

Stock Index Funds: A Synthetic Alternative

by

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Abstract

If one were to gauge the importance of a development by the amount of press coverage, then stock index funds would likely make the top ten investment topics as the second millenium draws to a close. Scarcely a week elapses without an article in the business press about index funds. Yet little formal attention has been paid to them.

This paper examines the properties and performance of stock index funds, which account for over \$100 billion in net stock market investment value. If an index fund is to track the a target stock market index, then the most efficient, and cost effective means for doing so should be used. A simple, engineered strategy that emulates the S&P 500 using U. S. Treasury securities with S&P 500 index futures contracts is compared to index fund returns in this paper. The question of index fund performance is considered vis-à-vis the Standard & Poor's 500 index, the benchmark that most such funds purport to emulate.

Stock Index Funds: Cost, Performance, Alternatives

The central theme of stock index funds is that they provide a way for investors, especially smaller investors, to invest in a broad-based market index. The index used most is the S&P 500, which contains high capitalization companies, representing all major U.S. industrial segments.¹ These funds purport to track their target indices, neither doing markedly better nor worse than the corresponding index.

In July, 1997, *Barron's Mutual Fund Supplement* listed 21 index funds, belonging to 12 fund families. The Vanguard Index 500 Portfolio and Vanguard Institutional Index Fund together accounted for over \$64 billion of a total for all 21 funds of \$71.8 billion, or 75.4 percent of the total.

By January, 1998, *Barron's* listed more than 60 index funds. The Vanguard Index 500 Portfolio and Vanguard Institutional Index Fund together accounted for \$63.4 billion, virtually unchanged from mid-1997, but slipping to 60.5 percent of the total index fund assets of \$104,712 billion. Overall, the growth in assets of all such index funds over the period measures 45.8 percent. Table 1 presents the performance of these funds to 1998.

In terms of longevity Vanguard Index 500 Portfolio Fund, Stagecoach Corporation Stock fund, SEI E fund, and Corefund Y, are the only funds that have existed for 10 or more years. It is interesting that the Stagecoach's and Corefund's ten-year returns are almost a full percent less than Vanguard's and with lower dividend yields. This should not be expected in index funds

¹Recently other indices have become available, providing some variety of index choices to investors.

that truly emulate the same index, unless there are significant differences in management fees, brokerage costs, or other important factors.

Table 2 contains data on the 10 top-rated index funds (out of 89 such funds) that met the *Consumer Reports* criteria for inclusion in their March, 1998 list. The 79 others were excluded because they have high expense ratios, loads, or 12b-1 fees, and thus excessive costs for funds purporting to mirror a market index.² Despite their higher costs, their performances were not significantly better than the ten selected (as we would expect of index funds), so their inclusion would contribute little to the analysis or discussion in this paper.

It is noteworthy that the turnover ratios in Table 2 range from 1 to 29, a wide variation. One might ask why, considering the objective is to track a market index, two of the funds, including the largest, have such a high turnover. Also, though the funds included in Table 2 did not have “excessive fees” the fee range among these top ten rated funds is from 0.20 to 0.67. The fund with 0.67 has only \$26 million under management, so this is understandable, but the next highest, at 0.57, has \$1,431 million under management and thus its expense ratio seems questionably high compared to the others.

As Tables 1 and 2 illustrate, index funds generally earn returns that are very similar to one another. On average they earn returns that are very close to the cash index they target. Figure 1 graphs the S&P 500 index with the net asset value of the Vanguard Index 500 fund. The closeness of fit is very tight, as would be expected, with the slight divergence over time explainable as withdrawals by investors, and reflecting transaction and administrative costs. One

²“How to Choose Mutual Funds,” *Consumer Reports*, Vol. 63, NO. 3(March 1998): 30-36.

might ask whether the funds, or other investors, can earn a superior return to the cash index while tracking its overall performance closely. Doing so might be possible if a low margin deposit can be used to buy the index while earning a risk-free or low risk return on the funds available for investment.

Changes in U.S. federal tax law effective in early August, 1997 allow mutual funds to use futures contracts more effectively than before. Now mutual funds may invest in short-term derivatives, such as futures contracts and options, without jeopardizing their “flow through” status that taxes investment profits at shareholder level instead of fund level. Prior to the revision in tax law the “short-short” rule meant funds were taxed an additional 35 percent corporate rate when they derived over 30 percent of their income from investments held less than 90 days. With freedom to use futures and options it will be possible to track popular stock market indices more effectively and cheaply than before, though in principle a fund with long-term perspective could have used them before the change in tax law.³

With the exception of a paper by Herbst and Ordway (1984) the academic literature has been largely silent on the substitution of an index future plus Treasury bill synthetic portfolio for a stock portfolio. Herbst and Ordway did not consider index funds, since at the time they were not a factor in the mutual fund industry. In this paper we specifically consider how a synthetic portfolio based on an index future with Treasury bills might substitute for an index mutual fund, given the current market and regulatory environment.

³Lucchetti, Aaron, “Tax Change Prompts Funds to Buy Riskier Commodities,” *The Wall Street Journal Interactive Edition*, October 23, 1997. “Futures on financial instruments such as Treasuries and stock index futures indexed have been interpreted as good income . . .” which is not subject to the punitive tax on funds that derive more than 10 percent of their income from ‘bad income areas’ such as commodity futures.

Assumptions

We assume the following in order to perform a systematic analysis and comparison of index fund alternatives:

- Mutual funds pay no taxes but taxes are paid by the shareholders at their own rates, and our calculations will reflect this
- Mutual funds invest via cash accounts, though they can use margin accounts if they choose
- Index funds are always net long the index they track
- T-Bill 90-day yield of 5.29 percent (5.15 percent discount)
- Merrill Ready Assets yield of 5.12 percent as a surrogate for non-Treasury short-term yield
- Tax rate on ordinary income of 39.6 percent
- Tax rate on long-term capital gains of 28 percent
- Blended tax rate on futures of 32.64 percent (60 percent long-term, 40 percent short-term)
- S&P500 futures contract margin of \$21,000
- S&P Index value of 950
- T-Bills or other short-term to maturity Treasury securities may be used as margin for positions in index futures contracts
- The mandate of the fund management is to track the target index, not outperform it
- For illustration, capital of \$100 million is assumed available
- If index futures are used to track the index, the underlying stock investment is the same as with cash or margin purchase of the index's stock — Using *Barron's* 1/26/98 values of

Market/Book = 526.61%, and \$Book = \$182 we calculate S&P500 Mkt/Book * Book value * 100 Shares * 500 = \$47,957,381 = Amount in Cash Portfolio. The number of S&P 500 Index futures contracts is determined from the Amount in Cash Portfolio/(500*S&P500 Index Value) rounded to the nearest whole contract.

- The dividend rate on the S&P 500 index is 1.65 percent per annum

Table 3 illustrates the results under these assumptions of the earnings that might be expected from an S&P 500 stock portfolio given a 10 percent move in the index in either direction. Both long and short position results are shown. However, this is only for the sake of completeness, simulating what an individual investor might do, and not because any index fund engages in short selling. It is assumed that long positions are held long enough for capital gains. For a rising market the returns to long and short positions are +11.65 percent and -11.65 percent. For a falling market the returns to long and short positions are -4.66 and +6.59 percent. The asymmetry is introduced by the different tax treatment accorded long and short positions.

In Table 4 are the results of a synthetic S&P 500 index portfolio created by investing in U.S. Treasury bills and depositing them as initial margin for purchase of a number of S&P 500 Index Futures equivalent in value to the cash portfolio illustrated in Table 3. For a rising market the returns to long and short positions are +15.02 percent and -4.98 percent. In a falling market these results are reversed to -4.98 percent and +15.02 percent. This is due to the symmetry in tax applied to futures profits and losses, irrespective of holding period.

Comparison of results demonstrates that synthetic portfolios can offer superior returns to cash portfolios, whether long or short, in a rising or a falling market. The implication is clear: individual investors can readily construct a synthetic portfolio that offers superior results over a

stock portfolio if they wish to emulate the overall market. And index funds can reduce commission costs and obtain superior results by means of synthetic portfolios, as long as market liquidity can accommodate their activities. Until enough funds attempt to adopt this strategy liquidity should not be a problem.

If the function of an index fund is truly to emulate a market index, then it makes sense for the most efficient, responsive, and cost-effective means of achieving that objective to be employed. To actually construct a portfolio of index stocks is a formidable task, involves substantial commissions and slippage in transactions, and thus often means that portfolio management in practice takes short cuts. The short cuts involve building portfolios that are thought to closely track the market index, based on correlation of historical data, or else require larger investment than some funds can afford if index stocks are to be held in proper proportion to their role in the index that is to be tracked. Consequently, it makes sense to employ a simple, efficient, and cost-effective alternative, such as the one discussed in this paper. Doing so may offer some real advantages to investors, if not to the fees and commissions of those in the securities industry.

References

“Books and Bytes: A New Primer on Index Funds,” *Mutual Funds*, July 1997, p. 67.

“Funds and Gains,” *Consumer Reports*, Vol. 63, No. 3 (March 1998), pp. 30-36.

Damato, Karen, “S&P 500 Still Beats Most Managers,” *The Wall Street Journal*, July 3, 1997, R1.

Dorfman, John R., “Intel Fires Active Money Managers in Switch to Indexing,” *The Wall Street Journal*, August 25, 1995, C1.

Herbst, Anthony F., and N. Ordway, “Stock Index Futures and the Separability of Returns,” *The Journal of Futures Markets*, Vol. 4, No. 1 (Spring 1984), pp. 87–102.

Ip, Greg, “Why Index Funds Aren’t as All-Powerful as Some Think,” *The Wall Street Journal*, March 11, 1998, p. C1.

Koski, Jennifer Lynch, and Jeffrey Pontiff, “How Are Derivatives Used? Evidence from the Mutual Fund Industry,” Working Paper, University of Washington, January, 1996 version.

Lowenstein, Roger, "Indexing's Real Uncertainty Principle," *The Wall Street Journal*, January 30, 1997, C1.

Lucchetti, Aaron, "New Tax Law is Expected to Increase in Options by Mutual-Fund Managers," *The Wall Street Journal*, August 11, 1997, C15.

Lucchetti, Aaron, "Tax Change Prompts Funds to Buy Riskier Commodities," *The Wall Street Journal Interactive Edition*, October 23, 1997.

McGee, Suzanne, "Got a Bundle to Invest? Think Stock-Index Futures," *The Wall Street Journal*, February 21, 1995, C1.

O'Neal, Edward S., "How Many Mutual Funds Constitute a Diversified Mutual Fund Portfolio?" *Financial Analysts Journal*, Vol. 53, No. 2 (March/April 1997), pp. 37-46.

Siconolfi, Michael, and Robert McGough, "Equalling S&P Results Can Be More Difficult Than It Appears," *The Wall Street Journal Interactive Edition*, January 28, 1997,.

Waggoner, John, "Vanguard Yellow Flags Index Funds," *USA Today*, February 19, 1997, 3B.

Table 1: Recent Index Fund Performance

S&P Index Fund Name	Assets (\$Millions)	----- Percentage Returns -----						DIV YLD (Percent)	P/E
		NAV	QTR	1YR	3YRS	5YRS	10YRS		
1 VANGUARD Index 500	48,264.6	90.07	2.84	33.19	31.03	20.12	17.84	1.5	21.6
2 VANGUARD INTL IDX	15,112.1	89.56	2.87	33.36	31.20	20.28	*	1.5	21.5
3 Fidelity US EQ	9,572.8	34.98	2.81	33.04	30.84	19.98	*	1.1	21.5
4 Fidelity MKT	3,697.9	68.50	2.83	33.03	30.73	19.86	*	1.4	21.4
5 VANGUARD INSTL IX	2,972.0	89.56	2.87	*	*	*	*	0.0	*
6 T Rowe Price EQ	1,833.5	26.38	2.80	32.87	30.75	19.83	*	1.3	21.4
7 BT INSTL EQ	1,520.2	125.63	2.84	33.24	31.04	20.17	*	1.5	21.6
8 SSGA	1,476.6	19.66	2.85	33.10	30.78	19.96	*	1.5	21.4
9 Dreyfus S+P	1,367.7	28.70	2.72	32.63	30.41	19.58	*	1.0	21.4
10 Federated MAX-CAP INST	1,216.9	20.23	2.66	32.69	30.56	19.79	*	1.5	21.6
11 SEI E	1,106.7	30.65	2.83	33.07	30.86	19.98	17.69	1.5	21.5
12 Schwab INV	988.4	14.93	2.74	32.47	*	*	*	0.9	*
13 MNSTY INSTL EQ	939.0	27.05	2.76	32.88	30.64	19.74	*	1.3	21.6
14 Dreyfus Basic	858.9	20.57	2.82	33.02	30.73	*	*	1.4	21.1
15 First American C	855.1	19.63	2.75	32.84	30.61	*	*	1.4	21.4
16 Benchmark A	844.6	18.89	2.62	32.25	30.68	*	*	1.4	21.3
17 Nations EQ PRM A	641.6	19.74	2.58	32.70	30.65	*	*	1.3	21.5
18 BT Pyramid INV EQ	627.8	124.95	2.79	33.02	30.86	19.94	*	1.4	21.6
19 Pegasus EQ I	626.2	21.37	2.84	33.00	30.83	19.95	*	1.4	*
20 USAA	595.4	15.16	2.78	33.03	*	*	*	1.4	*
21 Norwest ADV	574.5	41.03	2.77	33.18	30.34	*	*	1.4	*
22 Kent FDS INST	572.9	19.14	2.78	32.55	30.17	19.52	*	1.3	21.4
23 One Group FID	570.9	23.26	2.87	32.99	30.74	*	*	1.4	*
24 Galaxy II LgeCo	536.2	28.07	2.81	32.81	30.67	19.81	*	1.5	*
25 Stagecoach CORPST	510.6	61.95	2.61	31.89	29.76	19.00	16.74	0.7	*
26 Victory Stock	493.6	18.70	2.69	32.40	30.21	*	*	1.5	21.4
27 Merrill A	419.6	12.55	2.83	*	*	*	*	0.0	*
28 Mainstay EQ	417.2	30.91	2.69	32.26	29.94	19.17	*	0.0	*
29 Prudential DryDnl	402.5	21.87	2.77	*	*	*	*	0.0	*
30 DFA GrpUS Lge10	343.7	28.74	2.78	33.09	30.79	19.96	*	1.4	21.4
31 Postico EQ INSTL	334.2	65.80	2.81	32.59	30.64	19.70	*	1.4	21.6
32 Harris INS	294.1	23.51	2.81	32.74	*	*	*	1.2	*
33 SEI A	291.6	30.59	2.76	32.82	*	*	*	1.3	*
34 Munder Y	280.6	20.96	2.93	32.95	30.75	19.91	*	1.5	*
35 Federated MAX-CAP INSV	265.1	20.20	2.60	32.32	30.16	*	*	1.2	21.6
36 Corefund Y	261.7	39.65	2.64	32.54	30.55	19.52	16.86	1.3	21.4
37 Wachovia EQ Y	254.2	18.74	2.76	32.70	*	*	*	1.6	*
38 Dean Witter B	248.8	10.27	2.58	*	*	*	*	0.0	*
39 One Group B	230.1	23.25	2.63	31.71	29.42	*	*	0.6	*
40 Prudential Z	211.8	21.85	2.64	32.28	30.30	19.55	*	0.9	*
41 Compass SVC	202.1	18.70	2.68	32.53	30.25	*	*	1.2	21.4
42 Pegasus EQ A	181.8	21.36	2.73	32.68	30.69	19.88	*	1.2	*
43 Compass INST	181.5	18.70	2.76	32.91	30.62	*	*	1.5	21.4
44 Schwab CAP E	151.8	14.95	2.87	32.72	*	*	*	0.9	*
45 Merrill D	149.1	12.54	2.78	*	*	*	*	0.0	*
46 One Group A	143.1	23.26	2.85	32.68	30.33	19.47	*	1.2	*
47 AON Y	125.7	14.34	2.80	32.83	*	*	*	1.5	*
48 Munder A	124.4	20.94	2.87	32.82	30.60	19.76	*	1.4	*
49 Munder K	122.7	20.93	2.87	32.63	30.42	19.68	*	1.3	*
50 Munder B	83.6	20.96	2.80	32.37	*	*	*	1.0	*
51 Benchmark C	83.2	18.85	2.54	33.22	*	*	*	1.3	*
52 Postico RET	81.4	65.75	2.76	32.29	*	*	*	1.3	21.6
53 CA INV TR II	77.0	21.13	2.90	32.99	30.80	19.93	*	1.5	21.8
54 Northern FDS Stock	60.9	13.24	2.77	32.68	*	*	*	1.0	*
55 Wachovia EQ A	46.0	18.73	2.64	32.32	30.36	*	*	1.3	21.4
56 Compass INV B	42.7	18.60	2.48	31.32	*	*	*	0.5	21.4
57 Keyfunds Stock	39.4	13.34	2.77	32.44	*	*	*	3.0	*
58 Mason STK A	34.9	12.70	2.57	*	*	*	*	0.0	*
59 Compass INV A	30.3	18.69	2.58	32.27	30.06	19.31	*	1.1	21.4
60 Kent FDS INV	26.1	19.15	2.72	32.24	29.84	19.30	*	1.1	21.4
61 First American B	26.0	19.55	2.44	31.49	29.34	*	*	0.5	21.4
62 First American A	24.7	19.64	2.63	32.51	30.28	19.65	*	1.2	21.4
63 Transam INV	23.5	15.49	2.87	33.13	*	*	*	2.1	*
64 Strong Index 500	17.8	12.16	2.79	*	*	*	*	0.0	*
65 Arch EQ A	0.2	12.10	2.72	*	*	*	*	0.0	*
Total	\$104,711.8	30.05	2.75	28.65	20.17	9.11	1.06	1.12	10.57
Assets (\$	NAV	QTR	1YR	3YRS	5YRS	10YRS	DIV YLD	P/E	

Data Source: *Barron's* January 12, 1998
S&P 500 Index * * 2.72 32.60 * 19.74 17.29 * *
Value Line Funds as 60.52%

Table 2: Top Ten Rated Index Mutual Funds

Fund Name	Total	Annualized % Returns for			Expense	Net	Turnover	Manager
	1997	3 years	5 years	10years	Ratio	Assets	Ratio	Tenure
Vanguard Index Growth	36.3	32.6	19.5	--	0.20	2,281	29	6
BT Investment Equity 500 Index	33.0	30.9	19.9	--	0.25	628	6	6
California Investment S&P500 Index	33.0	30.8	19.9	--	0.20	77	2	6
Dreyfus S&P500 Index	32.6	30.4	19.6	--	0.57	1,431	5	2
Galaxy II Large Company Index Ret.	32.8	30.7	19.8	--	0.40	547	5	3
Schwab 1000	31.9	29.9	19.1	--	0.47	2,823	2	4
T. Rowe Price Equity Index	32.9	30.8	19.8	--	0.40	1,834	1	8
U.S. Global Inv. All America Equity	30.8	27.9	16.9	11.3	0.67	26	7	2
Vanguard Index 500	33.2	31.0	20.1	17.8	0.20	48,265	5	11
Vanguard Index Value	29.8	29.4	20.5	--	0.20	1,728	29	6
Averages:	32.6	30.4	19.5	2.9	0.36	5,964	9.1	5.4

Source: Data extracted from Ratings table, *Consumer Reports*, Vol. 63, No. 3 (March 1998), p. 34-35

Table 3: S&P500 Stock Portfolio				
Tax Rate:	39.60%			
Capital Gains Rate:	28.00%			
		Long		Short
(At t = 0)				
Margin for SP500 Contract	\$23,338,465.70			\$23,338,465.70
Cash Surplus	23,338,465.70			23,338,465.70
Total Invested	\$46,676,931.40			\$46,676,931.40
A. Market rises 10% over holding period				
(At t = 1)				
Profit on SP500 Stock Portfolio	\$4,667,693.14			-\$4,667,693.14
Tax or Tax Reduction	1,306,954.08			-1,848,406.48
After-tax Capital Gain or Loss		\$3,360,739.06		-\$2,819,286.66
Dividends	770,169.37			-770,169.37
Tax or Tax Reduction, Dividends	304,987.07			-304,987.07
After-tax Dividends		465,182.30		-465,182.30
Interest on Money Fund	1,194,929.44			1,194,929.44
Tax on Money Fund Interest	473,192.06			473,192.06
After-tax Money Fund Return		721,737.38		721,737.38
Total Net, After-tax Return		\$4,547,658.74		-\$2,562,731.57
Net, After-tax Return on Capital		9.74%		-5.49%
Pre-tax Return on Capital		11.65%		-11.65%
B. Market Falls 10% over holding period				
(At t = 1)				
Profit on SP500 Stock Portfolio	-\$4,667,693.14			\$4,667,693.14
Tax or Tax Reduction	-1,306,954.08			1,848,406.48
After-tax Capital Gain or Loss		-\$3,360,739.06		\$2,819,286.66
Dividends	770,169.37			-770,169.37
Tax or Tax Reduction, Dividends	304,987.07			-304,987.07
After-tax Dividends		465,182.30		-465,182.30
Interest on Money Fund	1,194,929.44			1,194,929.44
Tax on Money Fund Interest	473,192.06			473,192.06
After-tax Money Fund Return		721,737.38		721,737.38
Total Net, After-tax Return		-\$2,173,819.38		\$3,075,841.74
Net, After-tax Return on Capital		-4.66%		6.59%
Pre-tax Return on Capital		-8.35%		8.35%
T-Bill Yield	5.29%		(Discount 5.15%)	
Merrill Ready Assets Yield. . . .	5.12%			

Table 4: Synthetic S&P500 Stock Portfolio				
S&P500 Futures Margin	\$21,000			
Tax Rate:	39.40%			
Capital Gains Rate:	28.00%			
#S&P Contracts	100			
S&P Index Value	933.54			
		Long		Short
(At t = 0)				
Margin for SP500 Contract	\$2,100,000.00			\$2,100,000.00
Cash Surplus	289,858.89			289,858.89
Treasury Bills	\$44,287,072.51			\$44,287,072.51
Total Invested	<u>\$46,676,931.40</u>			<u>\$46,676,931.40</u>
A. Market rises 10% over holding period				
(At t = 1)				
Profit on SP500 Stock Portfolio	\$4,667,700.00			-\$4,667,700.00
Tax or Tax Reductioi	-1,519,803.12			1,519,803.12
After-tax Capital Gain or Loss		\$3,147,896.88		-\$3,147,896.88
Interest on T-bills	2,342,786.14			2,342,786.14
Interest on Money Fund	14,840.78			14,840.78
Total Interest	2,357,626.91			2,357,626.91
Tax, or tax reduction	-928,905			-928,905
After-tax interest		1,428,721.91		1,428,721.91
Total net, after-tax return		<u>\$4,576,618.79</u>		<u>-\$1,719,174.97</u>
Net, After-tax Return on Capital		10.33%		-3.88%
Pre-tax Return on Capital		15.02%		-4.98%
B. Market Falls 10% over holding period				
(At t = 1)				
Profit on SP500 Stock Portfolio	-\$4,667,700.00			\$4,667,700.00
Tax or Tax Reductioi	1,519,803.12			-1,519,803.12
After-tax Capital Gain or Loss		-\$3,147,896.88		\$3,147,896.88
Interest on T-bills	2,342,786.14			2,342,786.14
Interest on Money Fund	14,840.78			14,840.78
Total Interest	2,357,626.91			2,357,626.91
Tax, or tax reduction	-928,905			-928,905
After-tax interest		1,428,721.91		1,428,721.91
Total net, after-tax return		<u>-\$1,719,174.97</u>		<u>\$4,576,618.79</u>
Net, After-tax Return on Capital		-3.88%		10.33%
Pre-tax Return on Capital		-4.98%		15.02%
T-Bill Yield	5.29%			
T-Bill Discount.	5.15%			
Merrill Ready Assets Yield. . . .	5.12%			

Figure 1: S&P 500 Index and VFINX

