

**Momentum Strategies versus Directional Momentum Strategies: A  
Comparative Study with No-load Mutual Funds**

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# **Momentum Strategies versus Directional Momentum Strategies: A Comparative Study with No-load Mutual Funds**

## *Abstract*

The textbook definition of weak form efficient market hypothesis suggests that past security price changes do not predict future price changes. But a large body of empirical evidence claims that over horizons of three months to a year stock prices exhibit momentum, that is, continuation in a price direction. This pattern of stock price momentum is exploited by some mutual funds that typically buy past stock winners and sell past stock losers. In this paper, we show that if momentum is modified to take into consideration price patterns within the formation period, the directional momentum strategy applied to stock and/or bond no-load mutual funds proves very profitable for long horizon (ten to twenty years) investors.

## **I. Introduction**

The weak form of the efficient market hypothesis claims that past security price changes do not predict future security prices. Empirical evidence, however, suggests that the relationship, if any, between past security price changes and future security price changes partially depends on the horizon. For three to five year horizons what goes up (down) subsequently goes down (up); similarly for very short horizons of days or weeks. However, for three month to one year horizons stock prices exhibit momentum or continuation in a price direction. In other words, what goes up (down) tends to keep going up (down). As Badrinath and Wafal (2002) document, this pattern of stock price momentum is exploited by institutional investors such as investment advisors and mutual funds, pension funds and banks. More specifically, Chan, Jegadeesh and Lakonishok (1999, p.80) state that "mutual funds typically buy past winners and sell past losers. In addition, stocks with strong buy recommendations from analysts typically exhibit high price momentum, and stocks with strong sell recommendations typically exhibit low price momentum."

The traditional momentum strategy involves ranking each stock in the sample under consideration based on its past compound return (Chan, Jagadeesh & Lakonishok (1999, p. 81) or its past average return (Rouwenhorst (1998, p. 271). For example, at the end of each quarter all stocks are ranked into, say, deciles based on their past 3-month average or compound return. The equally weighted decile of stocks with the highest past performance is called the "winner" portfolio and that with the lowest past performance is called the "loser" portfolio. The momentum variable thus obtained reflects the aggregation of individual securities in the decile portfolio and is justified by the noise in the data. However, to replace, say 50 stocks of likely different degrees of momentum by their average and thus implicitly assume that all stocks in the decile portfolio are homogeneous in momentum increases the odds of missing economically relevant information. Further, ranking stocks based on their past 3-month return does not consider their intra 3-month return behavior that may differentially affect investors' expectations.

Let us illustrate the above arguments graphically. Since the investor considers "winner" portfolios only, we assume that the return of the 3-month formation period is positive. Let the sequence of intra-quarter security prices be  $P_0, P_1, P_2, P_3$ , where  $P_0(P_3)$  is the beginning (end) of quarter price. Figure 1 considers all possible patterns of monthly returns that produce the same quarterly return. Intuitively, patterns 3, 4, and 7 do not reflect the momentum idea in terms of trend continuation or projection. Thus, although all 7 price patterns have the same 3-month positive return, investors are likely to prefer patterns 1 and 5, rather than 4 and 7, since they better reflect the idea of momentum. Figure 1 was produced considering patterns of price changes only. However, in addition to the ROR signs, momentum investors are likely to find price acceleration over time a desirable characteristic.

Figure 2 considers both monthly ROR sign and change of returns within pattern 1. In terms of price acceleration sub-pattern (a) is likely more desirable than the other 3 sub-patterns and the momentum investor will expect on average higher subsequent returns from securities exhibiting this sub-pattern than from the others.

In this paper we analyze the momentum effect with no-load mutual funds over the 20-year period 1982 to 2001. Research by Jegadeesh and Titman (1993), Rouwenhorst (1998) and many others documents that average stock returns are positively related to past performance over medium term (3 to 12 month) horizons. In other words U.S. and European stocks with high (low) returns over the past three months to one year continue to out-(under-) perform stocks with low (high) past returns over the same period.

The momentum effect has been documented using data mainly from domestic and international stock markets. Although Chordia and Shivakumar (2002) claim that momentum strategies' returns show strong robustness and are not due to data mining, Hameed and Kusnadi (2002) show that when these traditional strategies are applied to Pacific Rim stock markets, they lack evidence of profitability.

This paper differs from earlier work in two ways. We do not work with stocks only, but with no-load mutual funds of all categories and we also consider not only past 3-month performance but also the intra-quarterly directional changes as previously outlined. We find that over the three-month horizons the profitability of the traditional momentum investment strategy using our universe of mutual funds is mediocre. However, when we select mutual funds based on the directional momentum methods, the resulting long-term performance is impressive.

The remainder of the paper is organized as follows. Section II describes the sample, briefly discusses the survivorship bias issue and provides the fund selection rules to be compared and contrasted. Section III documents the sub-par risk-adjusted profitability of 3-month traditional momentum. Further, it shows that the directional momentum strategies, i.e., strategies that exploit intra-formation period price patterns can be very profitable. Section IV provides conclusions and suggestions for further research.

## II. Sample Construction, Survivorship Bias, and Fund Selection Rules.

### *Sample Construction*

All the data used in our study come from the Morningstar Pricipia Pro CD-ROM. We are interested in developing an investment strategy that is accessible to the small investor. For this reason we limit the universe of mutual funds to no-load mutual funds for which the minimum initial investment is less than or equal to \$5,000. Due to the nature of our study, a no-load mutual fund has to have at least a 3-month history to be included in the universe of mutual funds. The first universe of no-load funds is formed at the beginning of 1982.2 and the last one at the end of 2001.3. Table I shows the size of the universe of no-load funds at each month over the 1982 to 2001 sample period, that meets the above criteria. It shows that the number of no-load mutual funds has increased twenty-fold, from 119 funds in January of 1982 to 2,353 funds in December 2001 and this increase has been monotonic.

Since we do not work with stocks but with mutual funds that are portfolios of securities, we need portfolios of one to several mutual funds only in order to economically exploit the momentum in returns present in aggregate securities. In this paper we opt to select and evaluate single-fund portfolios on a quarterly basis.

### *Survivorship Bias*

The Morningstar data include only funds that survive. As Malkiel (1995) shows, this condition can bias performance results upward. Further, as Blake, Elton, and Gruber (1993) note, since bond funds exhibit lower performance variability, the survivorship bias is less important for bond funds than for stock funds. Although our sample is not free of survivorship-bias, we believe that the main results we derive are qualitatively robust. Since extremely successful funds have better survivorship than poorly performing funds, our selections that exhibit favorable directional momentum should minimize this bias.

### *Fund Selection Rules*

#### A. The traditional momentum strategy (Strategy A)

At the end of each quarter, we rank the available universe of no-load funds from top to bottom based on each fund's past quarterly compound return and select the fund that has the maximum value. Mathematically, the traditional momentum strategy can be expressed as select the fund with

$$\max(1 + R_{t-1})(1 + R_{t-2})(1 + R_{t-3})$$

where  $R_{t-i}$  ( $i=1,2,3$ ) is the rate of return on a fund  $i$  months before the decision and implementation time.

B. The directional momentum strategy with price acceleration (Strategy B)

This strategy can be mathematically expressed as, choose the fund that

$$\max(1 + R_{t-1})(1 + R_{t-2})(1 + R_{t-3})$$

s.t.

$$R_{t-1} > 0, R_{t-2} > 0, R_{t-3} > 0$$

and

$$\frac{(1 + R_{t-2})}{(1 + R_{t-3})} > 1, \frac{(1 + R_{t-1})}{(1 + R_{t-2})} > 1$$

The above inequality ratios imply that, if available, the chosen fund's price accelerates over the last three months before investment is made.

C. The directional momentum strategy with recent price acceleration (Strategy C)

In this case we assume that the investor believes more recent returns convey more information than less recent ones. Mathematically, this strategy is expressed as follows:

Select the mutual fund that

$$\max(1 + R_{t-1})(1 + R_{t-2})(1 + R_{t-3})$$

s.t.

$$R_{t-1} > 0, R_{t-2} > 0, R_{t-3} > 0$$

and

$$\frac{(1 + R_{t-1})}{(1 + R_{t-2})} > 1$$

This strategy assumes that the directional momentum investor pays more attention to  $R_{t-1}$  and  $R_{t-2}$  than to  $R_{t-3}$  and, hence, wants to select the fund that exhibits price acceleration over the two most recent months.

D. The directional momentum strategy with increasing price acceleration (Strategy D)

This strategy is the most difficult to implement and is expressed as follows. Select the mutual fund, if available, that

$$\max(1 + R_{t-1})(1 + R_{t-2})(1 + R_{t-3})$$

s.t.

$$R_{t-1} > 0, R_{t-2} > 0, R_{t-3} > 0$$

and

$$(1 + R_{t-2}) / (1 + R_{t-3}) > 1$$

and

$$(1 + R_{t-1}) / (1 + R_{t-2}) > (1 + R_{t-2}) / (1 + R_{t-3})$$

Unlike with Rule B, Rule D demands that the fund that meets the above constraints exhibit increasing price acceleration over the quarterly formation period.

For all strategies other than the traditional momentum Strategy A, when no no-load mutual fund under consideration meets all the constraints of a directional momentum strategy, then the investment is placed in U.S. Treasury bills.

### **III. Temporal Composition and Risk-Adjusted Performance of Traditional and Directional Momentum Strategies**

In this section, we examine two pieces of evidence on the returns from applying the traditional and three directional momentum strategies on the same universes of no-load mutual funds: graphical evidence and CAPM-evidence. In Table 2, we report the name of the fund and its subsequent “realized” quarterly return from following each of the above-mentioned strategies over the period beginning 192.2-ending 2001.4. We emphasize that the decision on which fund to invest in is made every quarter based on return information provided by the previous three months.

Perusal of Table 2 shows that the selections cover the whole spectrum of asset categories: small and large capitalization funds, growth and value funds, gold and precious metals funds, Treasury and municipal and international bond funds, utility and Euro stock index funds etc. Further, most names appear in the sample only once.

In general, the greater the number of constraints in the fund selection rule, the greater the chances that the rule will not find a suitable fund and thus the investment money will be placed in T-bills.

#### *Graphical Evidence*

Figure 3 shows the evolution of wealth at quarterly intervals, from buying \$1 at beginning 1982.2 and following either one of the four momentum strategies or investing in the S&P 500 portfolio till the end of 2001.4. Figure 3 provides graphical support for the view that Strategy A, the traditional momentum strategy, produces poor performance relative to the other directional momentum strategies. The same Figure 3, also shows that the buy-and-hold strategy of investing in the S&P 500 portfolio obtains better (worse) performance results than the traditional (any directional) momentum strategy. Finally, it appears that only in the last few years, when the stock market bubble burst, did the

directional momentum strategies clearly exhibit superior performance relative to that of the S&P 500 portfolio or the traditional momentum strategy.

Figures 4 and 5 consider the wealth behavior of the strategies under consideration over the two ten-year subperiods, 1982-1991 and 1992-2001, respectively. Over the first subperiod, strategy A, the traditional momentum strategy, produces progressively inferior wealth performance relative to the other four strategies that behave like a herd. Over the second ten-year subperiod, strategy B is the clear winner, with strategies D and C in second and third place, and the traditional momentum strategy A competing with the buy-and-hold strategy of holding the S&P 500 portfolio for last place.

Figures 6, 7, 8, and 9 revisit the comparative wealth behavior of the strategies under consideration at five-year intervals. Over the 1982-1986 period all strategies behave similarly, over the next five-year period, however, the buy and hold strategy is dominant and the traditional momentum strategy takes last place. The behavior of the strategies is similar during the 1992-1996 period (Figure 8) but there is a differentiation in terminal wealth performance over the last five-year subperiod (Figure 9). All three directional momentum strategies vastly outperform the traditional momentum and buy and hold strategies, which perform similarly.

In generating the above figures we used five-year, ten-year and twenty-year intervals to reflect the view of average, long-term and very long-term horizon investors. The general impression one obtains from perusing the above figures is that the momentum strategies show more terminal wealth variability than the buy-and-hold strategy of investing in the S&P 500 portfolio.

#### *CAPM-Based Evidence*

In examining the performance of the traditional momentum strategy relative to the directional ones, we use the S&P 500 portfolio as the benchmark. In terms of measure of performance, we utilize the Jensen-alpha. This measure uses the characteristic line to evaluate fund or strategy performance. Let us define the following variables:  $R$  is the single mutual fund quarterly rate of return,  $f$  is the three-month U.S. Treasury bill rate constructed from one-month bill rates,  $M$  is the S&P 500 portfolio rate of return, and  $e$  is the residual rate of return. Then the characteristic line used to evaluate performance is

$$R - f = a + b(M - f) + e$$

$R - f$  ( $M - f$ ) is also called excess fund (market portfolio) return. If the securities market is mean-variance efficient, then the intercept  $a$  (= Jensen-alpha) is statistically insignificant. If, however, the performance of a strategy is superior (inferior), then  $a > 0$  ( $a < 0$ ). The slope  $b$  is also called beta or systematic risk and is the measure of risk that matters to a well-diversified investor. We know that diversification into bonds, foreign stocks and precious metals produces significant reductions in systematic risk. Since the temporal composition of the momentum strategies is very heterogeneous, we expect the beta of the momentum strategies measured over different estimation periods to be less than one.

Table 3 reports the results from applying the above characteristic line on the traditional momentum strategy (Panel A) and on the directional momentum strategies (Panels B, C, and D) over different estimation periods. Looking at Panel A, we see that only over the 1992-2001 period and over the 1997-2001 period was the Jensen-alpha positive, but statistically insignificant. However, the systematic risk of this strategy, with the exception of the 1987-1991 period, was greater than one.

As for directional momentum strategies, it appears that strategies B and D provide similar results whereas strategy C provides somewhat less impressive results. The most successful directional momentum strategies (B&D) have betas mainly less than one, whereas strategy C's betas are around one.

It appears that there is an inverse relationship between a momentum strategy's beta and its Jensen measure of performance, alpha. Further, the higher the  $R^2$  of a strategy, the greater its systematic risk and the lower its Jensen-alpha.

With the exception of the most recent years, the 1982-2001 period was associated with primarily rising equity prices. If one considers both graphical and CAPM-based statistical evidence, it appears that there are differences between the traditional standard momentum strategies and directional ones. These differences favor especially strategy B, both in terms of terminal wealth and risk-adjusted performance forms. We believe that strategy D would have outperformed strategy B if the universe of no-load funds had been in the thousands throughout the 1982-2001 period. We therefore believe that strategy D will be a credible competitor to strategy B from now on..

#### **IV. Conclusions and Recommendations**

In this paper we show that when the traditional momentum strategy is applied to no-load mutual funds, the results are mediocre. However, we also show that when a more nuanced definition of recent return performance that discriminates among alternative price growth patterns is used, it can enhance the profitability of the momentum effect. This finding has implications for the published momentum literature. Since this literature does not consider the intra-formation period return behavior that differentially influences investors' expectations, one can argue that its claims of risk-adjusted superior performance for these strategies are conservative and that if these studies are replicated with portfolios formed on a measure of directional momentum, the results will be better still.

A major finding of this paper is that directional momentum strategies perform best when the stock market is turbulent and prices are declining. Under conditions like that the directional momentum strategies perform best by obtaining generous positive alphas and exhibiting lower than one betas. This behavior should make directional momentum strategies very attractive to the small investor.

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**Table 1**  
**Month-by month universe size of no-load mutual funds over the 20-year period January 1982-December 2001**

Month	# funds	Month	# funds	Month	#funds	Month	#funds	Month	# funds
Jan-82	119	Jan-86	240	Jan-90	407	Jan-94	772	Jan-98	1535
Feb-82	119	Feb-86	241	Feb-90	407	Feb-94	777	Feb-98	1544
Mar-82	119	Mar-86	242	Mar-90	408	Mar-94	798	Mar-98	1565
Apr-82	122	Apr-86	243	Apr-90	410	Apr-94	818	Apr-98	1589
May-82	122	May-86	246	May-90	410	May-94	823	May-98	1594
Jun-82	122	Jun-86	249	Jun-90	414	Jun-94	836	Jun-98	1604
Jul-82	122	Jul-86	253	Jul-90	420	Jul-94	746	Jul-98	1619
Aug-82	122	Aug-86	257	Aug-90	421	Aug-94	762	Aug-98	1625
Sep-82	122	Sep-86	259	Sep-90	423	Sep-94	768	Sep-98	1635
Oct-82	124	Oct-86	264	Oct-90	428	Oct-94	900	Oct-98	1651
Nov-82	125	Nov-86	267	Nov-90	433	Nov-94	913	Nov-98	1657
Dec-82	128	Dec-86	273	Dec-90	436	Dec-94	918	Dec-98	1668
Jan-83	137	Jan-87	286	Jan-91	447	Jan-95	948	Jan-99	1720
Feb-83	138	Feb-87	290	Feb-91	453	Feb-95	955	Feb-99	1725
Mar-83	139	Mar-87	291	Mar-91	456	Mar-95	963	Mar-99	1746
Apr-83	141	Apr-87	297	Apr-91	459	Apr-95	975	Apr-99	1761
May-83	143	May-87	301	May-91	462	May-95	979	May-99	1788
Jun-83	144	Jun-87	307	Jun-91	469	Jun-95	986	Jun-99	1804
Jul-83	145	Jul-87	308	Jul-91	472	Jul-95	1007	Jul-99	1818
Aug-83	151	Aug-87	312	Aug-91	476	Aug-95	1011	Aug-99	1833
Sep-83	152	Sep-87	316	Sep-91	478	Sep-95	1021	Sep-99	1845
Oct-83	155	Oct-87	323	Oct-91	481	Oct-95	1040	Oct-99	1871
Nov-83	158	Nov-87	324	Nov-91	484	Nov-95	1054	Nov-99	1877
Dec-83	163	Dec-87	326	Dec-91	486	Dec-95	1064	Dec-99	1880
Jan-84	166	Jan-88	336	Jan-92	497	Jan-96	1076	Jan-00	1910
Feb-84	171	Feb-88	338	Feb-92	501	Feb-96	1083	Feb-00	1915
Mar-84	176	Mar-88	340	Mar-92	505	Mar-96	1111	Mar-00	1927
Apr-84	179	Apr-88	343	Apr-92	511	Apr-96	1124	Apr-00	1948
May-84	182	May-88	346	May-92	518	May-96	1141	May-00	1973
Jun-84	190	Jun-88	350	Jun-92	526	Jun-96	1150	Jun-00	1986
Jul-84	191	Jul-88	351	Jul-92	539	Jul-96	1165	Jul-00	2023
Aug-84	192	Aug-88	353	Aug-92	546	Aug-96	1179	Aug-00	2033
Sep-84	194	Sep-88	355	Sep-92	561	Sep-96	1189	Sep-00	2064
Oct-84	195	Oct-88	361	Oct-92	571	Oct-96	1222	Oct-00	2100
Nov-84	197	Nov-88	365	Nov-92	579	Nov-96	1245	Nov-00	2113
Dec-84	199	Dec-88	370	Dec-92	592	Dec-96	1268	Dec-00	2123
Jan-85	205	Jan-89	374	Jan-93	623	Jan-97	1300	Jan-01	2247
Feb-85	207	Feb-89	376	Feb-93	635	Feb-97	1319	Feb-01	2259
Mar-85	208	Mar-89	377	Mar-93	640	Mar-97	1338	Mar-01	2297
Apr-85	211	Apr-89	378	Apr-93	649	Apr-97	1364	Apr-01	2301
May-85	212	May-89	378	May-93	661	May-97	1386	May-01	2318
Jun-85	212	Jun-89	381	Jun-93	671	Jun-97	1395	Jun-01	2327
Jul-85	216	Jul-89	387	Jul-93	683	Jul-97	1417	Jul-01	2336
Aug-85	218	Aug-89	390	Aug-93	690	Aug-97	1429	Aug-01	2338
Sep-85	218	Sep-89	392	Sep-93	701	Sep-97	1457	Sep-01	2347
Oct-85	226	Oct-89	395	Oct-93	716	Oct-97	1472	Oct-01	2348
Nov-85	229	Nov-89	397	Nov-93	726	Nov-97	1486	Nov-01	2349
Dec-85	233	Dec-89	400	Dec-93	746	Dec-97	1501	Dec-01	2353

**Table 2**  
**Mutual Funds Selected and Holding Period Returns**

<b>Selection Quarter</b>	<b>Strategy A Fund Name</b>	<b>Quarterly Return (%)</b>	<b>Strategy B Fund Name</b>	<b>Quarterly Return (%)</b>	<b>Strategy C Fund Name</b>	<b>Quarterly Return (%)</b>	<b>Strategy D Fund Name</b>	<b>Quarterly Return (%)</b>
1982.1	Stein Roe Managed Municipals	4.62	T. Rowe Price New Income	3.49	Strong Balanced	4.18	T-Bill	3.23
1982.2	Gintel	9.46	T-Bill	2.52	Strong Large Cap Growth	6.31	T-Bill	2.52
1982.3	U.S. Global Inv Gold Shares	54.77	Spectra N	24.62	Spectra N	24.62	State Farm Interim	6.90
1982.4	U.S. Global Inv Gold Shares	-4.96	T-Bill	2.09	Salomon Bros Opportunity	16.83	T-Bill	2.09
1983.1	FMI Common Stock	13.94	Strong Large Cap Growth	18.55	Sit Mid Cap Growth	21.67	Strong Large Cap Growth	18.55
1983.2	American Cent Ultra Inv	-7.65	Fidelity Independence	-3.94	American Cent Ultra Inv	-7.65	T-Bill	2.38
1983.3	Japan S	10.41	SAFECO Dividend Income	2.34	Stratton Monthly Div REIT	-4.54	SAFECO Dividend Income	2.34
1983.4	Greenspring	3.91	Japan S	15.35	Japan S	15.35	Japan S	15.35
1984.1	Bailard, Biehl Intl Equity	-13.13	T-Bill	2.56	Bailard, Biehl Intl Equity	-13.13	T-Bill	2.56
1984.2	Nicholas II	10.94	Strong Large Cap Growth	4.37	Strong Balanced	2.74	T-Bill	2.69
1984.3	Armstrong Associates	-13.24	Fidelity Capital & Income	3.96	HighMark Bond Fid	7.47	T-Bill	2.33
1984.4	Century Shares Trust	14.91	Copley	5.59	Century Shares Trust	14.91	SAFECO CA Tax-Free Inc	4.79
1985.1	Fidelity OTC	9.78	USAA Cornerstone Strategy	3.10	Scudder Large Co Val S	6.47	Stratton Monthly Div REIT	12.39
1985.2	American Cent Targt 2010 Inv	-5.41	Stratton Monthly Div REIT	-6.49	American Cent Targt '10	-5.41	T-Bill	1.83
1985.3	Bailard, Biehl Intl Equity	20.98	Bailard, Biehl Intl Equity	20.98	Bailard, Biehl Intl Equity	20.98	Bailard, Biehl Intl Equity	20.98
1985.4	American Cent Targt 2005 Inv	45.49	American Cent Targt '05 Inv	45.49	American Cent Targt '05	45.49	Bailard, Biehl Intl Equity	29.20
1986.1	American Cent Targt 2010 Inv	-5.96	Fidelity Overseas	7.59	Fidelity Overseas	7.59	Fidelity Growth & Income	6.86
1986.2	Strong Opportunity Inv	-11.64	Strong Opportunity Inv	-11.64	Strong Opportunity Inv	-11.64	Strong Opportunity Inv	-11.64
1986.3	U.S. Global Inv Gold Shares	-0.65	U.S. Global Inv World Gold	6.40	U.S. Global Inv World Gold	6.40	T-Bill	1.37
1986.4	American Cent Targt 2010 Inv	0.61	T-Bill	1.42	American Cent Targt '10	0.61	T-Bill	1.42
1987.1	U.S. Global Inv Gold Shares	-11.36	U.S. Global Inv Gold Shares	-11.36	U.S. Global Inv Gold Shrs	-11.36	U.S. Global Inv Gold Shrs	-11.36
1987.2	Nomura Pacific Basin	7.36	Berwyn	6.81	Fidelity Europe	13.37	Berwyn	6.81
1987.3	USAA Gold	-37.37	T-Bill	1.55	Fidelity Europe	-25.33	T-Bill	1.55
1987.4	American Cent Targt 2015 Inv	4.77	Babson Tax-Free Income	2.75	American Cent Targt '15	4.77	T-Bill	1.48
1988.1	Stonebridge Aggressive Grth	-14.23	Mosaic Mid-Cap Growth	-1.07	Mosaic Mid-Cap Growth	-1.07	Mosaic Mid-Cap Growth	-1.07
1988.2	Vanguard Windsor	1.92	Vanguard Windsor	1.92	Vanguard Windsor	1.92	Vanguard Windsor	1.92
1988.3	Westcore Flexible Income	-3.07	FAM Value	3.47	FAM Value	3.47	FAM Value	3.47
1988.4	American Cent Targt 2015 Inv	-0.73	RSI Retrmnt STInvmt	2.18	Scudder Global S	9.84	T-Bill	2.21
1989.1	American Cent Ultra Inv	10.43	T-Bill	2.19	Scudder Large Co Val S	9.11	T-Bill	2.19
1989.2	American Cent Targt 2015 Inv	-4.23	American Cent Targt '15 Inv	-4.23	American Cent Targt '15	-4.23	Strong Discovery	7.73
1989.3	INVESCO Health Sciences Inv	5.90	T-Bill	1.97	American Cent Giftrust Inv	-4.03	T-Bill	1.97
1989.4	U.S. Global Inv Gold Shares	-12.24	Fidelity Utilities	-4.92	Fidelity Utilities	-4.92	Stein Roe High-Yield Muni	0.50
1990.1	Stonebridge Aggressive Grth	8.23	Merrill Lynch Sen Float Rt	2.36	Stonebridge Aggr. Grth	8.23	T-Bill	2.01
1990.2	American Cent Targt 2020 Inv	-13.34	Fidelity Capital & Income	-2.92	Fidelity Capital & Income	-2.92	Gabelli Mathers	0.84
1990.3	USAA Gold	-13.23	Scudder Medium-Term T/F S	2.16	USAA Gold	-13.23	Scudder Medium-Term T/F	2.16
1990.4	Fidelity Adv Eqty Grth Instl	37.10	Spectra N	35.29	Spectra N	35.29	State Farm Interim	1.88
1991.1	American Heritage	-0.90	JP Morgan US Sm Co Sel	-8.53	American Cent Ultra Inv	-6.19	UMB Scout Small Cap	2.99
1991.2	U.S. Global Inv Gold Shares	-15.41	Vanguard Precious Metals	-3.81	Vanguard Precious Metals	-3.81	Vanguard Precious Metals	-3.81
1991.3	INVESCO Financial Svcs Inv	4.15	Bailard, Biehl Bond Opp	5.32	Stonebridge Aggressive	15.45	Bailard, Biehl Bond Opp	5.32







**Table 3**  
**CAPM Regressions to Explain Quarterly Excess Returns on Standard and Directional Momentum Strategies**

$$R - f = a + b(M - f) + e$$

All returns are quarterly and measured in percentages. M is the S&P 500 Portfolio, f is the three-month U.S. Treasury bill rate constructed from one month bill rates and R is the single mutual fund portfolio return to be explained.

Panel A describes regressions where the mutual fund is selected based on traditional momentum methodology. t(a) (t(b)) is the t-value of the intercept (slope coefficient). The regression R<sup>2</sup> and residual standard error s(e) are adjusted for degrees of freedom. Finally n is the number of quarterly returns in the estimation period.

Panel B summarizes sets of regressions where the mutual fund is selected so that it maximizes the quarterly formation period compound return subject to  $R_{t-1} > 0, R_{t-2} > 0, R_{t-3} > 0$  and  $(1+R_{t-1})/(1+R_{t-2}) > 1$  and  $(1+R_{t-2})/(1+R_{t-3}) > 1$ , where  $R_{t-1}, R_{t-2}, R_{t-3}$  are monthly rates of return over the quarterly formation period.

Panel C summarizes a set of regressions where the mutual fund is selected so that the compound return over the quarterly formation period is maximized subject to  $R_{t-1} > 0, R_{t-2} > 0, R_{t-3} > 0$  and  $(1+R_{t-1}) > (1+R_{t-2}) > 1$ .

Panel D summarizes a set of regressions where the mutual fund is selected so that the compound return over the quarterly formation period is maximized subject to  $R_{t-1} > 0, R_{t-2} > 0, R_{t-3} > 0$ ,  $(1+R_{t-2})/(1+R_{t-3}) > 1$  and  $(1+R_{t-1})/(1+R_{t-2}) > (1+R_{t-2})/(1+R_{t-3})$

<b>Panel A</b>								
Estimation Period		n	a	b	t(a)	t(b)	R <sup>2</sup>	s(e)
Beginning	End							
1982.2	2001.4	79	-0.76	1.28	-0.37	5.03***	0.24	17.64
1982.2	1991.4	39	-3.44	1.35	-1.59	5.44***	0.43	12.80
1992.1	2001.4	40	1.78	1.23	0.50	2.64**	0.13	21.40
1982.2	1986.4	19	-1.29	1.86	-0.41	4.77**	0.55	12.32
1987.1	1991.4	20	-6.33	0.99	-2.36**	3.48***	0.37	11.62
1992.1	1996.4	20	-0.01	2.02	-0.00	2.04*	0.14	15.26
1997.1	2001.4	20	1.71	1.12	0.28	1.81	0.11	26.91

<b>Panel B</b>								
Estimation Period		n	a	b	t(a)	t(b)	R <sup>2</sup>	s(e)
Beginning	End							
1982.2	2001.4	79	4.77	0.54	2.61***	2.44**	0.06	15.44
1982.2	1991.4	39	0.81	0.65	0.48	3.34***	0.21	10.09
1992.1	2001.4	40	8.52	0.45	2.74***	1.11	0.01	18.87
1982.2	1986.4	19	1.56	1.19	0.64	3.88*	0.44	9.66
1987.1	1991.4	20	-0.81	0.30	-0.39	1.37	0.04	8.96
1992.1	1996.4	20	3.04	0.98	0.98	1.36	0.04	11.11
1997.1	2001.4	20	12.72	0.42	2.31**	0.76	-0.02	24.21

<b>Panel C</b>								
Estimation Period		n	a	b	t(a)	t(b)	R <sup>2</sup>	s(e)
Beginning	End							
1982.2	2001.4	79	2.54	0.80	1.67*	4.32***	0.18	12.87
1982.2	1991.4	39	-0.22	1.05	-0.12	5.11***	0.40	10.64
1992.1	2001.4	40	5.16	0.51	2.17**	1.64	0.04	14.43
1982.2	1986.4	19	1.14	1.49	0.48	5.00***	0.57	9.41
1987.1	1991.4	20	-2.24	0.75	-0.91	2.89***	0.28	10.65
1992.1	1996.4	20	1.42	1.47	0.44	1.96*	0.13	16.57
1997.1	2001.4	20	6.65	0.40	1.72	1.03	0.00	16.99

<b>Panel D</b>								
Estimation Period		n	a	b	t(a)	t(b)	R <sup>2</sup>	s(e)
Beginning	End							
1982.2	2001.4	79	4.07	0.38	2.39**	1.85*	0.03	14.39
1982.2	1991.4	39	1.22	0.31	1.04	2.31**	0.10	6.88
1992.1	2001.4	40	6.77	0.52	2.18**	1.27	0.02	16.79
1982.2	1986.4	19	2.12	0.71	1.09	2.92***	0.30	7.67
1987.1	1991.4	20	-0.31	0.04	-0.34	0.41	-0.05	3.95
1992.1	1996.4	20	1.79	0.54	0.52	0.68	-0.03	12.22
1997.1	2001.4	20	11.64	0.56	2.20**	1.03	0.00	23.27

Note: (\*\*\*, \*\*, \*) Denotes significance at the (1%, 5%, 10%) level



Figure 1

Possible intra-quarter monthly return patterns based on their ROR signs only ( $P_t/P_{t-1}$ )

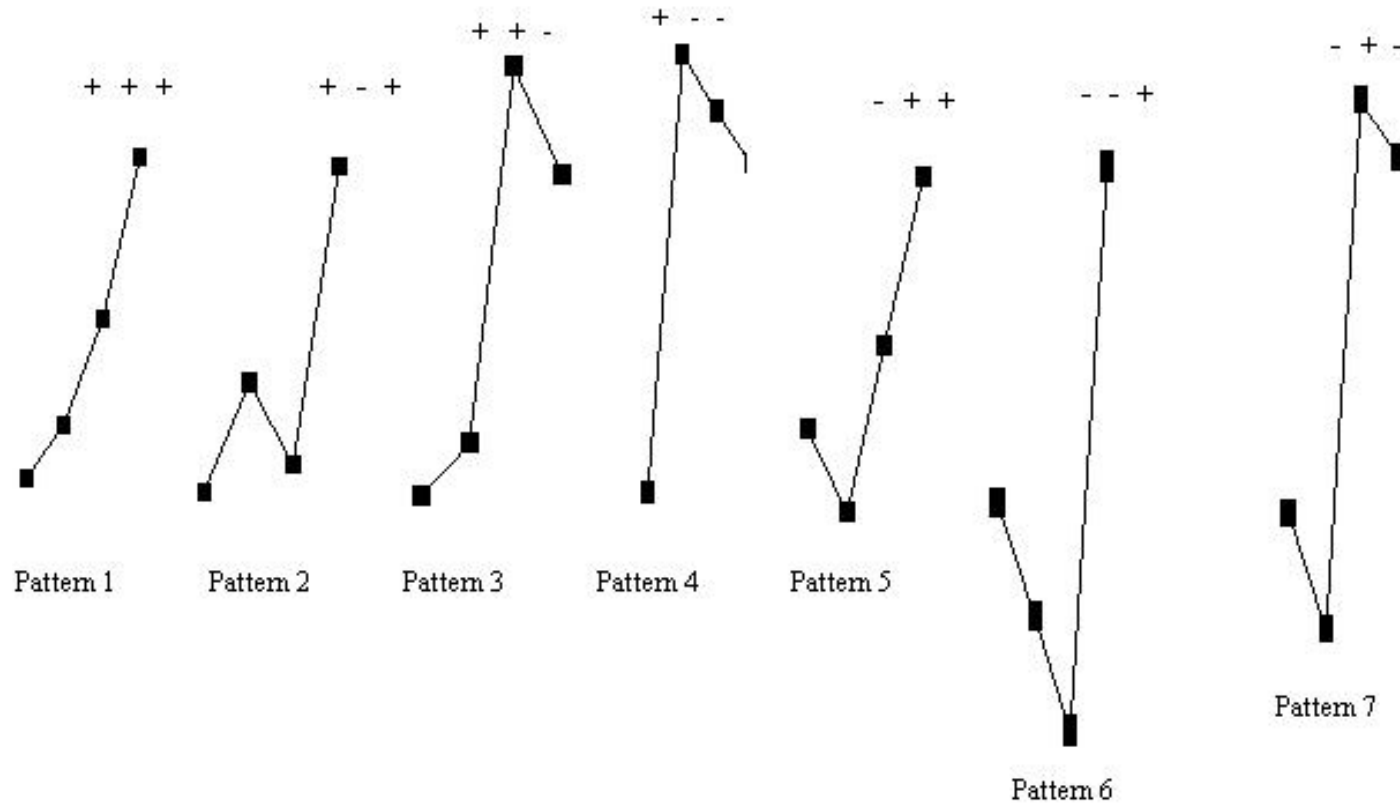
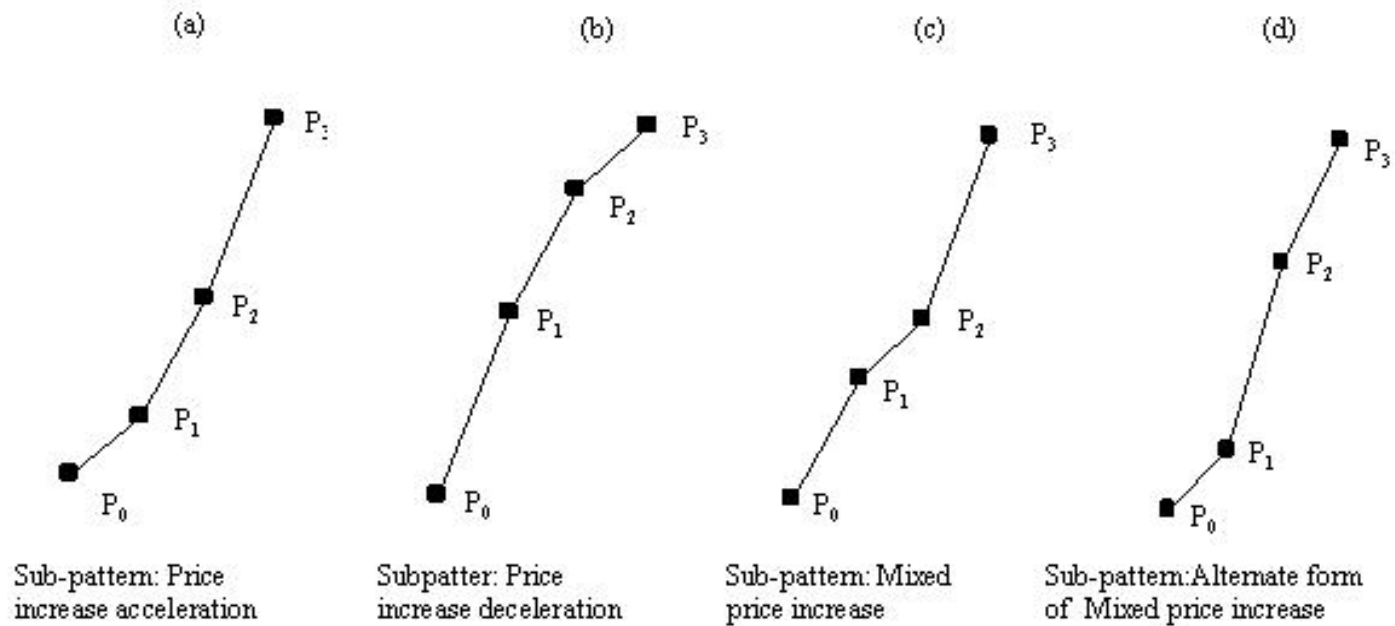


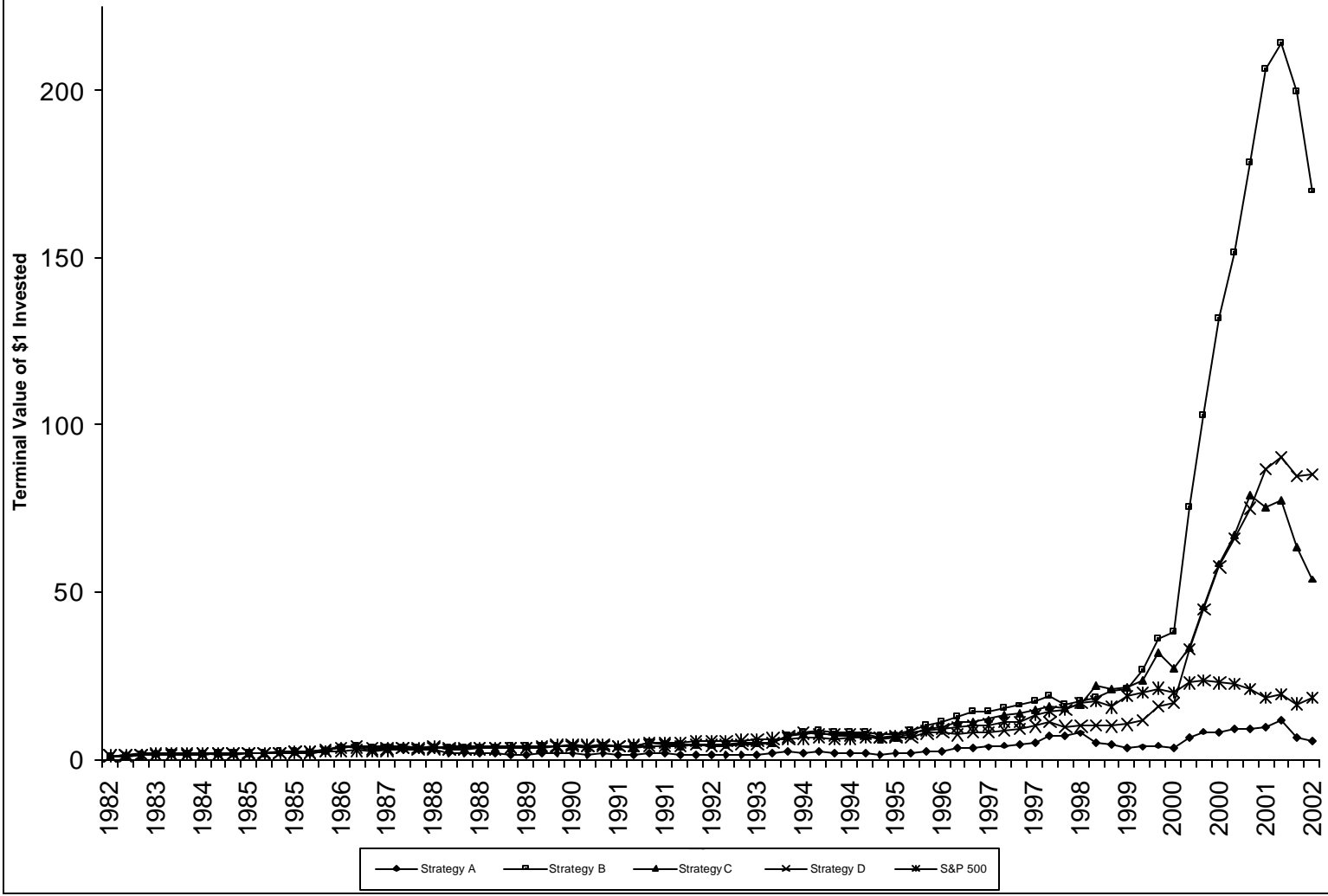
Figure 2.

Possible intra-quarter monthly return sub-patterns, within Pattern #1 in Figure 1, that consider both ROR sign and size

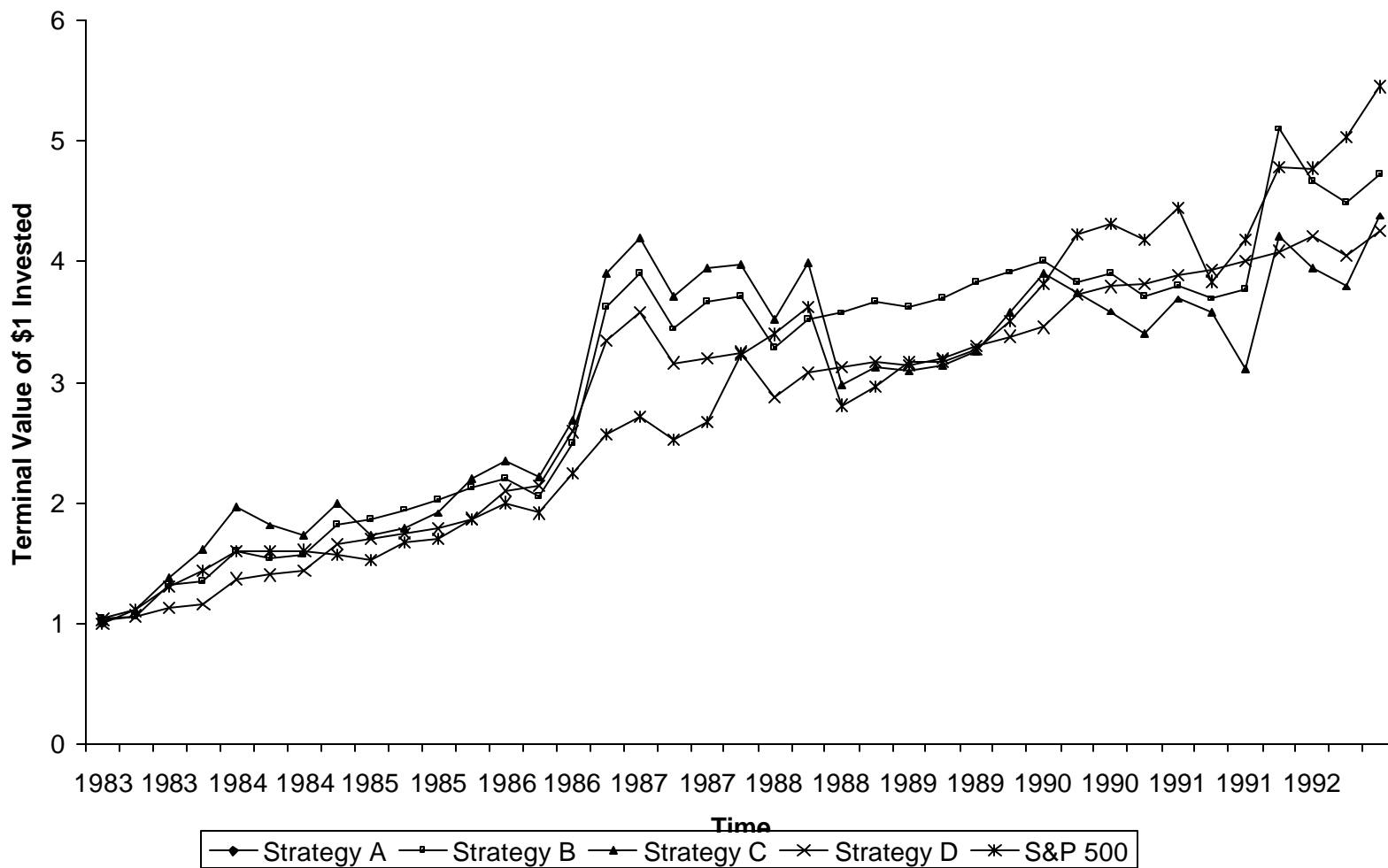




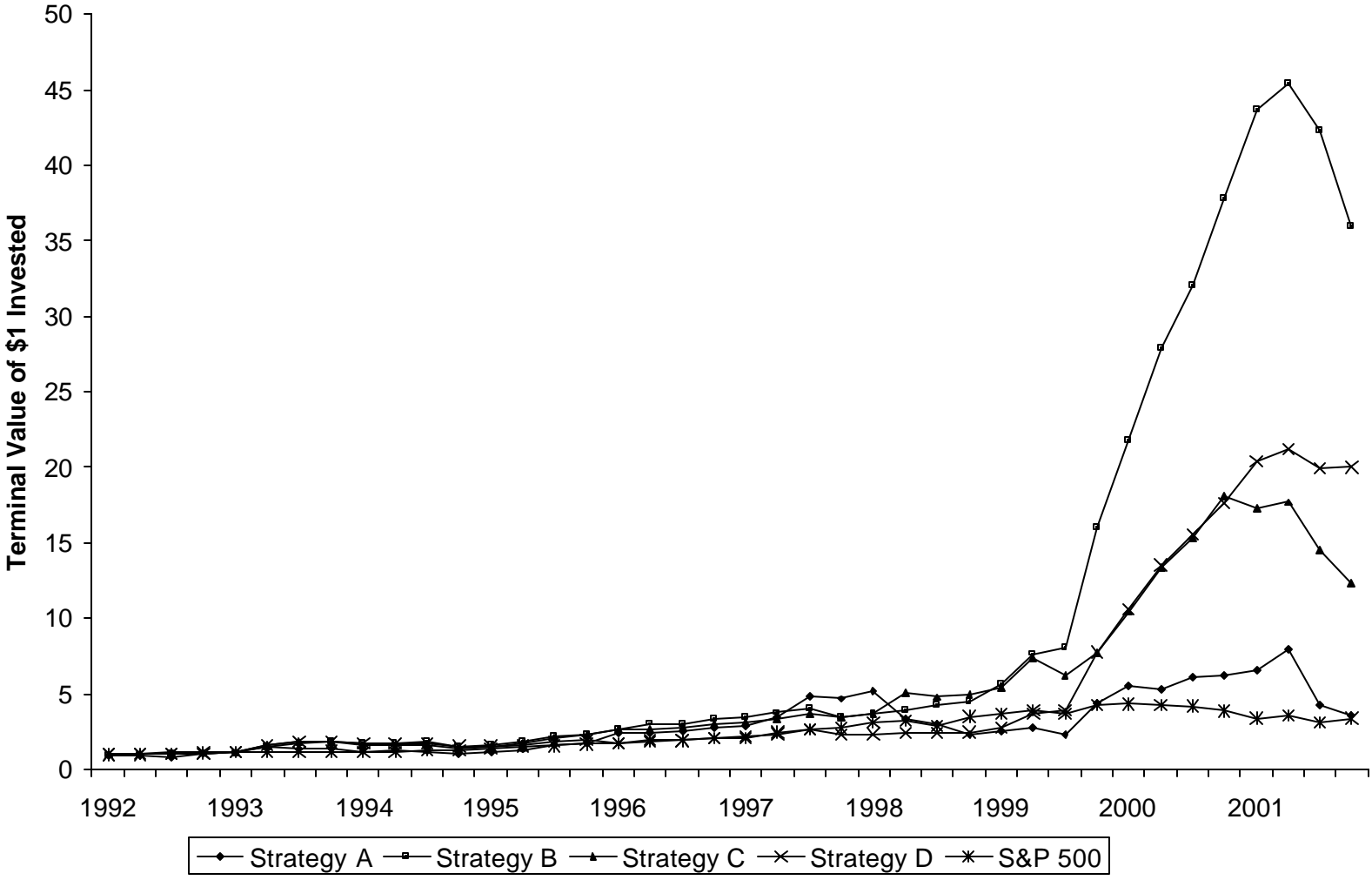
**Figure 3**  
**Terminal Value of \$1 Invested for the Full 20-year Period**



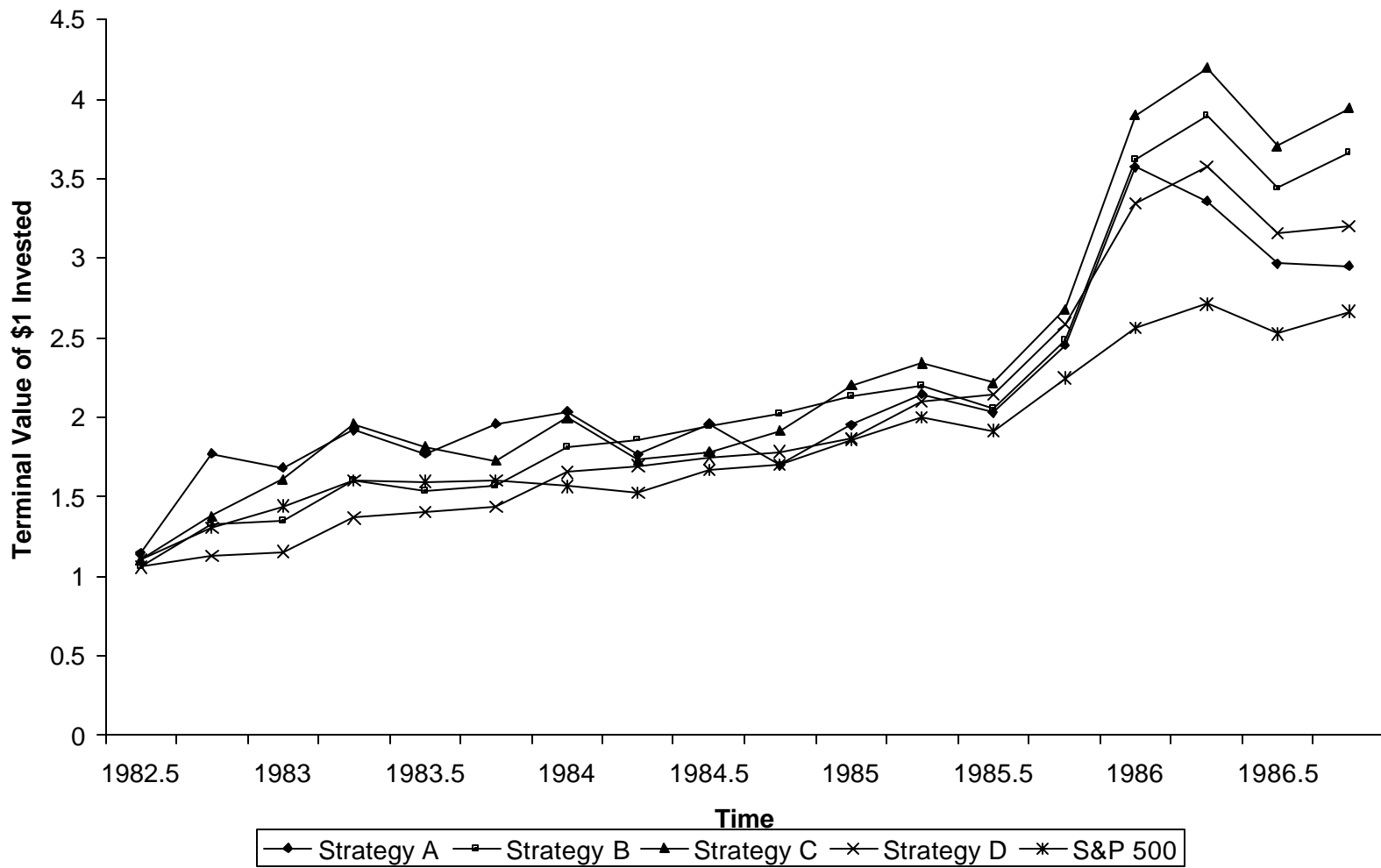
**Figure 4**  
**Terminal Value of \$1 Invested for the First 39 Quarters 1982-1991**



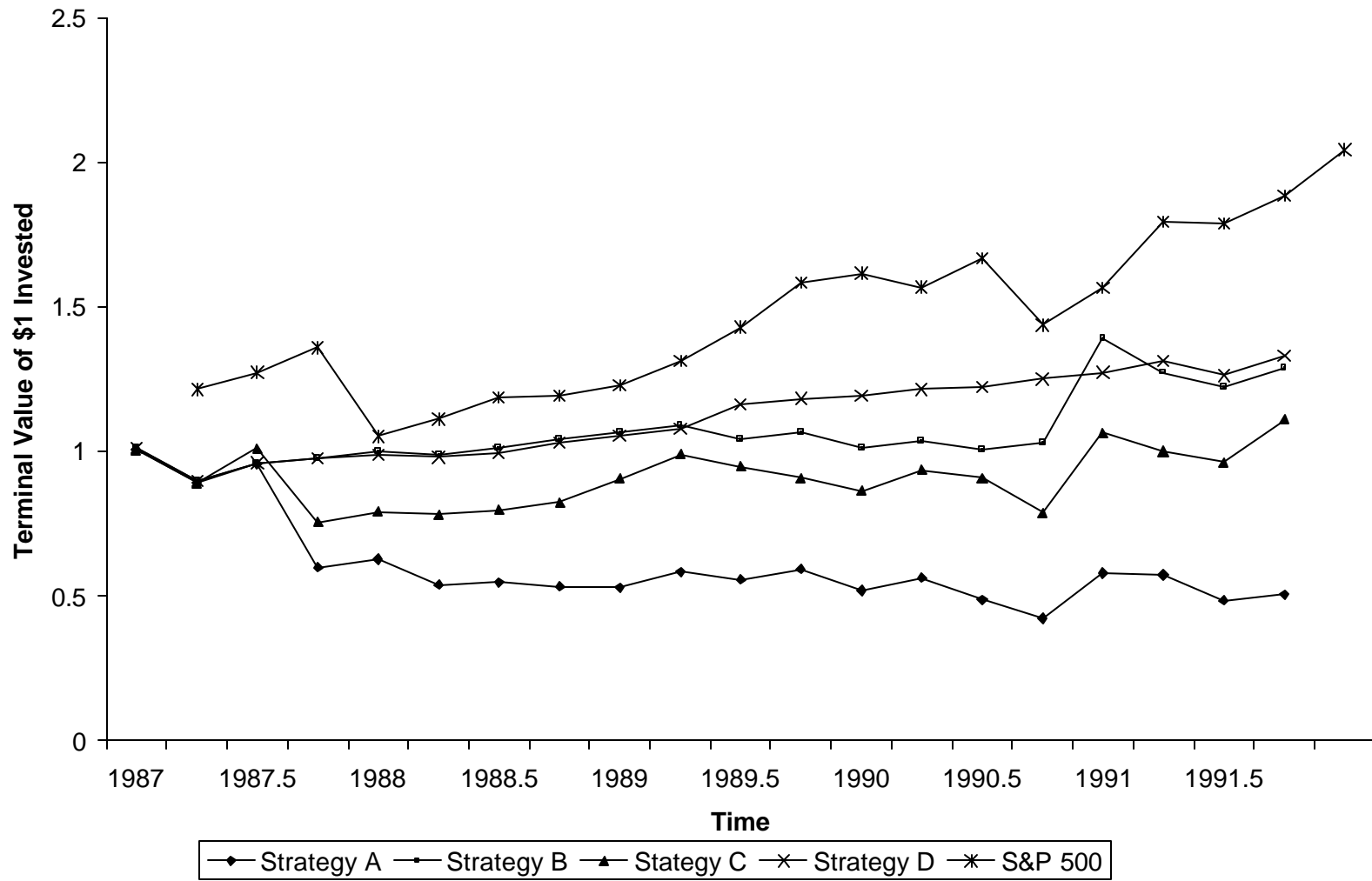
**Figure 5**  
**Terminal Value of \$1 Invested for the Last 40 Quarters 1992-2001**



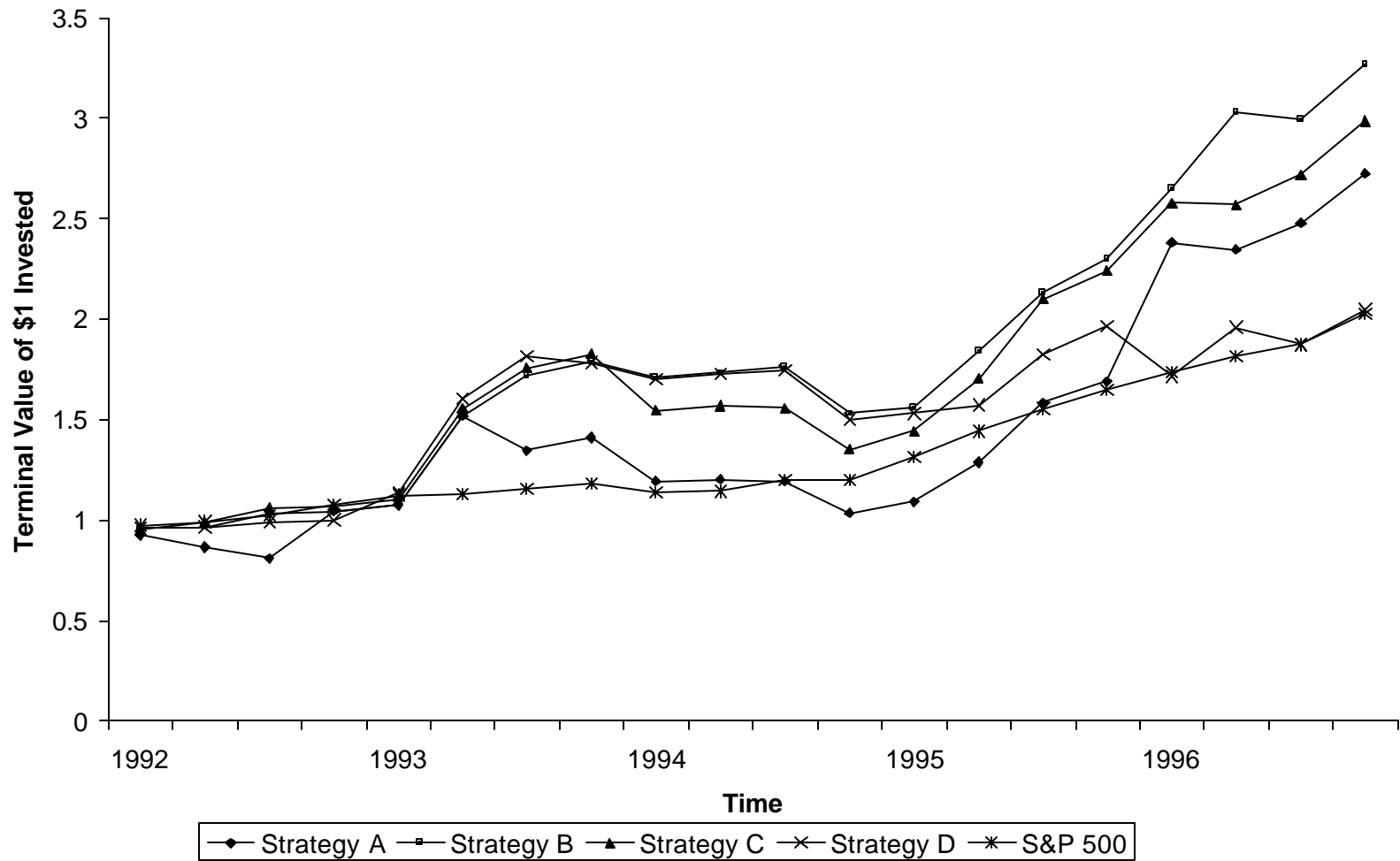
**Figure 6**  
**Terminal Value of \$1 Invested for the First 19 Quarters 1982 -1986**



**Figure 7**  
**Terminal Value of \$1 Invested for the Second 20 Quarters 1987-1991**



**Figure 8**  
**Terminal Value of \$1 Invested during the Third 20 Quarters 1992-1996**



**Figure 9**  
**Terminal Value of \$1 Invested for the Final 20 Quarters 1997-2001**

