Diversification Strategies for Equity-Dominant Portfolios

Volatility as Tradable Diversifying Asset Class

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Over the last five years markets have faced crises affecting portfolios in a way not predicted by financial models: Correlations across risky assets converged to one. This phenomenon rendered virtually useless a number of the putative diversifiers, such as fixed income, in institutional portfolios, leaving asset managers who believed they were well diversified with significant capital losses. Clearly, this requires rethinking the diversification strategy. In this paper, we explore a promising new approach to diversification: using "Realized equity volatility," or "REV". While a number of investors and analysts have been aware of the potential of REV as an equity diversifier – in particular, its significant negative correlation to equity returns in normal markets and even higher negative correlation during periods of market stress - until recently, there appeared no way to access this asset class with low execution costs using liquid instruments. Our research indicates that it is possible to cost-effectively generate return streams that are highly correlated with REV using liquid, tradable instruments. In brief, we have an attractive alternative to fixed income for investment portfolios.

I. Introduction

Over the last five years markets have faced crises affecting portfolios in a way not predicted by financial models: Correlations across risky assets converged to one. This phenomenon rendered virtually useless a number of the putative diversifiers in institutional portfolios, leaving asset managers who believed they were well diversified with significant capital losses. Clearly, this requires rethinking the diversification strategy. It also puts a premium on identifying better diversifiers, especially for the equity holdings that dominate most pension and endowment funds and other long-horizon investment portfolios.

What's needed is to identify asset classes with long-term return potential that show low or negative correlation to equities.

For such an asset class to be attractive as a diversifier it must:

- have a low or negative correlation to equities;
- have a positive expected return;
- be tradable in size without impacting market prices; and
- have low costs of execution.

Neither of the conventional equity diversifiers – short equities and long fixed income - meets all of these criteria:

- Short equities are negatively correlated to equities and can be traded with low execution costs, but they do not generate positive long-term returns.
- Fixed income has traditionally shown negative correlation to equities and is used widely to mitigate equity risk. Today, however, it by no means is clear that a fixed income diversifier can be effective. The extremely low interest rates currently prevailing make long fixed income a very costly holding, while negative correlation with equities is much less pronounced than in the past. Finally, sovereign bonds that typically form the core of an investment fund's fixed income assets are not risk free, as recent events have reminded us.

II. Foundation for a new approach

In this paper, we explore a promising new approach to mitigating equity risk that we believe meets all four tests enumerated just above: "Realized equity volatility," or "REV". While a number of investors and analysts have been aware of the potential of REV as an equity diversifier – in particular, its significant negative correlation to equity returns in normal markets and even higher negative correlation during periods of market stress - until recently, there appeared no way to access this asset class with low execution costs using liquid instruments.[1]

[1] Some managers have used equity put options and VIX futures to obtain equity volatility exposure. While put options and VIX futures are tradable, they are priced off *implied* volatilities, which measure future volatility expectations, rather than *realized* volatilities. The returns generated by trading these instruments are dependent on the *changes* in implied volatility. A long position in VIX futures or equity put options will generate positive returns if implied volatility goes up and negative returns if it goes down. It will not generate any returns if the level of the VIX remains unchanged. Meanwhile, the standard deviation of the level of VIX is 30%, while that for change in VIX is 67% - trading VIX as a hedge can be highly risky. Trading REV, in contrast, depends on the *level* of equity volatility. A long position in REV will result in higher (or lower) returns the larger (or smaller) the REV is during the period of investment. A change in REV from one period to another will not affect the returns generated by the investment. In other words, the volatilities are distinct from one another, and are imperfect substitutes at best. Moreover, VIX futures mostly trade in contango, meaning that future prices are higher than spot. The cost of the roll-down has averaged more than 3.7% per month, making it expensive to use VIX futures as diversifiers. Other managers have sourced REV through variance swaps in the OTC market. However, those swaps suffer from high execution costs and expose managers to counterparty credit risk. Consequently, they are not attractive when the overall size of the equity positions to be diversified is large.

Our research, however, indicates that it is possible to cost-effectively generate return streams that are highly correlated with REV using liquid, tradable instruments. In brief, we have an attractive alternative to fixed income for investment portfolios.

Returns that are correlated to REV may be generated by trading in the same equity instruments used to generate equity returns, say S&P 500 futures.[2] Contrary to the obvious conclusion, the use of the same instrument (in this case S&P 500 futures) does not mean that the equity and REV asset classes are capturing similar outcomes. The manner of investing in S&P 500 futures is very different for the two asset classes and this makes all the difference: The two approaches generate two very different return streams.

The key to using REV as a diversifier to equities rests on the negative correlation between the two asset classes. If we follow classical finance literature and assume that returns of the S&P 500 and other equity markets follow a normal distribution, there is little reason to expect this negative correlation. In fact, theory would suggest that these two asset classes should be uncorrelated and quite independent of one another.

In practice, the correlation between the monthly realized volatility of the S&P 500 index (calculated using daily returns data) and monthly S&P 500 returns is significant and negative (-0.39). This means that REV is higher when equity returns are negative and lower when returns are positive. The explanation for this difference rests in behavioral economics: Investors have a significant fraction of their net worth invested in equities. During periods of market stress, they become irrational sellers of their equity holdings and stock prices fall precipitously. Equity volatility rises during these periods of panic investor selling. On the other hand, when equity markets trend upward, investors enter the equity market more deliberately and equity volatility tends to be lower.

III. Generating Returns Correlated to REV

Our research shows that a return stream that is correlated to REV may be generated inexpensively using a simple trading strategy. This trading strategy requires the existence of a liquid futures market for the underlying equity asset – in this case a liquid futures market for the S&P 500 index. The following table provides summary characteristics of the returns generated by this strategy. The table is based on data from 6/1982—9/2011, i.e. data for more than 29 years. The month by month returns generated by this strategy are provided in Table 1 (see Appendix). These returns have a correlation of 0.77 against the monthly REV, provided in Table 2 (see Appendix), confirming that the trading strategy reasonably mimics an S&P 500 REV instrument.[3]

Table 1: summary characteristics of the returns

	Volatility Investment	S&P 500 TR	Barclay US Agg
Average Annual Return	10.3%	12.4%	9.0%
Annualized Compound Return	9.7%	11.3%	8.8%
Volatility	10.8%	15.6%	4.7%
Maximum Drawdown	-8.7%	-50.9%	-5.1%
Sharpe Ratio (risk free rate 0%)	0.91	0.76	1.84
RCG Performance Ratio	1.12	0.72	1.14
10Y Return	194.1%	32.0%	72.2%
5Y Return	117.5%	-5.8%	36.2%
3Y Return	73.5%	3.7%	25.0%
Correlation to S&P500 TR	-0.39	1.00	0.22
Slope of regression to S&P 500 TR	-0.27	1.00	0.07
Intercept of regression to S&P 500 TR	13.9%	0.0%	8.1%

The return characteristics delivered by this strategy are consistent with those of a good diversifier as it satisfies the four criteria mentioned earlier:

- a low and stable negative correlation of -0.39 to S&P 500 returns;
- an annualized compound return of 9.7%;
- tradable in size without affecting market returns; and
- low execution costs because it uses the highly liquid S&P 500 futures market.

Investments using this trading strategy would have generated positive returns on a consistent basis. Over the past 29 years, these investments would have had negative annual returns in only one year, namely -2.5% in 2010. Their maximum annual returns would have been 68.4% in 1987 followed by 61.8% in 2008. These investments would have generated positive returns in about 75% of the months over the 29 year period with a largest single month loss of -6.3% and a largest single month gain of 46.2%.

Since 1982, the trading strategy returns have had a maximum drawdown of 8.7% of nominal capital deployed. The relatively low drawdown of the strategy (during 1985-86), and its use of futures instead of cash instruments, means the nominal capital deployed to this strategy could be reduced. In that case, the maximum drawdown would increase proportionately as would the strategy's annualized compound returns. For example, if the nominal capital allocated to the strategy were halved, the maximum drawdown would be doubled and the annualized compound return would also be doubled.

The nominal value of the futures exposure needed to generate these returns would, on average, be a fraction of the value of the nominal capital allocated to the strategy. Over the

[2] REV is calculated on a calendar month basis using daily returns of S&P 500 futures.

[3] This correlation of 0.77 is higher than the correlation of 0.74 between VIX (spot) at month end and the realized volatility in the next month.

past 29 years, this average has been 0.25. Consequently, if the nominal capital allocated to the strategy was halved and the futures exposures left unchanged, the average leverage would double to 0.5. However, the leverage of the strategy varies over time, and the strategy's maximum leverage over the past 29 years has been as high as 4.9 in October 1987. If the nominal capital was halved, as suggested above, this maximum leverage would be doubled to 9.8. If we exclude October 1987 (which is not unreasonable as the market structure has changed since then) the maximum leverage of the strategy was 2.75 in October 2008. Here again halving the nominal capital allocated would increase the leverage to about 5.5. Of course, the strategy could be implemented with a constraint on total leverage but that would impact average annual returns.

IV. Conceptual Model

All trading strategies may, at the most basic level, be classified as trend-following or mean-reverting. Trend-following models assume, as their name suggests, that the past trend in price movements of a security will continue. Mean-reverting strategies on the other hand assume that the past trend in prices will break and that the security price will move in the opposite direction. Realized volatility is generated by the price of a security moving up and down and, as such, capturing returns correlated to REV requires a mean-reverting trading model.

A good mean-reverting model should generate returns that are only dependent on the realized volatility of the security and are independent of the underlying trend in the security.[4] In practice, most mean-reverting models generate returns that are dependent on both realized volatility and trend to varying degrees; as such, the efficacy of a mean-reverting model depends on how much of its return is generated by the trend component. The higher the fraction generated by the trend component, the higher the correlation of the model's returns with the returns of a trend model, lower its diversification benefits and larger the potential drawdown of a portfolio constructed using both models.

The trading strategy we have developed is a mean-reverting strategy. To test its efficacy we calculate the correlation of the returns generated by this strategy with the realized variance (square of volatility) of the S&P 500 index.[5] This correlation is 0.88 (as opposed to the correlation of 0.77 with realized volatility) which is reasonably close to that of the ideal model that should generate returns with a correlation of one. Moreover, the returns generated by the strategy have a correlation of -0.39 with the S&P 500 return, which is almost identical to the correlation of -0.38 between realized returns and realized variance of S&P 500.

A mean-reverting model assumes a break in trend and that prices will move in a direction different from the recent past. The key decision to be made by the trading strategy is the sizing of positions in the underlying security. It needs to do this taking into account the price moves in the security and the capital gains/losses on the strategy while simultaneously adjusting for any trend in the security price over the time period.

V. Using REV as Portfolio Hedge

We analyzed the impact of making allocations to this trading strategy on portfolios using an efficient frontier approach. We generated the efficient frontier (see Figure 1), by increasing the allocations to the REV trading strategy from 0% to 100% in increments of 5%, and reducing allocations to equity proportionately. The portfolio was rebalanced on a monthly basis and the returns and volatility of portfolio were calculated over the two time horizons, 6/1982—9/2011 (more than 29 years), and 10/2001—9/2011 (10 years). The efficient frontier using fixed income instead of REV as a diversifier is shown for comparison in Figure 1. The maximum drawdown of these portfolios is shown in Figure 2.

Figure 1A and 1B shows that over the past 29 years and over the past 10 years, the addition of the REV trading strategy to an equity only portfolio increases portfolio returns and reduces portfolio volatility. The maximum reduction in portfolio volatility occurs when the allocation to the REV trading strategy is about 60% of the portfolio. The reduction in portfolio volatility is mirrored by a reduction in the portfolio maximum drawdown, as shown in Figure 2A and 2B. The maximum drawdown drops from 50% to 30% as the allocation to the REV trading strategy increases from 0% to 30%. In summary, the addition of the trading strategy to an equity portfolio diversifies the portfolio and enhances its capital preservation characteristics.

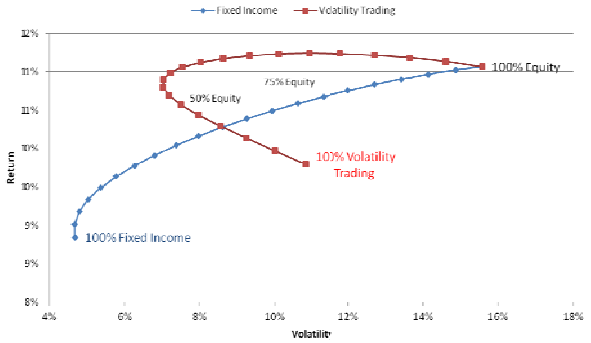

Figure 1A : The return-risk efficient frontier for the period from 6/1982 to 9/2011.

[4] As discussed earlier, there is a negative relationship between returns (trend) and realized volatility. Consequently, mean-reverting models generating returns that are positively dependent only on realized volatility will appear to be negatively dependent on trend. A good mean-reverting model should generate returns that are independent of trend, after adjusting for the dependence between trend and realized volatility.

[5] We use variance (as opposed to volatility) to calculate these correlations as it is theoretically possible to capture only variance – and not the volatility – of any return series. This is the reason for the existence of variance (as opposed to volatility) swaps as tail hedges.

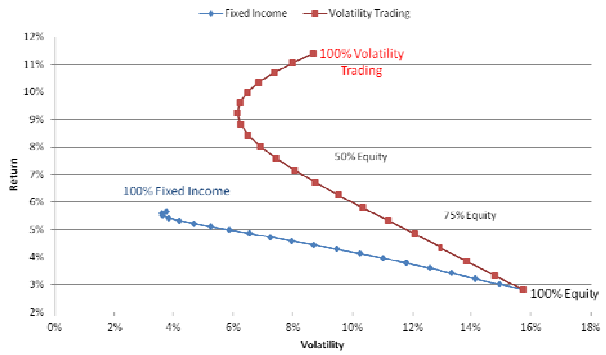

Figure 1B : The return-risk efficient frontier for the period from 10/2001 to 9/2011

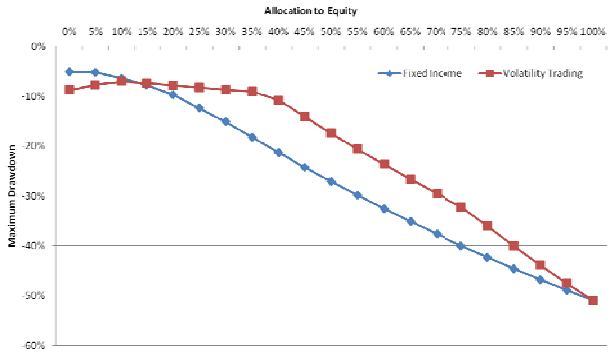

Figure 2A: The maximum drawdown vs. the allocation to equity for the period from 6/1982 to 9/2011.

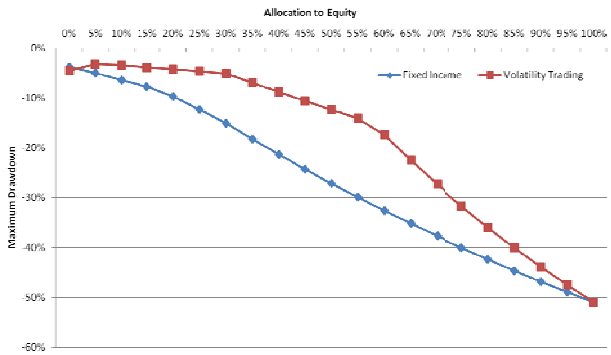

Figure 2B: The maximum drawdown vs. the allocation to equity for the period from 10/2001 to 9/2011.

Figure 3 compares the frequency distribution of returns of the S&P 500 and that of a portfolio with 50% allocated to S&P 500 and 50% to the REV trading strategy. The allocation to 50% of the capital to the REV trading strategy significantly reduces the volatility of the portfolio, and more importantly, truncates the left tail of the return distribution.

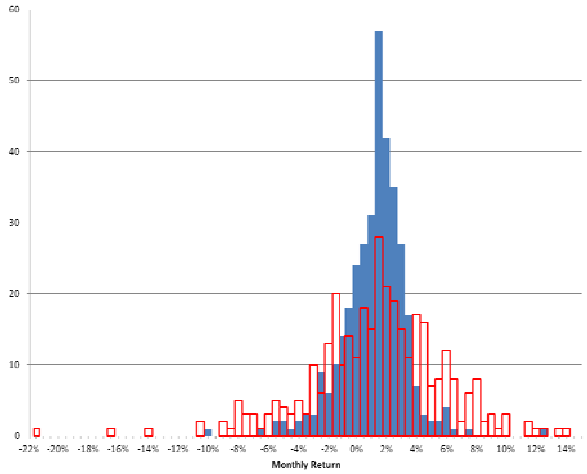

Figure 3: The frequency chart is based on data from 6/1982 to 9/2011. The red colored bars represent the frequency of returns for the S&P 500 index, while the blue bars represent the frequency of returns for a portfolio with 50% allocated to the S&P 500 index and 50% to the REV trading strategy.

VI. Conclusions

The strong negative correlation between equity returns and REV is well documented in literature. Given the low long-term return potential of fixed income, REV is an obvious choice for diversifying investment portfolios if it can be accessed in a cost-effective manner. Our research shows that such a return stream, which mimics REV, may be generated inexpensively using a simple trading strategy. Moreover, empirical analysis has validated its attractiveness as a diversifier in equity dominant investment portfolios as it reduces the volatility and drawdown of these portfolios without degrading their return potential.

The trading strategy that mimics REV is based on strong theoretical foundations. Moreover, the empirical implementation of the trading strategy worked almost as well as the underlying theoretical model. The S&P 500 future used for this trading strategy is perhaps the largest and most liquid of markets. Consequently, there is almost no constraint on the size of the equity portfolio to be diversified. This opens up the potential for its use by very large investment funds. Of course, the size of the futures contract (as with the mini futures contract) puts a constraint on how small the equity portfolio to be diversified can be – approximately $1 million. While this paper has articulated the use of REV as an alternative diversifier to fixed income in equity portfolios, we believe there are many other potential uses of this trading strategy including its use in active equity management.

Appendix

Table 2 : Monthly returns of the realized equity volatility trading strategy

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2012	-0.8%												-0.8%
2011	0.2%	0.0%	1.2%	-0.1%	0.4%	1.1%	0.8%	7.3%	1.8%	-1.8%	3.5%	1.4%	16.6%
2010	0.3%	0.5%	-1.7%	0.8%	0.5%	1.6%	-0.9%	0.5%	-2.9%	-0.4%	1.0%	-1.9%	-2.5%
2009	2.4%	-1.1%	6.1%	-1.9%	0.9%	1.5%	-1.0%	0.6%	0.3%	1.7%	-1.0%	0.3%	8.8%
2008	0.3%	0.9%	3.1%	0.0%	0.8%	-2.1%	2.1%	1.5%	5.0%	11.9%	18.2%	9.2%	61.8%
2007	0.4%	0.9%	1.0%	-0.4%	0.1%	0.8%	0.8%	2.5%	0.3%	1.0%	1.8%	1.3%	11.1%
2006	0.4%	0.5%	0.4%	0.4%	0.5%	1.1%	0.9%	0.2%	0.2%	0.0%	0.4%	0.3%	5.4%
2005	0.1%	0.3%	0.4%	0.8%	0.1%	0.4%	-0.2%	0.5%	0.4%	0.9%	-0.2%	0.4%	3.7%
2004	0.3%	0.2%	0.9%	0.5%	0.5%	0.3%	0.0%	0.7%	0.4%	0.6%	-0.3%	-0.1%	4.0%
2003	1.9%	1.1%	2.9%	-2.1%	-0.4%	0.9%	0.9%	0.4%	0.7%	-0.9%	0.4%	-0.9%	5.0%
2002	1.2%	1.3%	0.3%	-0.7%	2.0%	-0.5%	3.7%	4.5%	-2.6%	3.1%	0.1%	-0.1%	13.0%
2001	2.1%	-2.7%	1.4%	1.0%	1.4%	0.5%	1.5%	-0.7%	0.0%	1.6%	-1.6%	1.0%	5.5%
2000	1.6%	1.5%	-0.2%	3.9%	2.4%	1.0%	1.1%	-1.0%	-0.7%	3.1%	-1.1%	3.4%	15.8%
1999	1.7%	1.3%	1.3%	1.1%	1.2%	-0.3%	0.3%	1.4%	1.4%	0.8%	0.9%	-0.6%	11.0%
1998	1.7%	-1.5%	-0.3%	1.1%	0.6%	1.1%	1.2%	-6.2%	4.6%	-0.7%	-0.3%	0.2%	1.3%
1997	-0.7%	1.0%	0.3%	0.6%	-0.5%	0.8%	-1.5%	0.4%	0.5%	5.5%	0.7%	1.3%	8.7%
1996	0.6%	0.8%	1.4%	0.8%	0.7%	0.5%	0.3%	0.8%	-0.7%	0.3%	-1.7%	0.9%	4.7%
1995	0.1%	-0.1%	0.3%	0.1%	0.4%	0.4%	0.2%	0.4%	-0.3%	0.5%	-0.3%	0.6%	2.4%
1994	-0.2%	0.2%	-0.3%	0.8%	0.4%	0.3%	-0.2%	0.0%	0.2%	0.7%	0.1%	0.6%	2.7%
1993	0.4%	0.7%	0.5%	0.1%	0.2%	0.4%	0.3%	-0.3%	0.3%	0.1%	0.3%	0.3%	3.5%
1992	0.3%	0.5%	0.1%	0.9%	0.5%	0.5%	0.1%	0.1%	0.5%	0.6%	-0.1%	0.3%	4.4%
1991	1.3%	-0.6%	0.9%	1.3%	0.5%	-0.4%	-0.1%	1.0%	0.3%	0.8%	0.3%	-4.7%	0.5%
1990	-0.5%	0.9%	0.8%	0.7%	-2.7%	1.1%	1.0%	-1.7%	-0.2%	3.2%	-0.2%	0.8%	2.9%
1989	-1.3%	0.5%	1.0%	-0.3%	0.4%	1.0%	-2.7%	1.1%	0.6%	5.5%	0.7%	0.6%	7.3%
1988	6.3%	0.0%	0.8%	2.6%	1.8%	0.6%	1.7%	0.4%	0.3%	0.9%	0.7%	0.5%	17.7%
1987	-6.3%	0.3%	1.2%	3.5%	1.7%	0.1%	-0.9%	0.6%	1.6%	46.2%	11.2%	1.9%	68.4%
1986	1.8%	-1.1%	-0.4%	1.8%	-0.5%	1.3%	-0.3%	-1.6%	-1.4%	-0.9%	1.2%	0.4%	0.3%
1985	-0.5%	0.4%	0.8%	0.6%	-0.3%	0.6%	0.7%	0.6%	0.1%	0.2%	-1.5%	0.4%	2.3%
1984	0.6%	0.2%	0.9%	1.1%	-1.1%	1.1%	0.9%	-2.4%	1.2%	1.4%	0.9%	1.0%	5.9%
1983	1.6%	2.3%	1.8%	-2.1%	1.0%	0.6%	0.9%	1.1%	0.8%	0.8%	0.8%	0.7%	10.7%
1982						3.2%	1.6%	0.4%	3.4%	-2.9%	3.8%	3.0%	12.9%

Table 2 : Monthly realized volatility of S&P 500 futures calculated using daily returns

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	2.2%											
2011	3.2%	3.3%	5.1%	2.7%	3.2%	5.0%	4.5%	14.0%	8.4%	8.9%	8.6%	5.7%
2010	4.4%	4.5%	2.1%	4.4%	9.2%	7.5%	5.8%	5.4%	4.6%	2.7%	4.5%	2.7%
2009	10.7%	9.1%	14.0%	8.5%	7.2%	5.6%	5.9%	5.0%	4.4%	6.2%	4.2%	3.2%
2008	6.8%	5.2%	8.1%	5.2%	4.3%	5.6%	6.6%	5.7%	14.2%	27.5%	20.0%	13.6%
2007	2.2%	4.4%	4.0%	2.2%	2.3%	4.3%	5.0%	6.8%	4.0%	4.3%	7.7%	5.0%
2006	3.0%	2.6%	2.3%	2.4%	4.2%	4.5%	3.7%	2.0%	2.1%	1.7%	2.5%	1.9%
2005	2.7%	2.9%	3.0%	4.4%	2.8%	2.4%	2.4%	2.8%	2.4%	4.5%	2.1%	2.1%
2004	3.0%	2.3%	4.5%	3.6%	3.3%	2.9%	3.2%	3.6%	2.7%	3.7%	2.8%	2.3%
2003	6.9%	4.9%	7.8%	5.2%	4.3%	4.4%	4.6%	3.4%	4.0%	3.4%	2.9%	2.7%
2002	5.1%	5.5%	4.3%	4.9%	6.5%	6.5%	12.7%	9.7%	7.5%	11.5%	6.6%	5.6%
2001	6.9%	5.2%	8.7%	8.4%	5.0%	3.8%	5.5%	5.0%	8.7%	5.9%	4.7%	4.6%
2000	8.2%	5.3%	8.2%	9.4%	6.8%	4.5%	4.6%	2.7%	3.8%	7.9%	5.9%	8.3%
1999	6.3%	6.1%	6.0%	5.5%	5.4%	4.2%	3.8%	5.1%	5.8%	6.9%	4.0%	3.5%
1998	5.6%	2.8%	3.0%	4.3%	3.8%	5.6%	4.7%	10.5%	11.7%	8.1%	4.8%	6.0%
1997	3.9%	4.3%	5.1%	6.4%	4.7%	5.1%	4.8%	6.1%	5.4%	11.0%	5.3%	5.1%
1996	4.1%	3.6%	5.0%	3.5%	3.7%	2.4%	5.4%	3.8%	2.8%	3.1%	2.6%	4.8%
1995	1.6%	2.0%	2.5%	1.7%	3.5%	2.7%	2.8%	1.7%	1.8%	2.6%	2.3%	2.9%
1994	1.8%	3.5%	3.3%	3.8%	2.8%	3.4%	1.8%	2.6%	2.8%	3.7%	3.6%	2.9%
1993	2.1%	3.5%	3.6%	3.0%	3.1%	2.4%	2.2%	1.4%	2.1%	2.0%	2.4%	1.7%
1992	2.8%	2.9%	2.1%	4.6%	2.5%	2.9%	3.3%	2.0%	3.0%	3.3%	2.4%	2.1%
1991	6.1%	5.0%	4.1%	4.7%	4.3%	3.5%	3.4%	4.4%	2.2%	3.5%	4.7%	4.1%
1990	6.1%	3.6%	3.5%	3.9%	3.9%	4.1%	3.8%	8.2%	4.5%	7.7%	5.0%	3.2%
1989	2.9%	3.7%	3.8%	2.8%	3.2%	3.9%	2.7%	4.1%	2.4%	10.5%	3.3%	2.9%
1988	11.3%	4.4%	4.8%	6.9%	5.9%	5.0%	5.5%	4.3%	3.6%	4.0%	3.5%	2.6%
1987	5.6%	3.9%	4.9%	8.3%	5.6%	4.0%	2.7%	4.3%	5.7%	39.6%	8.5%	8.6%
1986	5.6%	3.3%	3.7%	6.3%	4.0%	4.7%	5.4%	3.6%	7.3%	4.3%	4.8%	3.4%
1985	4.4%	3.1%	3.3%	2.6%	2.9%	2.5%	3.1%	2.9%	3.3%	3.4%	3.1%	3.6%
1984	2.1%	4.8%	3.4%	3.9%	2.9%	3.9%	3.5%	6.0%	4.1%	4.4%	3.8%	3.9%
1983	6.6%	6.5%	5.7%	3.9%	3.9%	4.7%	4.9%	3.9%	2.7%	3.4%	3.2%	2.7%
1982						7.6%	5.2%	9.9%	8.0%	9.5%	9.1%	7.5%

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