firms have market values in consonance with market values for firms in that industry;

b) Industry groups which contain medium sized S&P firms are underrepresented in the S&P, i.e. such industry groups have more value than what their S&P firms contain; and

c) Industry groups with the largest S&P firms are overrepresented in the S&P, i.e. such industry groups have less value than what their S&P firms contain.

The above specifications imply that managers and analysts of industry groups included in observation a) above may suitably use the S&P benchmark whereas for the other two subsets, corrections are required. We now seek to determine exactly the industries falling in each of these categories. To do so we conduct a principal components analysis. Principal components analysis is a multivariate technique for examining relationships among several quantitative variables. The technique enables us to summarize data and detect linear relationships. The technique is also useful in exploratory data analysis, in reducing the number of independent variables and reducing the effects of clustering. Principal components analysis allows us to infer the number of important factors (components) affecting and explaining changes in a dependent variable. However, care should be taken in applying this technique; for example, if the components are calculated from unstandardized covariance matrices rather than correlation matrices, then the components may provide biased (biased factor loadings) results. In our analysis we took all precautions necessary to provide impartial results. By the same token we also benefit from the validity of our results as the output of a very powerful and robust technique.

The principal components analysis reveals that the first two components account for 97% of the variations in the market value for both firms in the S&P and the industry and that the first component accounts for 89% of all variations. Therefore, an analysis of the first two components is considered sufficient. The first component measures the industry groups that dominate the market in value. Given that the factor loading for each of the years are about equal, the second component may be used to measure which industries have dominated other industries over different time intervals. In the analysis of the components (Table 7 shows the principal component analysis for market value while Table 8 exhibits the same analysis but for changes in market value) we break the 28 groups into 3 categories: the nine most dominating groups, the middle 10 groups and the 9 least dominating groups. This should provide accord with our earlier categorization from the scatterplot.

Consider the first component in Table 7. There are two areas of concern. Groups that are important when considered against all other industries in market value (e.e. 4, 7, 20) are not given the same importance in the S&P index whereas for other groups (e.g. 14, 13, 17, 18) the S&P considers them of more value than how the entire market values them. The second area of concern are differences in valuation between moderately and least dominating market value groups. For example, the S&P index favors some groups (12, 5, 26, 25) much more than what their proportionate industry value is and the reverse is true for other groups (i.e. 1, 10, 11). In general, we may say that if a group is much higher (much lower down) up in dominance in the S&P than the industry, that industry is overrepresented (underrepresented) by its large firms in the S&P.

The second principal component in Table 7 shows a near perfect fit between the S & P and the industry. This result suggests the existence of an industry life-cycle and in which firm size is irrelevant. Thus, we can say that firms of all sizes in the services industry (eg. 28.27,26,25) had more value in the latter years of this study than in the earlier years. This observation is consistent with the history of the large growth in the services sector during the mid-eighties onwards.

The principal components analysis in Table 8 concerns changes in market value. Since percentage changes in market value are essentially market returns, the analysis in Table 8 is important as this allows us to observe the mismatching of returns and therefore, be able to determine the exact industries for which the S&P benchmark was inappropriate and the magnitude of comparison errors.

The analysis of the first component in Table 8 shows a tremendous mismatch of returns for an industry and for the returns of the S&P firms in that industry. We will point out a few examples of the above here. Consider the returns from all the firms in the industry groups 28, 21, 25, 27. The largest firms in these industry groups had very high returns and for the S & P, these groups show up right at the top. However, most of the other firms in these groups did not fare as well and subsequently these industry returns are far down the industry list. The opposite is also true for other groups (e.g. 5, 7, 12, 17). Such drastic differences have obviously serious implications.

The second component indicates which groups' returns were highest in the latter years as compared to earlier years, i.e., lead-lag between industry and large firm. One striking observation is that the S&P very inadequately represents the changing values in industry sectors over time. For example, most industries which changed in value greatly in the latter years were considerably under-represented in the S&P. The reverse is also true. The inflexibility of the S&P structure (its inability to easily change the component firms) is clearly detrimental to its role as a benchmark. However, the consequences of such a tainted benchmark are much more damaging.

To summarize the results of the principal components analysis, we tabulate its main inferences in Table 9. These troubling inferences can be divided primarily into three observations: a) industry groups that are under or overrepresented by the S&P; b) inability of the S&P to accurately represent changes in sectoral values; and c) the combined effect of a) and b) which shows up in leads-lags in growth of industries to the S&P firms.

CONCLUSION

The S&P index is a widely used benchmark for reasons of liquidity, investability (index funds) and its acceptance by plan sponsors. It is also a benchmark that will probably survive all its detractors. Therefore, we consider it more appropriate to interpret the results of this study more in the spirit of a guide in the benchmark's use.

Managers measuring performance vis-a-vis the S&P 500 should be wary of the structure of their portfolios. Caution is especially warranted for managers of medium to small cap funds, sectoral funds and growth funds. The results of this study point to the need for increased understanding of appropriate benchmarks.

Active managers, too, must take into consideration the S&P biases. Selection and valuation methods that incorporate a market index (a S&P proxy) or factor models that incorporate both market and industry indexes would not be appropriate for all industrial sectors.

We conclude this study by noting that much remains to be done in the area of performance benchmarks and the construction of benchmarks appropriate for different purposes promises to provide a rich avenue for further research.

FIGURE 1

Number Of Firms Required To Replicate S&P 500 Index
(January 1972 Through January 1991)

(Small)

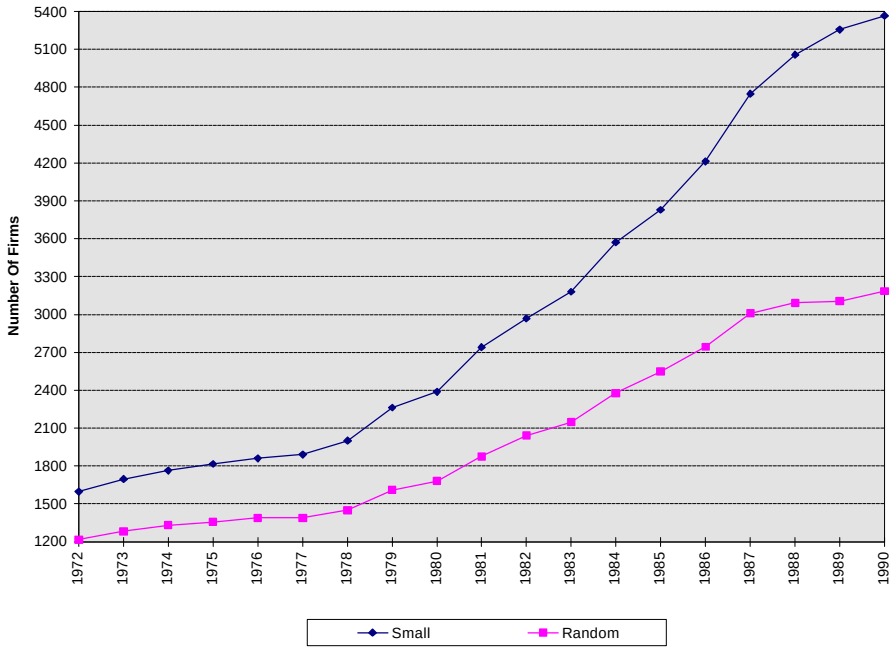

FIGURE 1
Number Of Firms Required To Replicate S&P 500 Index
(January 1972 Through January 1991)

(Large)

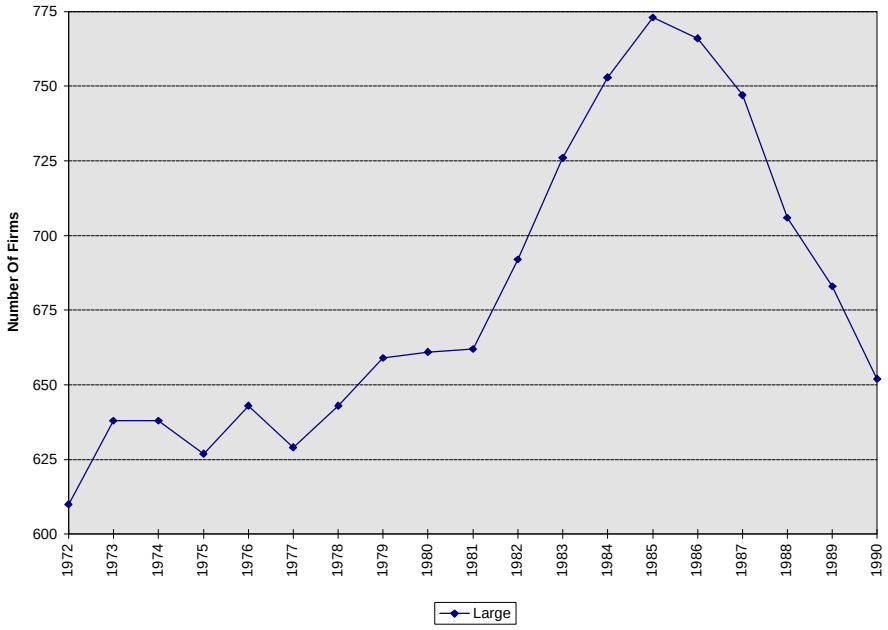

FIGURE 2
Scatterplot Of Market Values Of S&P Firms To All Firms, By Industry Groups

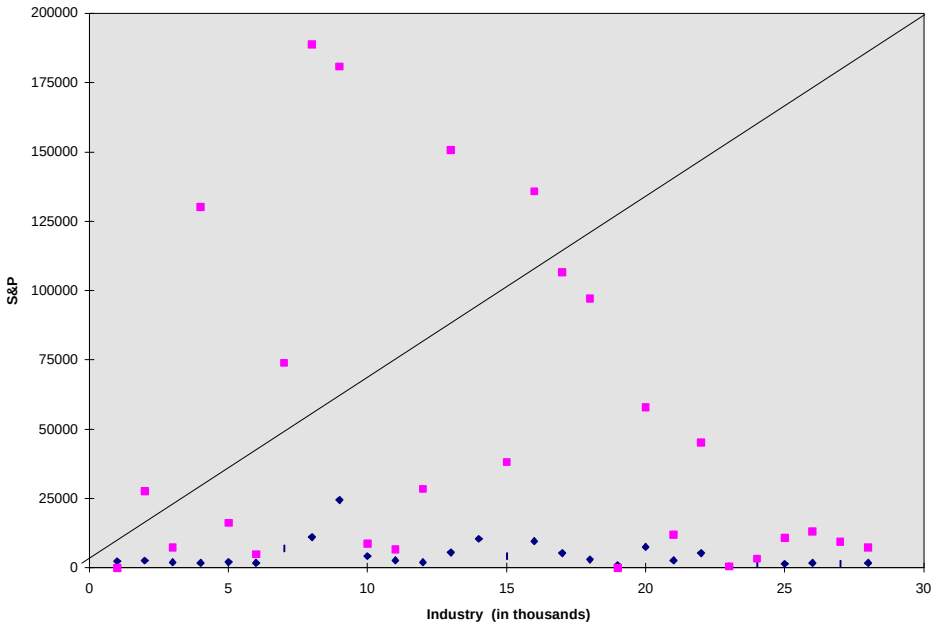

TABLE 1
Number Of Firms Required To Replicate The S&P 500 Index
(January 1972 Through January 1991)

Index	Number of Firms - Mean	Minimum	Maximum
S&P 500	500 (6.9)[a]	500 (6.9)	500 (6.9)
Large	679 (9.4)	609 (8.5)	773 (10.7)
Small	3,072 (42.7)	1,597 (22.2)	5,366 (74.5)
Random	2,049 (28.5)	1,215 (16.8)	3,184 (44.2)

a. The number of firms in each index as a percentage of the total number of firms (7,200) are shown within parenthesis. Note that the number of firms in any column will not add to 7,200; a firm may not be included in any index for some industry while it is possible that another firm from another industry may be included in all the indexes.

Number Of Firms Required To Replicate The S&P 500 Index
(Yearly Data)

Year	Large	Small	Random
1972	610	1597	1216
1973	638	1695	1283
1974	638	1765	1332
1975	627	1816	1357
1976	643	1860	1390
1977	629	1889	1389
1978	643	2000	1450
1979	659	2261	1611
1980	661	2388	1683
1981	662	2741	1876
1982	692	2968	2041
1983	726	3179	2146
1984	753	3570	2378
1985	773	3828	2546
1986	766	4213	2745
1987	747	4748	3011
1988	706	5057	3092
1989	683	5257	3105
1990	652	5367	3184

TABLE 2
Monthly Rates Of Return And Betas For The S&P 500 Index, Large Cap Index, Small Cap Index, And Random Index (January 1972 To January 1991)

Index	N	Mean Monthly Return	Annualized Return	Standard Deviation Of Monthly Returns
S&P 500	229	.0066	7.92%	.0471
Large	229	.0062	7.44%	.0472
Small	229	.0076	9.12%	.0485
Random	229	.0067	8.04%	.0476

TABLE 3
Monthly Rates Of Return And Betas For The S&P 500 Index, Large Cap Index, Small Cap Index, And Random Index (March 1986 Through January 1991, 59 Months)

Panel A: Rates of Return

Index	N	Mean Return [a] (μ)	Annualized Returns	Standard Deviation Of Monthly Returns
S&P 500	59	.0088	10.56	.0544
Large	59	.0092	11.04	.0545
Small	59	.0090	10.80	.0561
Random	59	.0092	11.04	.0555

Panel B: Index Betas

Index	N	Mean Beta	T of Beta[b]
S&P 500	59	1.110	62.55*
Large	59	1.051	13.40*
Small	59	0.999	0.19
Random	59	1.005	0.55

a. Mean monthly return.

b. Two-tailed T-test, Ho: $\beta=1$.

* Significant at ninety-nine percent.

TABLE 4
Correlation Analysis
(Monthly Returns And Betas, March 1986 To January 1991)

S&P ret[a]	1.0							
L[b] **ret**	.986	1.0						
S ret	.980	.986	1.0					
R ret	.989	.995	.995	1.0				
S&P beta	-.09	-.095	-.069	-.087	1.0			
L beta	-.008	-.006	.022	-.003	.81	1.0		
S beta	-.009	-.01	-0.13	-.008	.37	.61	1.0	
R beta	-.004	-.007	+0.22	-.002	.44	.71	.98	1.0
	S&P ret	**L ret**	**S ret**	**R ret**	**S&P beta**	**L beta**	**S beta**	**R beta**

a. Ret: Return
b. L,S,R: Large Cap, Small Cap, Random, respectively.

TABLE 5A
Mean Market Value Comparisons And Correlations Between The S&P Firms And Average Firms By Industry

			Market Value Statistics 1981-1990				
			Mean Market Value			Correlation (Industry - S&P)	
Industry Group	**SIC Code From To**	**Industry Heading**	**Industry**	**S&P**	**Size Difference**	**Market Value**	**Changes In Market Value**
1	0 -< 1000	Agricultural	2305	0	0	---	---
2	1000 -< 1500	Mining/Oil & Gas	2542	27648	10.87	0.385	0.40
3	1500 -< 2000	Construction	2015	7418	3.68	0.820	0.11
4	2000 -< 2200 2200 -< 2400	Food	1696	130177	76.75	0.976	0.74
5	5600 -< 5700	Textile/Apparel	2032	16218	7.98	0.881	0.35
6	2400 -< 2600	Lumber/Furniture	1692	4938	2.92	0.855	0.44
7	2600 -< 2800	Paper/Printing	6966	73936	10.61	0.965	0.60
8	2800 -< 2900	Chemical	11072	188750	17.05	0.884	0.62
9	2900 -< 3000	Petroleum	24456	180824	7.39	0.900	0.62
10	3000 -< 3100	Rubber/Plastic	4176	8686	2.08	0.966	0.58
11	3100 -< 3300	Leather/Cement, etc.	2649	6600	2.49	0.617	0.28
12	3300 -< 3500	Metal & Fabrication	1957	28378	14.50	0.955	0.63
13	3500 -< 3600	Machinery	5487	150625	27.45	0.743	0.36
14	3600 -< 4000	Electrical & Automotive	10481	207724	19.82	0.943	0.50
15	4000 -< 4800	Transportation	4187	38119	9.10	0.817	0.65
16	4800 -< 4900	Communication	9599	135844	14.15	0.964	0.11
17	4900 -< 5000 5000 -< 5500	Utilities	5299	106620	20.12	0.972	0.04
18	5700 -< 6000	Durable/ Non-Durable	2982	97206	32.60	0.955	0.22
19	5500 -< 5600	Automobile Dealers	980	58	0.06	0.086	---
20	6000 -< 6200	Financial Institutions	7546	57808	7.66	0.903	0.05
21	6200 -< 6300	Financial Brokers	2689	11888	4.42	0.473	-0.01
22	6300 -< 6500	Insurance	5304	45115	8.51	0.813	-0.08
23	6500 -< 7000	Real Estate	433	451	1.04	-0.418	0.64
24	7000 -< 7200	Hotels	1463	3337	2.28	0.472	0.50
25	7200 -< 7800	Service-General	1447	10784	7.45	0.967	0.64
26	7800 -< 8000	Entertainment	1676	13090	7.81	0.964	0.68
27	8000 -< 8400	Services-Professional	1453	9389	6.46	-0.206	0.15
28	8400 -< 9900	Services-Miscellaneous	1762	7320	4.15	0.922	0.05

TABLE 5B
Comparison Of Absolute And Changes In Market Value
Yearly Summary Statistics

Mean Market Values				Percent Changes in Mean Market Value		
Year	**Industry**	**S&P**	**Correlation**	**Mean Difference**	**Pairwise T-Statistic**	**Correlation In Changes In Market Value (S&P, Ind)**
1981	3269	30838	0.871			
1982	3074	35666	0.794	0.265	5.28*	0.52
1983	4231	43422	0.792	-0.546	-4.38*	0.07
1984	3924	43559	0.782	0.014	0.269	-0.26
1985	4584	53033	0.732	0.022	0.399	0.51
1986	5612	61005	0.773	-0.173	0.140	0.20
1987	6484	62694	0.758	-0.198	-3.78*	0.30
1988	5848	67687	0.780	0.153	3.28*	-0.16
1989	6829	83657	0.808	0.008	0.146	0.55
1990	6663	78779	0.800	-0.024	-0.933	0.77
All Years				-0.054	-1.96**	

TABLE 6
Analysis Of Variance
Significance Of F-Statistic Test

	Absolute Market Value		**Change in Market Value**	
	Industry	**S&P**	**Industry**	**S&P**
Model	2.27*	1.52	1.32	5.46*
Year	1.83	1.85	2.29**	9.25*
Industry	23.71*	11.30*	0.46	1.31
Industry Group × Year	0.33	0.10	0.47	2.19**

*,** Represents significances at 99% and 95%, respectively.

TABLE 7
Principal Components Analysis
Market Value

Component 1						Component 2					
Most Dominating		**Moderately Dominating**		**Least Dominating**		**Most Dominating**		**Moderately Dominating**		**Least Dominating**	
Industry	**S&P**	**Industry**	**S&P**	**Industry**	**S&P**	**Industry**	**S&P**	**Industry**	**S&P**	**Industry**	**S&P**
9	14	17	20	12	25	28	28	9	18	11	11
4	8	15	22	6	11	27	27	16	14	10	10
8	9	10	15	28	27	26	26	17	17	4	7
14	13	18	2	26	6	25	25	18	16	7	4
16	4	2	12	27	28	22	24	19	19	6	6
7	16	21	5	24	1	24	22	14	13	5	5
20	17	11	21	25	24	20	23	15	15	3	3
13	18	1	26	19	19	23	20	13	9	2	2
22	7	3	3	23	23	21	21	8	8	1	1
		5	10					12	12		

LEGEND:

1. Agricultural
2. Mining/Oil and Gas
3. Construction
4. Food
5. Textile/Apparel
6. Lumber/Furniture
7. Paper/Printing
8. Chemical
9. Petroleum
10. Rubber/Plastic
11. Leather/Cement, etc.
12. Metal and Fabrication
13. Machinery
14. Electrical and Automotive
15. Transportation
16. Communication
17. Utilities
18. Durable/Non-Durable
19. Automobile Dealers
20. Financial Institutions
21. Financial Brokers
22. Insurance
23. Real Estate
24. Hotels
25. Service-General
26. Entertainment
27. Service-Professional
28. Service-Miscellaneous

These legends may also be read from Table 5A.

TABLE 8
Principal Components Analysis
Percentage Change in Market Value

Component 1						Component 2					
Most Dominating		Moderately Dominating		Least Dominating		Most Dominating		Moderately Dominating		Least Dominating	
Industry	S&P	Industry	S&P	Industry	S&P	Industry	S&P	Industry	S&P	Industry	S&P
26	28	15	15	14	4	7	26	17	21	5	3
7	21	22	11	3	8	22	24	19	15	18	18
5	25	4	14	10	12	2	10	26	7	12	4
24	27	21	6	9	9	28	5	21	16	11	13
1	18	13	5	20	2	23	20	13	2	20	28
2	24	25	16	28	3	8	25	25	8	1	27
17	26	6	20	23	23	10	11	6	12	16	23
11	22	16	13	27	19	3	6	4	9	27	19
12	10	8	17	19	1	9	22	14	17	24	1
		18	7					15	14		

TABLE 9
Sector Discrepancies[a]

Absolute Market Value S&P		Changes In Market Value S&P		Growth Rates S&P	
Under Represents	Over Represents	Under Represents	Over Represents	Lags	Leads
1	12	1	28	23	24
10	25	2	27	28	20
11	26	7	18	19	11
4	18	12	10	3	5
7	5	17	25	2	16
20	13	4	21	7	26
	14	26	14	8	25
	17	3	20	13	6
				9	15
				17	12
				22	

a Table 9 shows how S&P firms in an industry group are related to all firms in that industry.

ENDNOTE

1. The BMV is occasionally adjusted when companies are substituted in the S&P Index. Since we back-out the BMV in our returns calculations, all changes in the BMV are reflected in our index return calculations.

REFERENCES

[1] Allen, G., "Performance Attribution for Global Equity Portfolios," ***The Journal of Portfolio Management***, Fall 1991, pp. 59-65.

[2] Bailey, J., "Evaluating Benchmark Quality," ***Financial Analysts Journal***, May-June 1992, pp. 33-39.

[3] Banz, Rolf W., "The Relationship Between Return and Market Value of Common Stock," ***Journal of Financial Economics*** 9, 1981, pp. 3-18.

[4] Blume, Marshall E. and Robert F. Stambaugh, "Biases in Computed Returns," ***Journal of Financial Economics*** 12, 1983, pp. 387-404.

[5] Chan, K.C., Nai-fu Chen, and David Hsieh, "An Explanatory Investigation of the Firm Size Effect," ***Journal of Financial Economics*** 14, September 1985, pp. 451-471.

[6] Christie, Andrew A. and Michael Hertzel, "Capital Asset Pricing Anomalies: Size and Other Correlations," Manuscript, Rochester, NY: University of Rochester, 1981.

[7] Cohen, Kalman and Jerry Pogue, "An Empirical Evaluation of Alternative Portfolio Selection Models," ***Journal of Business*** 46, April 1967, pp. 166-193.

[8] Collins, Bruce M. and Frank J. Fabozzi, "Considerations in Selecting a Small-Capitalization Benchmark," ***Financial Analysts Journal***, January/February 1990, pp. 40-46.

[9] Dumas, E. and J. Sengupta, "Non-Parametric Tests of Portfolio Efficiency Under Static and Dynamic Conditions," ***International Journal of Systems Sciences***, Vol. 22, No. 10, 1991, pp. 1929-1939.

[10] Elton, Edwin J. and Martin J. Gruber, "Homogenous Groups and the Testing of Economic Hypotheses," ***Journal of Financial and Quantitative Analysis***, Vol. IV, No. 5, January 1970, pp. 581-602.

[11] Etzioni, E., "Indexing Can Be Beat," ***The Journal of Portfolio Management***, Fall 1992, pp. 24-26.

[12] Farrell, James, "Analyzing Covariation of Returns to Determine Homogenous Stock Groups," ***Journal of Business***, Vol. 47, No. 2, April 1974, pp. 186-207.

[13] Feinstein, A., "The Right Benchmark: Trail to Peak Pension Investment Performance," ***Corporate Cashflow Magazine***, Vol. 11, No. 1, 1990, pp. 34-37.

[14] Fertuck, Leonard, "A Test of Industry Indices Based on SIC Codes," ***Journal of Financial and Quantitative Analysis***, Vol X, No. 5, December 1975, pp. 837-848.

[15] Fridson, M., "High-Yield Indexes and Benchmark Portfolios," ***The Journal of Portfolio Management***, Winter 1992, pp. 77-83.

[16] Gibbons, M., S. Ross and J. Shanken, "A Test of the Efficiency of a Given Portfolio," ***Econometrica***, Vol. 57, No. 5, 1989, pp. 1121-1152.

[17] Gould, F., "Thoughts About the Future of Implementable Indexing Without Cap-Weights," ***The Journal of Portfolio Management***, Fall 1991, pp. 24-26.

[18] Haugen, R. and N. Baker, "The Efficient Market Inefficiency of Capitalization-Weighted Stock Portfolios," ***Financial Analysts Journal***, Spring 1991, pp. 35-40.

[19] Ibbotson, Roger and Rex Sinquefield, Stocks, Bills and Inflation: The Past and the Future, (Charlottesville, VA: Financial Analysts Research Foundation, 1982).

[20] Keim, D., "Size Related Anomalies and Stock Return Seasonality: Further Empirical Evidence," ***Journal of Financial Economics*** 12, 1983, pp. 13-32.

[21] King, Benjamine, "Market and Industry Factors in Stock Price Behavior," ***Journal of Business*** 39, January 1966, pp. 139-40.

[22] McElreath, R. and C. Wiggins, "Using the COMPUSTAT Tapes in Financial Research: Problems and Solutions," ***Journal of Portfolio Management***, January-February 1984, pp. 71-75.

[23] Nagorniak, John, "Risk Adjusted Equity Performance Measurement," ***Journal of Finance***, Vol. XXXVIII, No. 2, May 1982, pp. 555-561.

[24] Reinganum, Marc R., "Misspecification of Capital Asset Pricing: Empirical Anomalies Based on Earnings Yields and Market Values," ***Journal of Financial Economics*** 9, 1981, pp. 19-46.

[25] Roll, Richard, "A Critique of the Asset Pricing Theory's Tests," ***Journal of Financial Economics*** 4, 1977, pp. 129-176.

[26] Sengupta, J., "Measuring Portfolio Efficiency: A Critique," ***International Journal of Systems Sciences***, Vol 21., No. 3, 1990, pp. 511-525.

[27] Sengupta, J., "Ambiguity When Performance is Measured by the Securities Market Line," ***Journal of Finance***, Vol. XXXIII, No. 4, September 1978, pp. 1051-1069.

[28] Sengupta, J., "Performance Evaluation and Benchmark Errors (I)," ***Journal of Portfolio Management***, Summer 1980, pp. 5-12.

[29] Sengupta, J., "Performance Evaluation and Benchmark Errors (II)," ***Journal of Portfolio Management***, Winter 1981, pp. 17-22.

[30] Sengupta, J., "A Possible Explanation of the Small Firm Effect," ***Journal of Finance*** 36, 1981, pp. 879-888.

APPENDIX

In this section we exemplify in some detail how the comparative indexes were constructed and returns calculated. Table A1 shows the firms in the pharmaceutical industry (SIC 283X) along with their market capitalization values for the months of July and August, 1989. The firms are sorted by size.

TABLE A1
Market Values Of Firms In The Pharmaceutical Industry (SIC 283X)

Company Name	MV Jul'89	MV Aug'89	Company Name	MV Jul'89	MV Aug'89
Merck & Company	30042.705	29005.033	Natures Sunshine Prod., Inc.	55.692	60.759
Glaxo Holdings PLC-ADR	18249.162	18713.957	United Guardian, Inc.	47.96	45.562
Johnson & Johnson	17777.908	17444.826	Chemex Pharmaceuticals	42.098	37.588
Lilly (Eli) & Company	17685.193	17130.363	MGI Pharma, Inc.	40.409	47.064
American Home Prod. Corp.	15147.282	14559.038	Barr Labs., Inc.	39.842	44.585
Abbott Laboratories	14705.001	14145.858	Emisphere Tech., Inc.	39.063	37.546
Bristol Myers Squibb	13890.734	14214.611	Chantal Pharmaceutical Co.	36.809	47.635
Pfizer, Inc.	10749.635	11452.495	Noven Pharmaceuticals, Inc.	36.468	42.079
Schering-Plough	8654.176	8710.555	Halsey Drug Co., Inc.	35.169	30.238
Warner-Lamber Company	7459.073	7171.535	Agouron Pharmaceuticals	30.209	30.852
Upjohn Company	6664.932	7243.485	Chattem, Inc.	28.105	28.81
Syntex Corporation	5668.775	5473.3	Duramed Pharmaceuticals	28.086	30.508
Marion Merrell Dow, Inc.	5396.425	5151.987	Macrochem Corp./De	26.537	23.948
Allegran, Inc.	1676.641	1651.617	Zenith Laboratories	23.855	31.807
Genentech, Inc.-Red	1491.079	1584.923	Belmac Corporation	23.81	21.429
Rhone-Poulenc Rorer	1340.303	1464.366	Vestar, Inc.	23.098	23.895
Alza Corporation-CL A	1160.621	1212.504	Jones Medical Inds., Inc.	18.942	20.23
Carter-Wallace	802.484	766.423	Cortex Pharmaceuticals	16.403	16.403
Forest Labs.-CL A	672.852	689.535	Escagenetics Corp.	16.056	15.597
Circa Pharmaceuticals, Inc.	601.124	444.778	Liposome Tech., Inc.	14.956	15.835
Mylan Laboratories	343.406	524.146	DDI Pharmaceuticals	13.08	16.195
Biocraft Labs., Inc.	273.828	284.292	Polydex Pharmaceuticals	13.049	10.542
Elan Corp. PLC-ADR	232.95	211.588	Purepac, Inc.	12.13	11.45
Xoma Corporation	206.119	222.608	Unimed, Inc.	9.278	7.664
Carrington Labs	199.799	197.827	Pharmacontrol Corp.	8.626	12.323
A.L. Labs., Inc.-CL A	193.934	174.412	Pharmos Corporation	8.487	8.487
Scherer (R.P.)/DE	177.644	174.824	Theragenics Corp.	7.523	6.583
Ivax Corporation	176.796	193.858	Biopharmaceutics, Inc.	6.728	8.286
Columbia Labs., Inc.	135.424	179.744	Alpha 1 Biomedicals, Inc.	6.096	6.418
SPI Pharmaceuticals, Inc.	129.364	118.482	Daltex Med Sciences	5.965	4.88
Viratek, Inc.	106.26	92.4	Natural Alternatives	5.892	5.892
Marsam Pharmaceuticals	97.11	85.905	Nature's Bounty, Inc.	5.521	5.645
Greenwich Pharmaceuticals	92.063	81.542	Montana Naturals Int'l.	4.225	5.015
ICN Pharmaceuticals Inc-DEL	87.401	75.368	Royce Labs., Inc.	2.965	4.938
Genzyme Corporation	86.862	86.862	Immuno Therapeutics, Inc.	2.945	2.945
Pharmaceutical Res, Inc.	83.28	77.728	Gynex Pharmaceuticals	2.361	2.361
Scios Nova, Inc.	82.418	75.313	Summa Rx Labs., Inc.	1.972	1.837
Synergen, Inc.	73.394	67.925	Evergood Prod. Corp.	1.6	2.2
KV Pharmaceutical-CL B	72.75	71.537			
Medco Research, Inc.	64.552	90.373	**Totals**	**183493**	**182094**

Assume that the Total Market Value (TMV) for the 7,200 Compustat firms for the month of July, 1989 was 7,500,000. Also assume that the S&P Market Value (S&P MV) for the 500 S&P firms was 5,500,000, for the same month, and the S&P Index equalled 360. Then, the following may be calculated:

1) Base Market Value (July) = $\frac{S\&P\ MV}{S\&P\ Index}(July) \times 10 = \frac{5{,}500{,}000}{360} \times 10 = 152{,}778$

2) The Industry Weights, $x_{j,j}$ = SIC 283X

x_j (July) = $IMV_j/TMV_{,j}$ = 183,493/7,500,000 = 0.0244657

3) The Representative Industry Value, RIV_j

RIV_j (July) = $x_j \times$ S&P $MV_{,j}$ = 0.0244657 × 5,500,000 = 134,562

In constructing the large firm index and calculating the returns, we will use RIV (July). We begin by adding the market values of the firms in Table A1 for the month of July until the sum equals RIV_{283X} (July). Table A2 shows the firms included from this industry group for the month of July in the large firm index. Note 1) only 79% of Warner-Lambert Company's market value is included in the index for this month, 2) that this industry's large firms are definitely overrepresented in the S&P 500, and 3) that for this industry, all the large firms are also S&P firms.

TABLE A2
Index Firms, July 1989: SIC 283X

S&P Index	Large Firm Index
Abbott Laboratories	Abbott Laboratories
American Home Products	American Home Products
Bristol Myers Squibb	Bristol Myers Squibb
Genentech, Inc.	Johnson & Johnson
Johnson & Johnson	Lilly (Eli) & Company
Lilly (Eli) & Company	Merck & Company
Marion Merrell Dow	Pfizer, Inc.
Merck & Company	Schering Plough
Pfizer, Inc.	Warner-Lambert Company (79%)
Schering Plough	
Syntex Corporation	
Upjohn Company	
Warner-Lambert Company	
MV 155,330	MV 134,562

This procedure is repeated for each of the 270 industry groups. Next, the market values for all the firms included in the large firm index for the month of July is summed and the value of the large firm index is calculated as follows:

Equation 1

$$\text{Large Firm Index (July, '89)} = \frac{\sum_{i}^{N} P_{i,July} Q_{i,July}}{BMV\ (July)} \times 10$$

and for the same firms included in the July large firm index, the index value for August, '89 is calculated as:

Equation 2

$$\text{Large Firm Index (July firms, August value)} = \frac{\sum_{i}^{N} P_{i,Aug.} Q_{i,Aug.}}{BMV\,(August)} \times 10$$

where N in both Equations 1 and 2 indicate the same firms included in the index for July '89. Now the large firm index returns are calculated as:

$$\text{Large Firm Index Returns (July)} = \frac{Equation\ 2 - Equation\ 1}{Equation\ 1}$$

Observe, first that the inclusion of a percentage of the nth. firms for each 4-digit SIC group (e.g. SIC 283X -- 79% of Warner-Lambert Company) implies that by construction design the value of the large firm index for July '89 must equal the value of the S&P Index for July '89, since the sum $\sum_{i}^{N} P_i Q_i$ = S&P MV. However, the large firm index for August '89 will be different, very generally, from the S&P Index August Value.[1] Also note that maintaining the fractional values of firms is not difficult but important for comparison. In each of the 270 industry groups this fractional firm may exist and the sum of their market values may imply that at the beginning of each month, the large firm index may differ substantially from the S&P Index Value. This in turn may defeat the purpose of this study by making the returns comparisons somewhat invalid. Second, the S&P 500 firms do not include ADR's in their composition even though these firms may be of considerable value. In Table A1 note that Glaxo Holdings U.S. market capitalization makes it the second largest in this industry group, but is ignored in the S&P 500. Further, Allegran, Inc. is larger than Genentech, Inc. but not included either for some unknown reason. In the indexes we construct, these flaws do not exist. Finally, the procedure applied to construct the large firm index is repeated for each of the 229 months in the period under study.

The same procedure is followed for the small firm and the random firm index as a well. For the small firm index, we sum up market values for this industry for the smallest firm upward till the sum equals the RIV for the industry. For the industry group SIC 283X it is obvious that the industry is characterized by a few gigantic firms and many small firms. We chose this group intentionally to highlight the industry bias problem. Because this industry is overrepresented by its large firms and due to the industry's character, small firms in this industry are grossly underrepresented. For this industry, the small firm index in July contains all firms in this group except Merck and Glaxo. Thus, if small firm behavior departs significantly from large firms, then the small firm index returns will also be significantly different from large firm and S&P returns. The same argument will also hold for firms randomly chosen. For the random index, the firms are chosen by using a random generator. The return calculations follow in a similar manner.

1. For the month of July, the returns for S&P firms in industry SIC 283X was -1.3% whereas the returns for all now S&P firms was +2.2%. This result illustrates the scope and magnitude of the problem in the S&P benchmark.