

# Ed Thorp

## A MATHEMATICIAN ON WALL STREET

# Statistical Arbitrage - Part VI

The launch of Ridgeline Partners brings the author back to the hedge fund business

*Time is the ultimate budget constraint.*—  
Jerome B. Baesel to the author.

**W**hy was I enticed back into the hedge fund business? Because we now had a large managed account from a savvy client that we knew well and for whom we were already trading successfully. I also had my own money to manage and this product seemed equal to or better than the outside hedge funds managers I could join. Best of all, it was intellectual fun to generate ideas to beat the market. So in



August of 1994, in addition to the large institutional account we managed from August 1992, we launched Ridgeline Partners, a statistical arbitrage hedge fund. After a slow start in 1994 and 1995, the pretax return to limited partners (i.e. after all fees and expenses) annualized at 18 per cent for its eight and a quarter years of operation.

We begin by presenting results for the large managed account. This was for the pension and profit sharing plan of a Fortune 100 company which for confidentiality we call XYZ. The first table, XYZ Performance Summary, gives basic statistics for 2,544

trading days, just over 10 years. These results are before leverage and before fees. We'll see later that the results for the investor were better because the gain from leverage more than covered fees.

The annualized return of 9.93 per cent and the annualized standard deviation of 16.91 per cent for the S & P 500 during this period are not far from its long-term values. The unlevered annualized return for XYZ before fees, at 21.10 per cent, is about twice that of the S & P and the standard deviation of 7.11 per cent is 60 per cent less. The  $\mu/\sigma$  ratio for XYZ at 2.97 is five times that of the S & P. Estimating 5 per cent as the average 3 month T-bill rate over the period, the corresponding Sharpe ratios are 0.29 for the S & P and 2.26 for XYZ.

Regressing daily returns on those for the S & P 500 shows that  $R(XYZ) = 0.00074 + 0.05149 R(S\&P)$  where  $R(\cdot)$  is

### XYZ Performance Summary

XYZ Performance Summary						
Start Date	8/12/1992					
End Date	8/15/2002					
Days Traded	2544					
Annualized Rate of Return	21.10%	12-month	8-month	3-month	1-month	
Annualized Standard Deviation	7.11%	8.44%	6.23%	4.00%	3.49%	
$\mu/\sigma$	2.97	1.73	1.36	1.00	1.08	
S&P 500 Annualized Rate of Return	9.93%	18.28%	18.82%	18.28%	18.28%	
S&P 500 Annualized Standard Deviation	16.91%	14.31%	17.82%	14.80%	16.76%	
S&P 500 $\mu/\sigma$	0.58	-0.75	-1.42	-1.30	-1.18	
<b>Regression Summary: XYZ Daily Return vs. S&amp;P 500 Daily Return</b>						
Coefficient: S&P500 Daily Return & T-Intercept	0.05149	0.00074				
Standard Error: S&P500 Daily Return & T-Intercept	0.00817	0.00080				
Coefficient of Determination ( $R^2$ ) & Standard Error of T-Statistic	0.01800	0.00441				
F-Statistic & Degree of Freedom	36.71	2542				

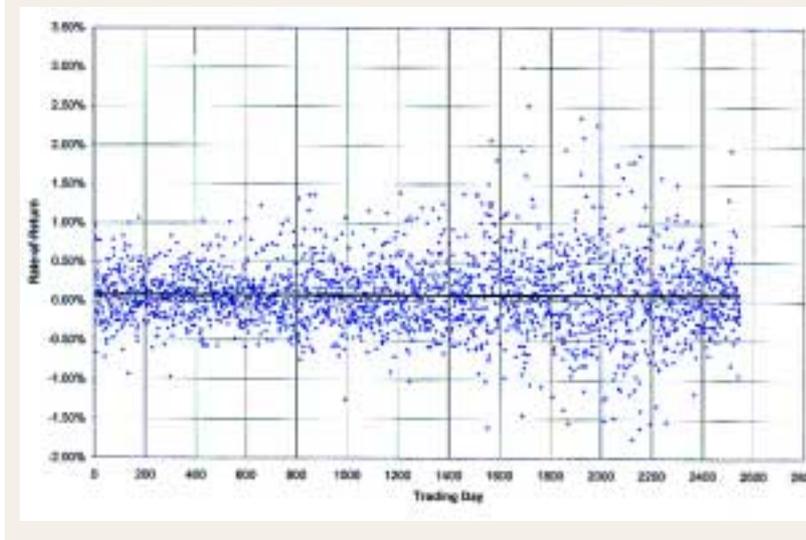
the corresponding daily return. Thus alpha was 7.4 basis points or 0.074 per cent per day which is about  $\exp(0.00074 * 252) - 1 = 20.5$  per cent annualized.

The next graph, XYZ Daily Performance, shows the daily fluctuations in portfolio value. The heavy black horizontal line is the mean daily return of 0.074 per cent.

Outliers, such as positive fluctuations greater than 1.5 per cent and negative fluctuations greater than 1 per cent, indicate a distinct increase in variability from about day 1,500 until about day 2,400 (and perhaps beyond?). With about 252 trading days per year, this corresponds to the period from about August 1, 1998 through the middle of February, 2002. The LTCM disaster occurred at the start and the dot com collapse and 9/11 occurred in the last couple of years of the period.

The graph “XYZ Performance Comparison I” shows the cumulative wealth relatives for XYZ (blue), the S & P 500 (magenta) and T-bills + 2 per cent (yellow). From about day 600 (the end of 1994) until about day 2,000 (about August 1, 2000) we see one of the great bull markets of all

### XYZ Daily Performance



time. Over about 5.6 years the S & P 500 exploded at a 26 per cent annual compound rate, a cumulative wealth relative of about 3.7.

However the customary arithmetic graph exaggerates the triumph of XYZ over the S & P and it is instructive to plot the logarithm of the cumulative wealth relatives, which we do in XYZ Performance Comparison II. In this graph straight lines correspond to constant compound

growth rates with the growth rate proportional to the slope of the line.

Laying a straight edge on the graph of the log of XYZ’s wealth relative, we see what appear to be two major “epochs.” The first, from day one (August 12, 1992) to about day 1,550 (early October, 1998) shows a nearly constant compound growth rate. The second epoch, from about day 1,550 until day 2,544 (September 13, 2002) has a higher overall rate of return, including a remarkable six month spurt just after the LTCM disaster. After the six month spurt (the last quarter of 1998 and the first quarter of 1999), the growth rate returns for the rest of the time to about what it was in the first epoch.

However the variability around the trend is noticeably greater, as we’ve already seen in the “Daily Performance” chart.

The explanation for the greater variability might be from any of several causes. Among them may be the election of George W. Bush (the outcome was delayed and disputed until December 2000). Preceded by uncertainty settled around day 2,080, we have an economic sea change from budget surpluses to increased

### XYZ Performance Comparison I



### XYZ Performance Comparison II

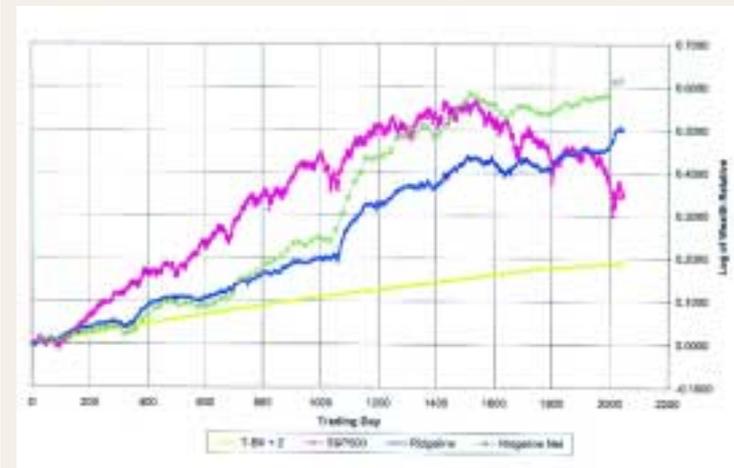


spending and massive deficits, caused by the tax rate reductions, the collapse of the dot com bubble, 9/11 and two wars. Also we had been continually revising, and hopefully improving, our stock selection algorithms. The choices we made may have contributed to increased variability, in hopes of higher expected returns.

The next graph, “RIDG Performance Comparison” shows us the results for Ridgeline Partners and a comparison with the corresponding XYZ chart gives us much new information.

First, the green line plots the log of the cumulative wealth relative as of each month end, as received by investors. Thus it incorporates the gains (in this case) from leverage and the reductions from the general partner’s fees. The overall result was that the increase in performance from leverage more than covered all the fees. These fees were 1 per cent per year, paid quarterly in

**RIDG Performance Comparison II**



pointed in our recent past performance. This accounted in total to more than a million dollars. We also had a waiting list during most of our history. Ridgeline was closed a large part of the time and even current partners were often restricted from adding capital. There were also occasions where we gave capital back to partners in order to reduce our size. As other hedge fund managers have demonstrated, under these conditions of excess demand we could have chosen to increase our fees either by raising our percentage of the profits or taking in “too much” capital and thereby driving down the net percentage return to limited partners. These strategies to capture nearly all the alpha for the general partner work according to economic theory and seem to also work in practice. Instead I prefer to treat limited partners as I would wish to be treated when I’m a limited partner.

Over the ten years of our latest statistical arbitrage operation, we ran several hundred million dollars using only 3.5 “full time equivalents” from our office. It was a highly automated, lean and profitable operation. The “shrink wrapped” software sits on our shelf and ought to have a tag saying, “add people and data to reactivate.” Why close down? Perhaps the most important reason for me was the increasing marginal value of (expected) time expended had exceeded the decreasing marginal value of (expected) money to be gained.

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advance, plus 20 per cent of profits paid only on “new high water.” The general partner also chose to reduce its fee on occasion after periods when performance was mediocre.

Many of today’s hedge fund managers would consider our fee policies economically irrational. Here’s why: We voluntarily gave back or reduced fees during some periods when we felt disap-