
INDEXATION OF MOMENTUM EFFECTS

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Momentum is now viewed as another factor of equity returns in addition to factors such as beta, market capitalization, and market-to-book ratio. In this paper, I propose indexation of momentum effects to pave the way for development of the momentum-based investment products and for improved performance evaluation of the actively managed funds. I also describe a family of the Momentum Index to be created, explain how to construct the Momentum Indexes, and demonstrate historical performance of the Momentum Indexes. Finally, I discuss implications and applications of the Momentum Indexes to practical investment management.



A large volume of empirical work has documented that stock returns exhibit momentum in the US as well as foreign markets.¹ To be specific, momentum effects refer to the tendency of those stocks with the highest and lowest return for the previous 3–12 months to outperform and underperform, respectively, the market in the following 3–12 month periods. Momentum effects remain one of the most puzzling anomalies since they contradict even with the weak form of the Efficient Market Hypothesis. Since empirical evidence on momentum effects is quite robust and consistent, momentum effects seem to be accepted now as almost a fact in the academic circle as well as the investment community. In fact, momentum effects

may deserve another factor which can explain stock returns in addition to factors such as beta, market capitalization, and book-to-market ratio. As Grundy and Martin (2001) put it succinctly, “if [the momentum effect] remains a fact, it becomes a factor.”

It is an open question whether and how long momentum effects will continue in the future. However, momentum effects are likely to persist if they are caused by factors such as human cognitive biases, institutional practices, or stochastic dividend growth rates.² This is because such factors may be resistant to learning or cure, or simply uncontrollable. There is some evidence that momentum effects are a product of some of these factors.³ Furthermore, momentum effects are not a phenomenon unique to the US market, but rather a universal phenomenon.

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While a considerable number of studies have attempted to explain momentum effects, there have been few attempts to explore the implications and applications of momentum effects to practical investment management. Momentum effects have several applications to investment management. For example, individual investors can enhance the investment return by buying a portfolio of past winners rather than, say, an S&P 500 index fund. Since past winners represent a unique segment of the market, individual investors can further reduce investment risk by adding past winners to their current portfolio. In addition, individual investors can evaluate better the security-picking skills of actively managed fund managers by separating momentum effects from fund performance. An efficient means for systematically measuring momentum effects, however, is needed first before the investment products based on momentum effects are developed. The purpose of this paper is to propose indexation of momentum effects to pave the way for development of the investment products capturing momentum effects, and for improved performance evaluation of the actively-managed funds. This paper also provides evidence that momentum effects are present even among liquid stocks.

1 Description

Momentum Indexes created in this paper attempt to systematically measure intermediate-term momentum effects. The Momentum Indexes consist of three main indexes and five subindexes. The main indexes include the Momentum 300 Index, the MomentumContra 300 Index, and the Impetus 300 Index. The subindexes include Momentum 100 Growth and Momentum 100 Value categorized by growth/value style, and Momentum 100 Large Cap, Momentum 100 Mid Cap, and Momentum 100 Small Cap sorted by market capitalization. The five subindexes intend to measure

momentum effects in growth, value, large cap, medium cap, and small cap stocks.

The Momentum 300 Index and the Impetus 300 Index consist of 300 stocks that performed the best and the worst, respectively, in the ranking period of 9–1 month before index member formation. The MomentumContra 300 Index attempts to measure simultaneously the long-term contrarian effect as well as the intermediate-term momentum effect. The long-term contrarian effect refers to the tendency of those stocks with the worst returns for the past 3–5 years to outperform the market in the subsequent 3–5 year periods. The MomentumContra 300 Index comprises 300 stocks with the lowest returns during the period of 58 to 10 months before index member formation among 600 stocks with the highest returns during the period of 9 months to 1 month before index member formation.

The Momentum 100 Growth and Value Indexes are composed of 100 stocks with the highest return in the ranking period that are chosen among the stocks with the highest and lowest composite value of book-to-price ratio and sales-to-price ratio, respectively. The Momentum 100 Large Cap, Mid Cap, and Small Cap Indexes each consist of 100 stocks with the highest return in the ranking period that are selected among the stocks with large, medium, and small market capitalization, respectively.

All the Momentum Indexes are market cap-weighted, which means that the level of an index reflects the total market value of all component stocks relative to a particular base date. The market cap-weighting system is chosen to minimize price impact costs of index component rebalancing. The only exception is the Impetus 300 Index which is equally weighted. There was no significant difference in performance between equal weighting and market-cap weighting of past losers. However, a portfolio of equally weighted past losers tended

to perform better in January than that of market cap-weighted ones. As a result, equal weighting of past losers will better serve investors who attempt to exploit seasonal regularities.

In each of the Momentum Indexes, no member firms account for more than 10% of an index, and, with respect to the smallest firms together constituting 40% of an index, any member firm limits its weight to 5%. If any member firm has so large a market cap that its market cap-based weight exceeds such a limit, the weight in excess of that limit will be allocated to other member firms in proportion to their market cap. The purpose of putting such limits on the weight of member firms is to accommodate the requirements for pass-through treatment of dividends and long-term capital gains by a regulated investment company (RIC), the tax structure used by most US-based funds, and/or by the undertaking for collective investment in transferable securities (UCITS), the diversification standard adopted by the European Union and several countries in Asia.

2 Construction method

2.1 Index membership criteria

For inclusion in the Momentum 300 Index, the MomentumContra 300 Index, and the Impetus 300 Index, all companies listed on NYSE, AMEX, and Nasdaq are initially screened. The screening process begins with the elimination of foreign stocks, bulletin board stocks, and pink sheet stocks. Foreign stocks are excluded due to the loss of any withholding tax credit on foreign shares by taxable US shareholders of index funds based on the Momentum Indexes. Preferred and convertible preferred stock, redeemable shares, participating preferred stock, warrants and rights, trust receipts, limited partnerships, royalty trusts, real estate investment trusts, exchange-traded funds, and closed-end investment companies are also

excluded. The following criteria are used to select the component stocks from the remaining stocks.

2.2 Liquidity

The remaining stocks are ranked by dollar trading volume in the ranking period between 9 months and 1 month before index member formation.⁴ Only the highest one third of the stocks in dollar trading volume are considered for inclusion in the Momentum 300 Index, the MomentumContra 300 Index, and the Impetus 300 Index. I believe that liquidity should be an important criterion for the Momentum Indexes. The Momentum Indexes must be replicable in order to serve as a template for exchange-traded or open-end funds or a benchmark for fund performance. If the Momentum Indexes include illiquid stocks as constituents, fund managers might have difficulty in replicating the indexes due to high transaction costs. In the same vein, those stocks trading at less than \$1.00 at the end of the ranking period are also excluded.

2.3 Past performance

The liquid set of stocks is then ranked by the holding period return in the ranking period. Seventy-five stocks (i.e. one fourth of the component stocks) with the highest and lowest returns in the ranking period are selected sequentially every 3 months to be included in the Momentum 300 Index and the Impetus 300 Index, respectively. For consideration toward inclusion in the MomentumContra 300 Index, 150 stocks with the highest returns in the period between 9 months and 1 month before index member formation are selected first every 3 months. Among these 150 stocks, 75 stocks with the lowest returns in the period between 58 and 9 months before index member formation are selected every 3 months. These 75 stocks must have price data available for at least 30 months before index member formation.

The individual stocks currently included in an index are excluded in the subsequent selection process of component stocks of that particular index. This would ensure that each index consists of the exact number of stocks as stated. The purpose of imposing such a constraint is to naturally meet RIC and/or UCITS requirements and reduce volatility of the Momentum Indexes.

2.4 *Style index methodology*

The process of selecting the component stocks of the momentum style indexes categorized by growth/value and market capitalization is similar to that for the main indexes. One notable difference is that the component stocks are selected from the most liquid one-half, instead of one-third, of the common stocks that meet the membership criteria specified above.

To construct the Momentum 100 Growth and Value Indexes, the most liquid one-half of US stocks is sorted by a composite value of two valuation ratios at the end of the ranking period, i.e. price-to-book ratio and price-to-sales ratio. Extensive academic and practitioner research reports that these two valuation measures are the most important factors that distinguish between growth and value stocks.⁵ To compute the composite value, each of the two ratios is first normalized by taking the difference between the ratio of each stock and the average ratio of a set of liquid US stocks at the end of the ranking period, and then dividing the difference by the standard deviation of the ratio. The normalized values of the two valuation ratios are then added to yield a composite value. The set of liquid US stocks is then ranked by this composite value and divided into three groups. Twenty-five stocks with the highest returns in the ranking period from each of the highest and lowest composite value groups are selected every 3 months to be included in the Momentum 100 Growth and Value Indexes, respectively.

For construction of the Momentum 100 Large Cap, Mid Cap, and Small Cap Indexes, the set of liquid US stocks is ranked by the market capitalization computed at the end of the ranking period and divided into three groups. Twenty-five stocks with the highest returns in the ranking period are then selected from each market capitalization group every 3 months for inclusion in each of the three market-capitalization subindexes.

2.5 *Index rebalancing*

The component stocks of all the Momentum Indexes are held for 12 months after the portfolio formation except for the Impetus 300 Index. The reason that the 12 month ranking period is chosen is to balance between maximizing the after-tax momentum index return and minimizing the index turnover. Momentum effects appear to be concave to the holding period. For instance, the Momentum 300 Index and the MomentumContra 300 Index lose the return by about 1.0% and 1.5% a year, respectively, when the holding period increases from 9 months to 12 months. On the other hand, holding the component stocks less than a year would cause the Momentum Index-based funds to distribute short-term capital gains and incur higher transaction costs.⁶ The component stocks for the Impetus 300 Index are held for 9 months. This is because holding past losers for less than 1 year is more likely to yield short-term capital losses.

Instead of replacing all the component stocks once at the end of the holding period, one-fourth of the component stocks are sequentially replaced every 3 months in February, May, August, and November. The reason is to alleviate the burden of the fund managers who attempt to replicate the Momentum Indexes. There is a 1-month interval between the ranking period and the holding period. The main reason for skipping 1 month between the ranking and holding periods is to give a sufficient time to

the fund managers who need to rebalance the index components.

2.6 Index maintenance

In order to maintain the Momentum Indexes, adjustments are made for component stock deletion due to mergers and acquisitions, exchange de-listing or a move to the pink sheets or bulletin boards, share changes, stock splits, stock dividends, and stock price adjustments due to restructurings or spinoffs. The component stocks that leave the index between rebalancing dates are not replaced. As a result, the number of component stocks in the indexes will vary with corporate actions. Some corporate actions, such as stock splits and stock dividends, would result in a change in the common shares outstanding and the stock prices of the companies in the indexes. Other corporate actions, such as share issuances and share repurchases, the percentage of which is more than 5% of the number of shares currently outstanding, would require an adjustment to prevent the value of the indexes from being unduly affected by the corporation action. To minimize the cost of rebalancing, all the adjustments will be made when one-fourth of the index component stocks are replaced every 3 months.

2.7 Total return

Gross dividends are included in the daily total return calculation of the Momentum Indexes based on their ex-dividend dates. The ex-dividend date is used rather than the payment date to determine the total daily dividends for each day because the market price adjustment for the dividend occur on the ex-dividend date. The total return of the Momentum Indexes is calculated assuming the reinvestment of dividends on a daily basis. Monthly, quarterly, and annual total-return numbers for the Momentum Indexes are calculated by compounding the reinvestment of dividends daily.

2.8 After-tax return

Most of the capital gains distributed by the Momentum Index-based funds would be treated as long-term capital gains. This is because the component stocks of all the Momentum Indexes except the Impetus 300 Index are held for 1 year. Therefore, the after-tax return to each of the Momentum Indexes will be equal to one minus the long-term capital gains tax rate (currently equal to 20%) times the before-tax return. By contrast, the component stocks of the Impetus 300 Index are held for less than 1 year. Since the Impetus 300 Index is more likely to make a negative return, the capital losses realized may yield an ordinary income tax credit. As a result, the after-tax return to the Impetus 300 Index will be equal to one minus the marginal ordinary income tax rate times the before-tax return.

3 Historical performance

This section reports the historical performance of the Momentum Indexes. Investigation of historical performance of the Momentum Indexes is important since it answers a question of whether momentum effects exist even in liquid stocks. Extant empirical evidence does not provide a clear-cut answer to this question since current empirical works include all US stocks, liquid or illiquid, in their sample. From the perspective of practical investment management, momentum effects are relevant only if these effects are present in liquid stocks as well. The following section shows that even the most liquid subset of US stocks exhibit strong momentum.

3.1 Main indexes

Table 1 presents risk and return statistics of the Momentum 300 Index, the MomentumContra 300 Index, and the Impetus 300 Index in the

Table 1 Risk and return characteristics of the Momentum 300, the MomentumContra 300, and the Impetus 300 in the period 1971–2002.

	Momentum 300	MomentumContra 300	Impetus 300	US Market
<i>Return</i>				
Mean				
Monthly (%)	1.47	1.49	0.12	0.96
Compound annual (%)	15.25	16.57	-3.55	10.71
Median (%)	1.50	1.46	-0.11	1.24
Maximum monthly return (%)	34.61	23.46	64.80	16.56
Minimum monthly return (%)	-30.85	-25.46	-32.44	-22.49
Alpha (%)	0.33	0.41	-1.04	0.00
Sharpe ratio*	0.127	0.152	-0.052	0.095
<i>Risk</i>				
Standard deviation				
Monthly (%)	7.51	6.33	9.32	4.65
Annual (%)	26.00	21.92	32.29	16.12
Beta	1.36	1.20	1.47	1.00
Skewness	-0.092	-0.131	0.988	-0.471
Kurtosis	2.791	2.252	8.052	2.038

*The Sharpe ratio is calculated using monthly returns, monthly standard deviations, and monthly T-bill rates provided by Ibbotson Associates (2003).

period 1971–2002.⁷ According to Table 1, the performance of the Momentum 300 Index and the MomentumContra 300 Index is remarkable compared to the performance of the US market. Specifically, the Momentum 300 Index and the MomentumContra 300 Index made average monthly returns of 1.47% and 1.49% in the sample period, respectively. These monthly returns are translated to compound annual returns of 15.25% and 16.57%, respectively. For comparison, the US market returned 0.96% a month or 10.71% a year in the same period.⁸ The monthly mean return difference between the MomentumContra 300 Index and the US market is statistically significant at the 10% level, but the return difference between the Momentum 300 Index and the US market turns out to be not significant.⁹ The Momentum 300 Index and the MomentumContra 300 Index had an alpha of

0.33% and 0.41%, respectively, and the alpha for the MomentumContra 300 Index is statistically significant at the 1% level. As shown in Figure 1, a \$1 investment in the Momentum 300 Index and the MomentumContra 300 Index in 1971 would have grown to \$93.91 and \$135.05 in 2002, respectively. For comparison, a \$1 investment in the US market would have increased only to \$25.95 in the same period. Figure 1 reveals that the return spread is quite consistent. Notice that the vertical axis in Figure 1 is logarithmic. This helps to highlight the steady divergence between the Momentum 300 Index or the MomentumContra 300 Index and the US market over the 32 year period. Figure 2 exhibits annual performance of the Momentum 300 Index and the MomentumContra 300 Index.

The Impetus 300 Index is in sharp contrast with the Momentum 300 Index or the

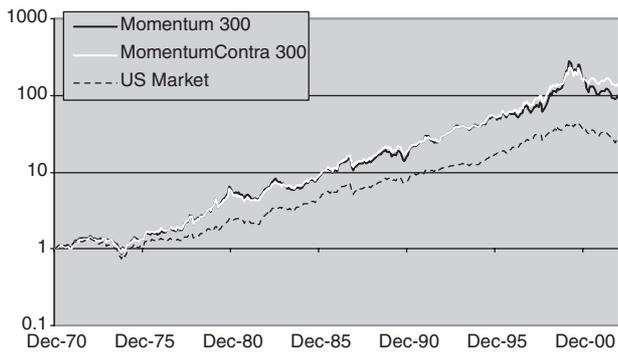


Figure 1 Cumulative performance of Momentum 300 and MomentumContra 300, 1971–2002.

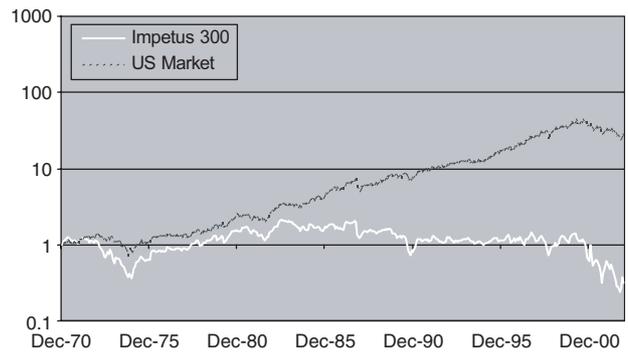


Figure 3 Cumulative performance of Impetus 300 1971–2002.

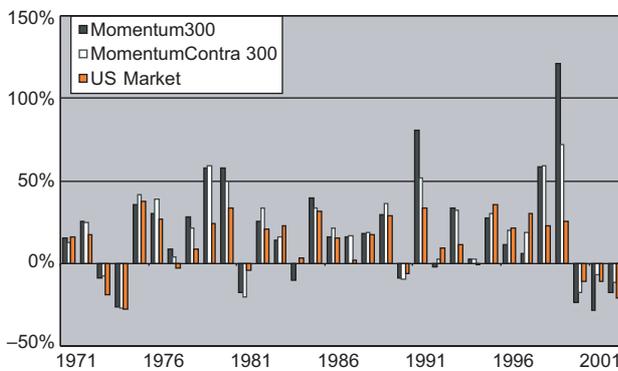


Figure 2 Yearly performance of Momentum 300 and MomentumContra 300, 1971–2002.

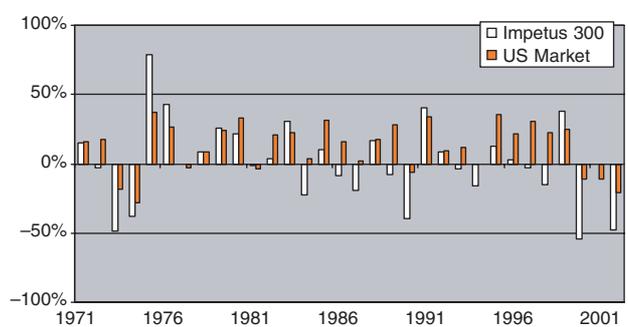


Figure 4 Yearly performance of Impetus 300, 1971–2002.

MomentumContra 300 Index in return (Table 1). The Impetus 300 Index made a monthly return of a mere 0.12% or a compound annual return of -3.55% in the sample period. The monthly return difference between the Impetus 300 Index and the US market is statistically significant at the 5% level.¹⁰ The Impetus 300 Index had an alpha of -1.04% , which is statistically significant at the 1% level. Figure 3 shows that a \$1 investment in the Impetus 300 Index in 1971 would reduce to \$0.31 in 2002. (See also Figure 4 for annual performance of the Impetus 300 Index.)

The Momentum 300 Index and the MomentumContra 300 Index appear to be riskier than the US market in standard deviation and beta. The Momentum 300 Index and the MomentumContra 300 Index had a monthly

standard deviation (beta) of 7.51% (1.36) and 6.33% (1.20) in the sample period, respectively. The monthly standard deviation difference between the Momentum 300 Index or the MomentumContra 300 Index and the US market is statistically significant at the 1% level.¹¹ A close examination reveals that the Momentum 300 Index is indeed riskier than the US market by any measure, but the MomentumContra 300 Index is comparable to the US market in downside risk. The MomentumContra 300 Index had a worst monthly return of -25.46% , compared to -22.49% for the US market, and a skewness of -0.131 , less negative than that of the US market (-0.471). This means that the MomentumContra 300 Index had more variations in positive returns, but not in negative returns, than the US market. Table 2 supports this observation. In Table 2, the sample period 1971–2002 is divided into two subperiods according to

Table 2 Average annual return of Momentum 300, MomentumContra 300, and Impetus 300 in up and down US markets in the period 1971–2002.

	Momentum 300 (%)	MomentumContra 300 (%)	Impetus 300 (%)	US market (%)	# of years
Up US market	31.98	30.85	11.87	21.50	23
Down US market	-13.45	-10.62	-27.46	-11.48	9

whether the US market returned positively or negatively. In the up market, the MomentumContra 300 Index made an average annual return of 30.85%, significantly higher than 21.50% for the US market, and close to 31.98% for the Momentum 300 Index. In the down market, the MomentumContra 300 Index returned -10.62% a year, similar to an annual return of -11.48% for the US market, but significantly greater than -13.45% for the Momentum 300 Index. This suggests that the MomentumContra 300 Index not only captures most of the momentum effects but also has limited downside risk. Taken together, the MomentumContra 300 Index has a Sharpe ratio of 0.152, greater than 0.127 for the Momentum 300 Index or 0.095 for the US market. The reason that the MomentumContra 300 Index has less downside risk than the Momentum 300 Index seems to be related to the selection criteria for component stocks, namely that companies must have stock price data available at least for 30 months for candidacy. As a result, the MomentumContra 300 Index may include more mature companies than the Momentum 300 Index.

The Impetus 300 Index had a monthly standard deviation of 9.32%, twice as high as the US market (4.65%), and a beta of 1.47 in the sample period. The Impetus 300 Index made a monthly return ranging from -32.44% to 64.80% over the sample period. The monthly standard deviation difference between the Impetus 300 Index and the US market is statistically significant at the 1% level.¹² Such a high volatility seems to be partially related to

the fact that most of the component stocks of the Impetus 300 Index are small cap stocks. According to the untabulated average firm size estimates, the Momentum 300 Index, the MomentumContra 300 Index, and the Impetus 300 Index had an average market capitalization of \$859M, \$1,246M, and \$345M in the sample period, respectively.

Table 3 shows the performance of the three main indexes by month over the sample period. According to Table 3, the Momentum 300 Index and the MomentumContra 300 Index performed well in November through June, particularly in December and January. Such a seasonal pattern of the intermediate-term momentum effects is also reported in other studies.¹³ The extant empirical evidence shows that the long-term contrarian effect is concentrated in January.¹⁴ Since the MomentumContra 300 Index consists of long-term losers that are selected among intermediate-term winners, the MomentumContra 300 Index is expected to display a strong performance in January. In fact, the MomentumContra 300 Index made the second highest return (2.75%) in January. The Impetus 300 Index did extremely well in January (7.84%), and made a negative return in the rest of the year except March, May, and November in the sample period. The outstanding performance of the Impetus 300 Index in January is consistent with the extant empirical evidence.¹⁵

Annual, rolling 3 year, and rolling 5 year returns of the three main indexes in the sample period are presented in Table 4. It turns

Table 3 Performance of Momentum 300, MomentumContra 300, and Impetus 300 by month in the period 1971–2002.

	Momentum 300 (%)	MomentumContra 300 (%)	Impetus 300 (%)
Jan	2.51	2.75	7.84
Feb	1.92	2.20	-0.57
Mar	1.05	1.43	0.52
Apr	1.98	1.25	-0.09
May	1.02	1.24	0.38
Jun	2.17	2.27	-1.47
Jul	0.01	0.33	-2.11
Aug	1.16	1.08	-0.32
Sept	-0.04	0.03	-2.97
Oct	0.01	-0.36	-1.54
Nov	2.51	2.40	2.58
Dec	3.36	3.18	-0.79
Average	1.47	1.49	0.12

out that time diversification significantly reduces the volatility of the Momentum 300 Index and the MomentumContra 300 Index. As the investment horizon increases to 1 year, the Momentum 300 Index and the MomentumContra 300 Index became close to the US market in downside risk. In particular, the Momentum 300 Index and the MomentumContra 300 Index made the lowest return of -28.64% in 2001 and -27.43% in 1974, respectively, while the US market had the lowest return of -27.93% in 1974. In addition, the Momentum 300 Index and the MomentumContra 300 Index outperformed the US market 20 and 22 times, respectively, for the last 32 years.

For the three investment horizons, the MomentumContra 300 Index turned out to be less risky than the US market. Specifically, the Momentum 300 Index and the MomentumContra 300 Index made the lowest 3-year return of -55.38% and -32.52% in 2002, respectively, and the highest 3-year return of 271.73% and 224.58% in 1999, respectively.

The US market had the lowest 3-year return of -37.44% in 2002 and the highest 3-year return of 114.66% in 1997. It is worthwhile to notice that in a severe bear market period of 2000 through 2002, the MomentumContra 300 Index performed better than the US market.¹⁶ The Momentum 300 Index and the MomentumContra 300 Index outperformed the US market 21 and 26 times out of the 30 three-year periods, respectively.

As the investment horizon increases to the 5-year period, the Momentum 300 Index and the MomentumContra 300 Index became even more impressive in risk and return. The Momentum 300 Index and the MomentumContra 300 Index had a 5-year return of 28.75% (in 1977) to 427.90% (in 1999), and 33.62% (in 1975) to 407.71% (in 1999), respectively, while the US market returned -4.08% (in 2002) to 229.14% (in 1999). The Momentum 300 Index and the MomentumContra 300 Index surpassed the US market 21 times and all but twice in the 28 five-year periods, respectively.

Table 4 Annual, rolling 3-year, and rolling 5-year performance of Momentum 300, MomentumContra 300, and Impetus 300 in the period 1971–2002.

Year	Momentum 300			MomentumContra 300			Impetus 300		
	Annual (%)	3 Year (%)	5 Year (%)	Annual (%)	3 Year (%)	5 Year (%)	Annual (%)	3 Year (%)	5 Year (%)
1971	15.30			12.54			14.81		
1972	25.70			24.62			-2.49		
1973	-8.75	32.25		-7.49	29.75		-48.61	-42.46	
1974	-26.18	-15.34		-27.43	-16.33		-37.99	-68.93	
1975	35.64	-8.64	32.42	41.91	-4.73	33.62	78.92	-42.98	-36.17
1976	29.95	30.12	49.24	39.10	43.25	65.15	42.56	58.15	-20.74
1977	8.44	91.15	28.75	3.94	105.16	37.74	-0.77	153.11	-19.34
1978	28.36	80.90	81.12	21.54	75.72	80.96	8.83	53.97	70.80
1979	57.86	119.74	287.34	59.05	100.92	296.60	25.91	35.98	246.84
1980	57.45	219.04	349.61	49.88	189.73	318.88	21.45	66.43	135.44
1981	-17.47	105.13	185.54	-20.63	89.20	139.01	-1.41	50.76	62.82
1982	25.16	62.63	229.55	33.20	58.46	206.31	3.84	24.33	70.38
1983	14.25	18.02	193.32	15.86	22.49	191.99	30.60	33.70	104.45
1984	-10.44	28.07	66.42	-0.45	53.64	82.77	-22.46	5.15	25.90
1985	39.50	42.75	47.45	33.35	53.81	62.61	9.84	11.23	13.87
1986	16.01	44.95	107.27	21.52	61.33	148.97	-8.53	-22.10	5.64
1987	16.19	88.04	92.42	16.49	88.77	117.74	-19.59	-19.21	-18.19
1988	18.29	59.45	99.22	18.63	67.94	122.95	16.39	-14.39	-27.09
1989	29.62	78.14	188.31	36.40	88.50	205.46	-8.05	-13.94	-13.54
1990	-9.19	39.23	87.67	-9.92	45.77	106.36	-39.97	-35.76	-52.75
1991	80.53	112.49	192.04	51.97	86.74	158.07	40.31	-22.56	-27.52
1992	-2.04	60.59	146.22	2.21	39.94	126.44	8.89	-8.29	-1.85
1993	33.55	136.19	177.99	31.82	104.77	151.62	-4.00	46.68	-19.04
1994	2.45	34.04	119.73	2.49	38.10	89.06	-16.10	-12.29	-26.13
1995	27.61	74.61	208.79	30.16	75.86	173.17	12.52	-9.37	38.47
1996	11.29	45.49	90.35	20.18	60.32	116.01	2.66	-3.08	1.32
1997	6.07	50.63	106.11	18.85	85.91	151.17	-2.62	12.49	-9.40
1998	58.58	87.19	144.73	58.82	126.84	202.61	-14.90	-14.93	-19.69
1999	121.00	271.73	427.90	71.96	224.58	407.71	38.08	14.43	32.18
2000	-23.85	166.87	215.02	-17.72	124.71	220.94	-53.96	-45.90	-45.92
2001	-28.64	20.09	101.99	-7.08	31.47	148.16	-0.57	-36.79	-47.62
2002	-17.88	-55.38	56.39	-11.74	-32.52	84.29	-47.76	-76.08	-71.90

Time diversification does not appear to work in the Impetus 300 Index. In fact, the Impetus 300 Index tends to become even riskier as the investment horizon increases. It made the lowest annual return

of -53.96% in 2000, and the highest annual return of 78.92% in 1975. The Impetus 300 Index underperformed the US market 23 times out of 32 years. For the 3-year investment horizon, the

Table 5 Average annual return of Momentum 300, MomentumContra 300, and Impetus 300 by decade in the period 1971–2002.

	Momentum 300 (%)	MomentumContra 300 (%)	Impetus 300 (%)	US market (%)
1970s	19.53	18.79	4.16	9.27
1980s	10.71	12.87	−6.01	12.40
1990s*	15.61	17.87	−7.57	10.53

*Includes year 2001 and 2002.

Impetus 300 Index returned −76.08% (in 2002) to 153.11% (in 1977), and underperformed the US market 26 times in the 30 three-year periods. For the 5-year investment horizon, the Impetus 300 Index returned ranging from −71.90% (in 2002) to 246.84% (in 1979), and underperformed the US market 25 times in the 28 five-year periods.

Table 5 presents the performance of the Momentum 300 Index, the MomentumContra 300 Index, and the Impetus 300 Index by decade. In the bull market of the 1990s, the momentum effects were strong. In the 1990s, the Momentum 300 Index and the MomentumContra 300 Index made an annual average return of 15.61% and 17.87%, respectively, compared to an annual return of 10.53% in the US market. In the relatively weak stock market period of the 1970s, the Momentum 300 Index and the MomentumContra 300 Index made an annual average return of 19.53% and 18.79%, respectively, more than twice as much as an annual return of 9.27% for the US market. A notable decade is the 1980s when the Momentum 300 Index slightly underperformed the US market. Specifically, the Momentum 300 Index made an annual return of 10.71%, compared to 12.40% for the US market. However, the MomentumContra 300 Index made a return of 12.87%, comparable to that of the US market. In contrast, the Impetus 300 Index (Table 5) made an annual return of −6.01% and −7.57% in the 1980s and 1990s, respectively, and made a modest gain of 4.16% per year in the 1970s.

3.2 Subindexes

Table 6 reports the risk and return characteristics of Momentum 100 Growth and Value Indexes. According to Table 6, both growth and value stocks show strong momentum. Specifically, the Momentum 100 Growth and Value Indexes made an average monthly return of 1.72% and 1.48% or a compound annual return of 16.12%

Table 6 Risk and return characteristics of Momentum 100 Growth Value in the period 1971–2002.

	Growth	Value
<i>Return</i>		
Mean		
Monthly (%)	1.72	1.48
Compounded annual (%)	16.12	16.79
Median (%)	2.08	1.61
Maximum monthly return (%)	50.37	23.28
Minimum monthly return (%)	−30.50	−28.84
Alpha (%)	0.50	0.48
Sharpe ratio	0.124	0.162
<i>Risk</i>		
Standard deviation		
Monthly (%)	9.70	5.92
Annual (%)	33.60	20.51
Beta	1.61	1.07
Skewness	0.117	−0.487
Kurtosis	2.683	2.931

and 16.79% in the sample period, respectively. Figure 5 demonstrates that a \$1 investment in Momentum 100 Growth and Value Indexes in 1971 would have grown to \$119.56 and \$143.50 in 2002, respectively. According to Table 6 and Figures 5 and 6, the Momentum 100 Value Index was much less volatile than the Momentum 100 Growth Index in the sample period. In fact, the Momentum 100 Value Index turns out to be the least volatile among all the Momentum Indexes. To be specific, the Momentum 100 Value Index had a monthly standard deviation of 5.92% and a beta of 1.07, compared to a monthly standard deviation of 9.70% and a beta of 1.61 for the Momentum 100 Growth Index. As a result, the Momentum 100 Value Index has the highest Sharpe ratio of 0.162, significantly greater than that of the Momentum 100 Growth (0.124). This means that the Momentum 100 Value Index yielded a higher return per

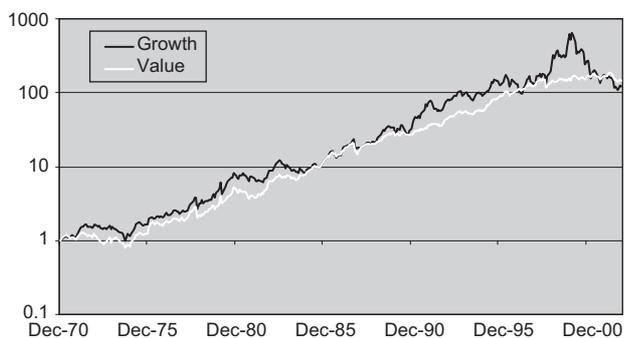


Figure 5 Cumulative performance of Momentum 100 Growth and Value, 1971–2002.

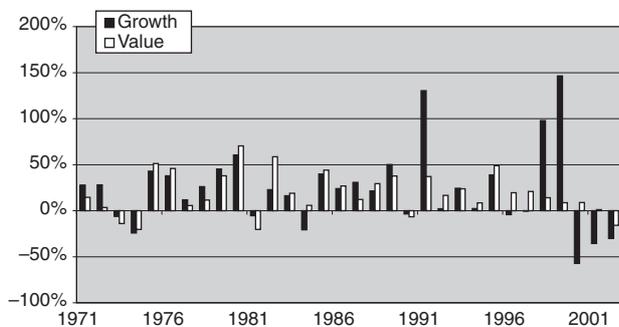


Figure 6 Yearly performance of Momentum 100 Growth and Value, 1971–2002.

unit of risk than the Momentum 100 Growth Index in the sample period.

According to Table 7, time diversification reduced the volatility of the Momentum 100 Growth and Value Indexes. Both the Momentum 100 Growth and Value Indexes surpassed the US market 23 times in the 32 one-year periods. The Momentum 100 Value Index remained quite stable in annual returns. The annual return of the Momentum 100 Value Index ranged from -20.31% in 1981 to 51.33% in 1975. The Momentum 100 Value Index returned negatively only four times (in 1973, 1974, 1981, and 2002) out of 32 years. In contrast, the Momentum 100 Growth Index turned out to be quite volatile in annual returns. The Momentum 100 Growth Index made an annual return of as high as 146.40% in 1999 and as low as -57.26% in 2000.

In the 30 rolling 3 year periods, the Momentum 100 Value Index underperformed the US market only twice with returns ranging from -28.91% (in 1974) to 162.35% (in 1980). In the same period, the Momentum 100 Growth Index outperformed the US market 21 times with returns ranging from -80.80% (in 2002) to 385.67% (in 1999). In the 28 rolling 5 year periods, the Momentum 100 Value Index lagged the US market only twice, while the Momentum 100 Growth Index underperformed the US market eight times. In particular, the Momentum 100 Value Index produced a 5-year return ranging from 14.73% (in 2002) to 220.37% (in 1995), while the Momentum 100 Growth Index returned from -6.33% (in 2002) to 546.44% (in 1999).

Table 8 provides summary statistics of the Momentum 100 Large Cap, Mid Cap, and Small Cap Indexes. According to Table 8, the large-cap and mid-cap stocks exhibited momentum as strong as any other Momentum Indexes, while the small-cap stocks showed relatively weak momentum in

Table 7 Annual, rolling 3-year, and rolling 5-year performance of Momentum 100 Growth and Value in the period 1971–2002.

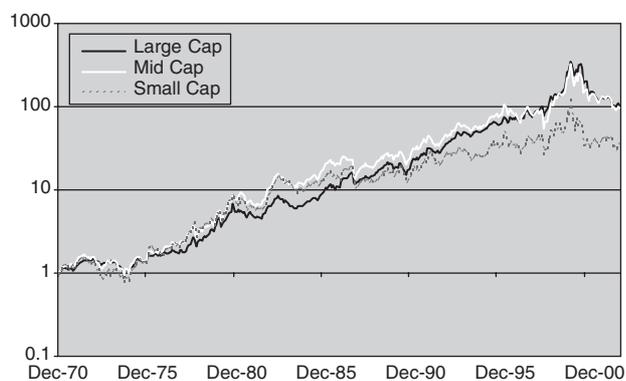
Year	Growth			Value		
	Annual (%)	3 Year (%)	5 Year (%)	Annual (%)	3 Year (%)	5 Year (%)
1971	27.87			14.58		
1972	28.09			3.52		
1973	-6.19	53.67		-13.85	2.17	
1974	-24.24	-8.96		-20.28	-28.91	
1975	42.86	1.54	66.32	51.33	3.93	23.26
1976	37.85	49.20	79.29	45.77	75.85	56.82
1977	11.71	119.99	56.36	5.61	132.96	59.98
1978	26.03	94.07	110.05	11.57	71.75	107.20
1979	45.24	104.48	302.68	38.01	62.61	258.70
1980	60.47	193.74	352.32	70.40	162.36	303.88
1981	-5.40	120.49	210.43	-20.31	87.40	120.80
1982	22.88	86.55	241.47	58.58	115.33	231.55
1983	16.20	35.08	214.82	18.95	50.32	253.48
1984	-20.64	13.32	72.03	5.71	99.39	170.75
1985	39.80	28.92	49.86	44.15	81.26	129.06
1986	23.95	37.52	96.35	26.80	93.21	264.45
1987	30.68	126.43	108.81	12.19	105.06	157.83
1988	21.42	96.66	118.20	29.33	83.97	180.33
1989	50.02	138.03	312.45	37.77	99.89	265.35
1990	-3.45	75.88	184.87	-6.50	66.59	136.97
1991	130.36	233.67	429.43	37.20	76.72	156.41
1992	2.15	127.20	313.86	16.59	49.56	166.48
1993	24.43	192.81	324.13	23.86	98.12	155.20
1994	2.41	30.18	189.54	8.57	56.79	101.12
1995	38.93	77.05	316.61	48.94	100.28	220.37
1996	-4.19	36.32	73.27	19.54	93.29	179.13
1997	-0.43	32.53	68.89	20.86	115.18	189.35
1998	97.96	88.84	168.69	14.20	65.00	166.81
1999	146.40	385.67	546.44	8.66	49.98	167.01
2000	-57.26	108.46	98.86	8.82	35.03	95.09
2001	-35.67	-32.26	33.53	1.07	19.50	64.95
2002	-30.15	-80.80	-6.33	-15.93	-7.54	14.73

the period 1971–2002. The Momentum 100 Large Cap and Mid Cap Indexes made a compound annual return of 15.64% and 15.31%, respectively, in the sample period, while the Momentum 100 Small Cap Index returned only 11.59% a year in

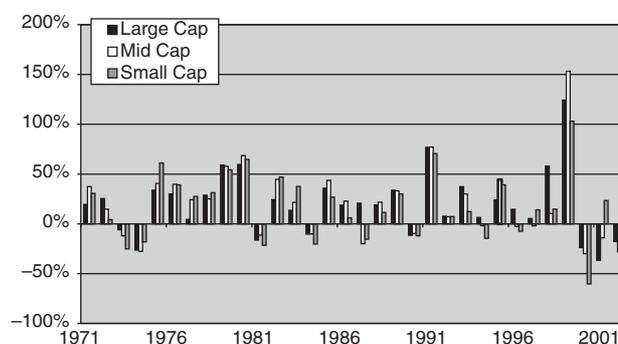
the same period. Table 8 and Figures 7 and 8 reveal that the Momentum 100 Large Cap Index was less volatile than the Momentum 100 Mid Cap or Small Cap Indexes in the sample period. The Momentum 100 Large Cap Index had an annual standard

Table 8 Risk and return characteristics of Momentum 100 Large Cap, Medium Cap, and Small Cap in the period 1971–2002.

	Large Cap	Medium Cap	Small Cap
<i>Return</i>			
Mean			
Monthly (%)	1.51	1.60	1.37
Compounded Annual (%)	15.64	15.31	11.59
Median (%)	1.49	1.75	1.37
Maximum monthly return (%)	33.99	48.20	48.94
Minimum monthly return (%)	-33.80	-36.23	-36.03
Alpha (%)	0.37	0.40	0.13
Sharpe ratio	0.130	0.120	0.090
<i>Risk</i>			
Standard Deviation			
Monthly (%)	7.63	9.03	9.49
Annual (%)	26.43	31.28	32.89
Beta	1.37	1.56	1.56
Skewness	-0.074	-0.058	-0.054
Kurtosis	3.256	3.156	3.057

**Figure 7** Cumulative performance of Momentum 100 Large Cap, Mid Cap, and Small Cap, 1971–2002.

deviation of 7.63% and a beta of 1.37, while the Momentum 100 Mid Cap and Small Cap Indexes had an annual standard deviation of 31.28% and 32.89%, respectively, and both had a beta of 1.56. This led the Momentum 100 Large Cap Index to

**Figure 8** Yearly performance of Momentum 100 Large Cap, Mid Cap, and Small Cap, 1971–2002.

have the highest Sharpe ratio of 0.130, compared to 0.120 and 0.090 for the Momentum 100 Mid Cap and Small Cap Indexes, respectively. Figure 7 shows that a \$1 investment in Momentum 100 Large Cap, Mid Cap, and Small Cap Indexes in 1971 would have increased to \$104.56, \$95.48, and \$33.41 in 2002, respectively.

Table 9 Risk and return characteristics of Momentum 100 Large Cap, Mid Cap, and Small Cap in the period 1971–2002.

Year	Large Cap			Mid Cap			Small Cap		
	Annual (%)	3-Year (%)	5-Year (%)	Annual (%)	3-Year (%)	5-Year (%)	Annual (%)	3-Year (%)	5-Year (%)
1971	19.43			37.45			30.55		
1972	25.30			14.81			4.20		
1973	-6.01	40.65		-12.12	38.68		-25.21		1.74
1974	-26.32	-13.23		-27.62	-26.97		-18.16		-36.22
1975	33.75	-7.38	38.61	40.56	-10.59	41.10	61.14	-1.38	34.16
1976	29.95	28.07	50.81	39.65	42.08	43.35	39.13	83.46	42.97
1977	4.49	81.61	25.77	24.21	143.82	55.09	27.45	185.72	74.88
1978	28.74	74.81	72.28	24.98	116.80	120.57	31.26	132.74	206.91
1979	59.10	114.03	271.99	57.82	145.00	380.92	54.18	157.92	478.22
1980	59.55	226.80	343.75	68.58	232.52	476.80	64.76	233.44	491.23
1981	-16.45	112.10	185.32	-11.29	136.01	266.39	-21.51	99.39	233.55
1982	24.28	65.68	239.35	44.76	116.48	327.00	47.09	90.22	284.95
1983	13.52	17.88	199.24	21.65	56.21	315.61	37.60	58.86	303.55
1984	-10.22	26.66	68.85	-10.08	58.35	136.80	-20.37	61.16	108.42
1985	35.78	38.38	43.70	43.71	57.19	101.86	26.87	39.00	60.48
1986	18.80	44.81	104.32	22.88	58.78	179.62	6.12	7.20	116.97
1987	20.80	94.85	98.59	-19.92	41.42	54.69	-15.38	13.92	24.82
1988	18.85	70.56	107.91	21.82	19.87	54.90	11.48	0.10	1.12
1989	33.86	92.18	210.00	33.15	29.90	129.38	30.06	22.69	65.18
1990	-11.49	40.82	102.08	-9.69	46.49	44.15	-12.12	27.41	14.41
1991	76.74	109.40	200.64	77.21	113.10	107.89	70.55	94.93	83.88
1992	7.67	68.44	167.98	7.09	71.39	177.99	7.22	60.69	132.99
1993	37.41	161.49	209.81	29.96	146.63	196.58	12.29	105.33	134.68
1994	6.39	57.40	146.22	-1.83	36.62	118.66	-14.66	2.75	53.99
1995	24.01	81.28	244.97	44.50	84.35	249.84	39.25	33.44	144.01
1996	14.71	51.33	123.90	-2.62	38.13	92.24	-7.32	10.14	32.60
1997	5.33	49.82	119.01	-2.06	37.81	75.82	14.08	47.23	41.10
1998	58.01	90.90	151.85	10.38	5.27	49.32	14.86	21.44	44.32
1999	124.18	273.08	430.70	153.19	173.71	285.14	103.06	166.08	243.39
2000	-23.81	169.88	226.07	-29.98	95.68	86.62	-60.47	-7.79	-2.51
2001	-36.66	8.20	80.06	-14.10	52.28	64.62	23.34	-0.99	29.74
2002	-17.84	-60.35	40.46	-28.11	-56.76	20.84	-21.82	-61.88	-11.09

Table 9 presents annual, rolling 3 year, and rolling 5 year performances of the three subindexes categorized by market cap in the sample period. Table 9 suggests that time diversification also worked in

these market-capitalization subindexes, although it seems to be not as strong as the case for the subindexes categorized by growth/value. The Momentum 100 Large Cap, Mid Cap, and Small

Cap Indexes produced an annual return ranging from -36.66% (in 2001) to 124.18% (in 1999), from -29.98% (in 2000) to 153.19% (in 1999), and from -60.47% (in 2000) to a whopping 285.14% (in 1999), respectively. As a result, the Momentum 100 Large Cap, Mid Cap, and Small Cap Indexes beat the US market 21, 18, and only 15 times over the last 32 years, respectively. In the rolling 3-year return, the Momentum 100 Large Cap, Mid Cap, and Small Cap Indexes outperformed the US market 21, 22, and 14 times out of the 30 periods, respectively. In the 28 rolling 5 year periods, the Momentum 100 Large Cap, Mid Cap, and Small Cap Indexes beat the US market 23, 20, and 14 times, respectively.

4 Applications

The Momentum Indexes may have several applications in investment management. First and foremost, the Momentum Indexes may serve as a good vehicle for exchange-traded or open-end index funds, futures, and options. Gastineau (2002) specifies the following 10 desirable characteristics for fund-friendly indexes:

1. It should meet RIC requirements for a US fund or UCITS requirements for a fund distributed outside the US at a low cost.
2. Rebalancing and replacement rules minimize portfolio turnover.
3. If the index or a related index does not include large-cap companies in its universe, the index and the fund retain exposure to the best performing companies in some way.
4. Style indexes (growth/value) should not cover all the companies in the corresponding broad market aggregate index because many companies are not distinctively growth or value.
5. This index creates a fund that makes investment sense and appeals to investors.
6. The resulting fund has multiple uses and useful derivatives.
7. The index is rules based. A backup decision-making entity is only used for emergencies not anticipated by the rules.
8. The fund is inherently tax efficient.
9. Index license fees are modest relative to benchmark index licensing fees unless the licensed name or other features promise to bring in enough assets to lower total fund costs.
10. The index fund structure must recognize the limited integration of clearance, settlement, and custody systems across international borders.

The Momentum Indexes proposed in this paper include most of the characteristics specified above. In particular, the Momentum Indexes perfectly satisfy the third criterion. As is seen in the previous section, the Momentum 300 Index, the MomentumContra 300 Index, and the five momentum subindexes have consistently outperformed the US market over the last 32 years. As long as momentum effects persist in the future, Momentum Index-based funds would perform better than the US market index-based funds such as the S&P 500 SPDRS. In fact, some supporters of indexing have correctly argued that the S&P 500 Stock Index is emphasized too much as an index for broad US market index funds. Furthermore, the Momentum Indexes are a style index which represents a unique segment of the market. As a result, inclusion of the Momentum Index-based funds into individual investors' portfolio may further reduce investment risk and improve the risk and return profile of their portfolio. It follows that the introduction of Momentum Index-based funds would increase the welfare of individual investors.

Several investment strategies with the Impetus 300 Index can also be developed on the part of individual investors. As demonstrated in the

previous section, the Impetus 300 Index has consistently underperformed the US market over the last 32 years. As a result, bearish investors can increase the investment return or hedge effectively their long position in the US stock portfolios by shorting an exchange-traded fund or futures contract tracking Impetus 300 Index, or purchasing a put option on the Impetus 300 Index. Investors who are uncertain about the future course of the US stock market can purchase an exchange-traded or open-end fund tracking MomentumContra 300 Index or Momentum 300 Index, and simultaneously short an exchange-traded fund mimicking the Impetus 300 Index. Of course, investors can directly buy a portfolio of past winners or short a portfolio of past losers. Such direct investment, however, may involve high transaction and search costs. In addition, the investment products based on the Impetus 300 Index can be used to take advantage of the seasonal regularities. As is evidenced in the monthly performance of the Impetus 300 Index, past losers perform extremely well in January. Consequently, investors can take a long position in the Impetus 300 Index-based exchange-traded funds or futures contracts in January to make a short-term gain.

One may wonder whether the momentum index-based funds remain to outperform the US market after accounting for trading costs including trading fees and price concessions. Such a concern is valid because the Momentum Indexes have a relatively high turnover (an annual turnover rate of 100%). A recent study by Korajczek and Sadka (2002) finds that, after taking into account the price impact induced by trades, as much as five billion dollars (relative to market capitalization in December 1999) may be invested in market cap-weighted winner-based momentum strategies before the apparent profit opportunities vanish. This suggests that transaction costs, in the form of spreads and price impact of trades, may not have a material impact on the performance of the Momentum Index-based funds.

Tax efficiency is not inherently high in the Momentum Index-based funds because of frequent realization of capital gains. Most capital gains in a Momentum Index-based fund might not come to the shareholder in the form of gains to be deferred as long as the shareholder stayed in the fund. However, the Momentum Indexes rebalance the component stocks only once a year. As a result, the Momentum Index-based funds would distribute most of the capital gains to the shareholder as long-term capital gains. Further research may warrant for improvement of tax efficiency of the Momentum Index-based funds.

The Momentum Index-based funds may be particularly appealing to the tax-deferred or tax-free accounts such as defined-contribution retirement plan accounts, Roth IRAs and 529 plans.¹⁷ The US government has recently proposed overhaul of tax-deferred savings and retirement accounts. The proposed life savings and retirement savings accounts allow investors to withdraw tax free the money that is accumulated. The Momentum-Index based investment products would be ideal for such savings accounts, if adopted as proposed.

The Momentum Indexes can also be used as a benchmark for the performance evaluation of actively managed funds. Extensive academic research reports and this paper confirms that momentum-based investment strategies yield an abnormal return significant enough to deserve another factor for stock returns in addition to beta, market capitalization, and price-to-book ratio.¹⁸ Furthermore, it is well known that a majority of the mutual fund managers use momentum-based investment strategies to enhance the fund performance.¹⁹ To assess the mutual fund managers' stock-picking skills and market-timing abilities, therefore, the performance of the mutual funds must be evaluated against a benchmark measuring momentum effects. However, there are few available momentum benchmarks to be used for

evaluation of the fund performance. To my knowledge, the only available benchmark is the monthly momentum factor which is provided by Professor Kenneth R. French at his personal web site.²⁰ However, there are several problems with using Professor French's momentum factor as a momentum benchmark. Professor French's momentum factor is based on a zero-investment strategy of buying winners and shorting losers. The existing literature reports, however, that momentum investing by mutual funds is concentrated in buying winners. Therefore, it is important to separate a benchmark measuring the return to buying winners from that measuring the return to shorting losers. In Professor French's momentum factor, winners consist of all NYSE, AMEX, and Nasdaq stocks whose returns are above the 30th NYSE percentiles in the ranking period. This means that winners include many illiquid stocks institutional investors cannot trade without bearing high transaction costs. In the Momentum Indexes proposed in this paper, winners are selected from a liquid subset of NYSE, AMEX, and Nasdaq stocks. As a result, all component stocks of the Momentum Indexes can be traded without bearing a significant trading cost so that performance of the Momentum Indexes is replicable.

The total-return calculation with all distributions included has become increasingly important. Both the Association for Investment Management and Research's (AIMR's) performance measurement standards and the Securities and Exchange Commission's (SEC's) executive compensation ruling require total-return performance calculations and comparison to appropriate market benchmarks. It is not clear how French's momentum factor takes cash and stock dividends paid into account. In the Momentum Indexes, returns are calculated with and without dividends included. Finally, French's momentum factor is computed monthly, while the Momentum Indexes are compiled daily.

5 Conclusion

In this paper, I have proposed indexation of momentum effects that would pave the way for development of investment products based on the Momentum Indexes and for improved performance evaluation of actively managed funds. The Momentum Indexes created in this paper may have several applications to practical investment management. In particular, the Momentum Index-based exchange-traded or open-end funds should be strongly appealing to investors, due to the outstanding past performance, representation of a unique segment of the market, and other desirable characteristics of the Momentum Indexes. Furthermore, the Momentum Index-based derivatives such as futures and options should be attractive to traders and arbitrageurs because of the volatility, seasonal regularities, and the rule-based construction method of the Momentum Indexes. I hope this proposal helps stimulate development of the Momentum Index-based investment products.

Acknowledgments

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Notes

- ¹ See Jagadeesh and Titman (1993), Chan *et al.* (1996), Fama and French (1996), Rouwenhorst (1998), Chui *et al.* (2000), Grundy and Martin (2001), and Jagadeesh and Titman (2001), among others.
- ² Barberis *et al.* (1998) and Daniel *et al.* (1998) explain momentum effects by a small number of cognitive biases a single representative agent might have. Hong and Stein (1999) conjecture that momentum effects are driven by the externalities that arise when heterogeneous traders interact with one another. Grinblatt and Han (2001) demonstrate that momentum effects may be caused by "the disposition

effect.” Johnson (2002) argues that stochastic dividend growth rates may account for some or all the momentum effects.

- ³ For instance, Lakonishok *et al.* (1992) report that pension fund managers tend to sell losers right before making quarterly performance reports. Hong *et al.* (2000) document that momentum effects are stronger among stocks with low analyst coverage.
- ⁴ The reported trading volume on Nasdaq is overstated relative to the NYSE and AMEX trading volumes because inter-dealer trading is included on Nasdaq, and most trades on Nasdaq are required to be submitted to a dealer, but crossing between brokers is not included in the reported trading volume on NYSE and AMEX. To remedy such a problem of inconsistency, we take half of the trading volume of stocks listed on Nasdaq in the ranking period when estimating the dollar trading volume.
- ⁵ See Fama and French (1992), and O’Shaughnessy (1998).
- ⁶ For tax-deferred or tax-free investment such as retirement accounts, the Momentum Indexes may be modified to hold the component stocks for 9 months.
- ⁷ All the risk and return statistics reported in this section are estimated with total returns including dividends paid.
- ⁸ Risk and return statistics of the US market are estimated by stocks listed on CRSP (Center for Research on Security Prices) at the University of Chicago.
- ⁹ Statistical significance is measured by the one-tail *t*-test and Wilcoxon sign-rank test.
- ¹⁰ Statistical significance is measured by the one-tail *t*-test and Wilcoxon sign-rank test.
- ¹¹ Statistical significance is measured by the *F* test.
- ¹² The level of statistical significance is computed by the *F* test.
- ¹³ See Sadka (2002).
- ¹⁴ See De Bondt and Thaler (1985), and Conrad and Kaul (1993).
- ¹⁵ See Jegadeesh and Titman (1993), and Sadka (2002).
- ¹⁶ When the component stocks of the MomentumContra 300 Index are held for 9 months, the cumulative return was even more impressive. The MomentumContra 300 Index made a cumulative return of -20.17% in the 3-year period 2000–2002.
- ¹⁷ As discussed in the previous section, the Momentum Indexes to be exclusively used for tax-deferred or tax-free accounts may be designed in such a way that the holding period of the component stocks is shortened. Shortening of the holding period would improve the performance of the Momentum Indexes with no adverse tax consequences for the tax-deferred or tax-free accounts.

¹⁸ See Jegadeesh and Titman (1993), and Fama and French (1996).

¹⁹ See Grinblatt and Titman (1989) and Grinblatt *et al.* (1995).

²⁰ Multex Investor, Inc. compiles a momentum index called the Relative Momentum Index. However, their definition of momentum is quite different. For instance, the criteria for index membership include: (1) a company’s year-to-year sales growth being more than 50% above the industry average in the last reported quarter and over the trailing 12-month period; (2) a company’s percentage share price change being greater than zero over the past 4 weeks and the past 52 weeks, and more than 50% above its industry average over the 4 and 52 week periods; (3) a price to earnings-to-growth ratio is above 1.00.

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