



Ed Thorp

A MATHEMATICIAN ON WALL STREET

# Statistical Arbitrage – Part I



*Newport Bay: Statistical arbitrage can get you this far*

The pioneer of statistical arbitrage guides us through a typical day at the office

*“Thorp, my advice is to buy low and sell high.”*  
Mathematician William F. Donaghue

It’s the spring of 2000 and another warm sunny day in Newport Beach. From 600 feet high on the hill I look 30 miles over the Pacific at Wrigley’s 26-mile-long Catalina Island, stretched across the horizon like a huge ship. To the left, 60 miles away, the top of equally large San Clemente Island is visible peeping above the horizon. The ocean ends two and a half miles away, with a ribbon of white surf breaking on wide sandy beaches. An early trickle of fishing and sail boats stream into the sea from Newport Harbor, one of the world’s largest small-boat moorings, with more than 8,000 sail and power vessels, and some of the most expensive luxury homes in the world. Whenever I leave on vacation I look back over my shoulder and

wonder if I’m making a mistake.

As I finish breakfast the sun is rising over the hills to the east behind me. It illuminates the tops of three financial towers to the west in the enormous business and shopping complex of Fashion Island. By the time the buildings are in full sun I make the 3-mile drive to my office in one of them.

## Statistical arbitrage in action

Logging onto our computer system, I learn that we have already traded more than a million shares electronically and are ahead \$400,000 in the first hour of trading. We’re currently managing a temporary high of \$340 million, with which we have established positions of \$540 million worth of stocks long, and an equal dollar amount short, consistent with our policy of keeping our portfolio dollar neutral. We know both from computer simulations and historical experience that our dollar neutral portfolio will also generally be close to market neutral. Market neutral means that the fluctuations in the value of the portfolio have very little relationship with the price changes in whatever benchmark is chosen to represent the market. For example one might choose as a benchmark for an equity portfolio the S&P 500 Index or the Wilshire 5,000 index. In

early 2000, after the 7 years and 5 months that we have operated the current system, our level of market neutrality as measured by what financial theorists call beta has averaged about 0.06 on a pre-fee unlevered basis with zero being completely market neutral and 1.0 representing the market itself. Our alpha, which measures risk-adjusted excess return, the amount by which our annualized return has exceeded that from investments of comparable risk, has averaged about 20 per cent per year. This means that our past annual rate of return before fees of 26 per cent can be thought of as the sum of three parts: 5 per cent from Treasury bills with no risk, about 1 per cent from our slight market bias of 0.06 (0.06 times the markets’ average annual return over the 7 years and 5 months of our track record is roughly 1 per cent) plus the difference, a risk adjusted excess return of 20 per cent. We were essentially market neutral.

Using our proprietary prediction model, our computers continually calculate a “fair” price for each of about one thousand of the largest, most heavily traded companies on the New York and American Stock Exchanges. Stocks with large trading volume are called “liquid”; they are easier to trade without inducing a large “market impact” cost. The latest prices flow into the com-

puters in “real time” and when the deviation from our calculated price for a security is large enough, we buy what we predict are the underpriced stocks and short the overpriced stocks. To control risk, we limit each stock we own to 2.5 per cent of our long portfolio. If every long position were at 2.5 per cent then we would have 40 stocks long. But we are continually entering and exiting positions so at any one time we can have between 150 and 300 stocks on the long side. Even with this level of risk control, plus additional constraints that tend to limit industry or sector concentration, we can have some nasty surprises. These come in the form of unexpected major company developments that we can’t predict, such as a disappointing earnings announcement. If we were to suddenly lose 40 per cent of a 2.5 per cent position, the portfolio could drop 1 per cent. Fortunately we rarely get more than one of these “torpedoes” per month. We also get about as many favorable surprises, leading to comparable windfall gains.

We limit each short position to 1.5 per cent of the portfolio so we would have 67 positions if all were at full size. In practice we typically have 150 to 300 positions because we’re always in the process of building new positions and taking off old ones. Our limit on the size of short positions is lower than for long positions because a sudden adverse move in a short position can be greater than for a long position. The worst outcome for a loss on a stock held long is for the stock to suddenly become worthless, leading to a loss of 100 per cent of the original value of the position. Similarly, if a stock sold short doubles in price, the seller loses 100 per cent of the original value of the stock sold short. But the stock could triple or quadruple in price, or worse, leading to losses of 200 per cent, 300 per cent or more, of the original value of the stock sold short.

Our caution and our risk control measures seem to work. Our daily, weekly and monthly results are “positively skewed,” meaning that we have substantially more large winning days, weeks and months than losing ones, and the winners tend to be bigger than the losers.

I scan the computer screen, which is showing me the day’s 48 most interesting positions, including the 12 biggest gainers and the 12

## Our 1.5 billion shares a year amounts to about 6 million shares a day, over 0.5 per cent of the total NYSE volume. A reduction of 0.16¢ on two thirds of our trades, or one billion of those shares, saves us \$1.6 million a year

biggest losers on the long side, and the same for the short side. By comparing the first few with the rest of the 12 in its group, I can see quickly if any winners or losers seem unusually large. Everything looks normal. Then I walk down the hall to Steve Mizusawa’s office. Steve is watching his Bloomberg terminal checking for unusual events that are not part of our prediction model but might have a big impact on one of the stocks we trade. When he sees one of these events, such as the announcement of a merger, takeover, spin-off or reorganization, he tells the computer to put the stock on the restricted list: don’t initiate a new position and close out any that we have. The restricted list also has those stocks which we are unable to sell short, due to our brokers’ inability to borrow them.

### 1.5 billion shares a year

Steve tells me, with his characteristic soft spoken modesty, that the broker where we do about two thirds of our business has reduced our commissions by about 0.16¢ per share. Steve has been working to achieve this but, as usual, doesn’t claim credit.

To appreciate the savings you need to realize how much we trade. Our portfolio turns over about once every ten days, and with about 253 trading days per year, that’s about 25 times per year. A turnover at current levels means we sell \$540 million of stocks held long and replace them with \$540 million of new stocks, for a total value traded of \$1,080 million. We also cover (buy back) \$540 million of stock previously sold short

and sell \$540 million of new shorts, for another \$1,080 million. So one turnover means about \$2,160 million and 25 turnovers a year means we are trading at the rate of about \$54 billion per year. With an average price of \$36 per share we’re trading 1.5 billion shares a year. Famed hedge fund manager Michael Steinhardt, when he retired recently, astonished many by announcing he had traded a billion shares in one year. The Medallion Fund, a hedge fund closed to new investors, run by mathematician James Simons, includes a similar even larger trading operation with a higher rate of turnover and a greater annual trading volume.

Our 1.5 billion shares a year amounts to about 6 million shares a day, over 0.5 per cent of the total NYSE volume. A reduction of 0.16¢ on two thirds of our trades, or one billion of those shares, saves us \$1.6 million a year. At an average trade size of 1,500 shares, we’re making 4,000 trades a day or 1 million trades (tickets) a year. At an all inclusive average cost of about 0.74¢ per share, our 1.5 billion shares a year generate \$11.1 million a year in commissions and ticket charges. Add to this another \$1.8 million per year profit which the brokers make from lending us \$210 million, and another \$1.4 million or more per year in profits to them from lending us stock to sell short, and our brokers currently collect about \$14.3 million per year from us. Our main broker was smart to stay competitive by reducing rates.

■ *To be continued in the next issue*