Why Trading Strategies Fail

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(working paper)

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0.1	September 4, 2008	Initial version issued for comment
0.2	October 14, 2008	Remove some content & rephrase

Contents

1 Introduction

Finding and implementing profitable stock trading strategies is an extremely difficult task, at least in terms of success rate. Quantitative strategies rely on the existence of at least small inefficiency and sometimes require complicated implementation techniques.

Major financial instructions are investing huge amounts in automated trading systems, the proportion of trading carried out by computers is growing rapidly and a few individuals have made a fortune from them.

In this article I claim that some strategies that might even work on historical data and will pass any statistical success tests will most likely fail in real test. It is not my claim though, that profitable strategies do not exist.

What is shown, is that even strategies that perform well on reliable historical data may fail in reality and in this article it is not intended to propose a modification of the analyzed strategy, merely to explain why it fails.

2 Pairs trading example

Pairs trading is a trading strategy that involves the simultaneous purchase of a stock and sale of another stock under the assumption that the price changes of this pair of stocks should be highly correlated. Whenever the difference between their price change exceeds some threshold, the trader buys the security that is priced lower (under priced), and short-sells the security that is priced higher (over-priced). Because the securities are highly correlated, their value is expected to become equal at some future time. At this point the trader sells the previously overpriced one, and buys the previously under-priced one, gaining twice the difference between the securities, excluding trading fees.

Ideally, pair trading should be executed against equivalent securities, such as companies that are traded across different markets at some overlapping hours, or different ETF securities that represent the same underlining index (like SPY and IVV), however, such trivial opportunities are very rare.

Another way to look for pair trading opportunities is to identify particular pairs of securities whose historic price changes are highly correlated and thus exploit statistical pair-taring profit opportunity. Some pairs trading strategies are based on fundamental research, such as equivalent P/E ratio instead of a direct usage of the price data. Pairs trading is strongly related to statistical arbitrage.

In this article we show that algorithms that generate profitable trading do exist for simulations that run on historical data, however, although these algorithms guarantee significant profitability, fails to do so in real trading. The reasons for this irregular phenomena are explained along this article.

The Strategy

The strategy is comprised of the following steps:

Input: List S&P 500 index constituents – 500 symbols, and in addition the index itself, which can be traded by buying or selling a ETF security whose underlining is the index.

More generally, for a candidate list of M securities, at a given date d:

1. Select S, $S \ll \frac{M \times (M-1)}{2}$ candidates (for a candidate portfolio with 501 constituents we choose $S \ll 125250$). $\frac{501 \times 500}{2} = 125250$ is the total number of pairs. (See 'Initial Selection Method')
2. For the set of N selected pairs, run the pairs trading algorithm (see 'The Pairs Trading algorithm') for the ten trading days that precede d: $[d-10 \ldots d-1]$
3. Select N top performers, $N \ll S$ and run them for the period [d...d+10).
4. The strategy's gross return is the average return of the N pairs.

Initial Selection Method

Let r_j^d, r_k^d denote the daily logarithmic return of the stocks j and k on day d:

$$r_k^d = \log_e(I_k^d) - \log_e(I_k^{d-w}), \quad r_j^d = \log_e(I_j^d) - \log_e(I_j^{d-w})$$

is the logarithmic daily return, and with I^d – the close value for day d .

The distance between two securities is defined as the maximum difference of daily return:

$$M_{\text{jk}} = \begin{Bmatrix} \max(|r_j^t - r_k^t|), t-D<t<d & j \neq k \\ \infty & j = k \end{Bmatrix}$$

with D – being the number of days to evaluate the stock return distance.

1. Calculate **M** – the matrix whose j,k element is M_{jk} . Exclude diagonal elements, M_{ii}
2. Sort the elements of **M** and select the lowest values (S pairs).

The algorithm selects pairs of highly correlated securities, for which the maximal daily return difference is smaller than some predetermined threshold. Once the pair of securities is selected.

the strategy is to buy one symbol whose one day return is the lower amongst the two securities, and to short sell the other one, assuming that within the next days the price changed will be balanced.

The Pairs Trading Algorithm

Input: two securities, i and j.

1

O_k^d, C_k^d are the day-open and day-close prices of security k on day d respectively

1.1 Let $s_k^d = \log_e(O_k^d) - \log_e(C_k^{d-1})$ be the night return and $t_k^d = \log_e(C_k^d) - \log_e(O_k^d)$ the intra-day return. Note that the return on price of a single day, $w = 1$ is simply: $r^d = t^d + s^d$.

1.2 for a period of 10 trading days, $d = 1..10$ do

1.2.1 On trade open: for i, j buy the security with smaller $s_{i,j}^d$ and sell the other one.

1.2.2 End of day: for i, j buy (or keep if already in long position) the one with smaller t^d and sell (or keep a short position) the other one.

2 Repeat for 10 days.

Simulation results

In simulations, with $N = 10,\ S = 300$ the above algorithm was executed in the range of dates: 7/28/2008-9/9/2008. The result was an average 10-days return of $r = 0.0265$ (a profit of +2.65%) and a standard deviation of $\sigma_{10\,days} = 0.0307$, implying an expected annual profit of 97%, and standard deviation of $\sigma_{year} = 0.16$

The number of tested pairs here was 300, and each pair was tested for position determination for a period of 10 days.

Testing other periods of time generates very similar results, $\langle r \rangle > 0.02$

Detailed Scenario of a Single Pair

As an typical example, approximately average in terms of return on value, consider the pair **Entergy Corp** (ETR), **Exelon Corp.** (EXC) in the two weeks range 7/30/2008-8/11/2008.

On the day open, 7/30 the algorithm's decision is to buy ETR and sell EXC because EXC's P/L was greater during the previous night.

The table below shows the trade activity for the pair (ETR,EXC) from trade open on day 7/30/2008 to trade close on 8/11/2008.

- The rows denoted as 'DAY' (light cyan) represent a position taken (or kept) at trade open and closed at trade close (or kept).
- The rows denoted as 'NIGHT' (white) represent position taken at trade close and closed at trade open on the next morning.
- The long and short positions are assumed to be balanced, therefore the total balance is the average of the linear long and short profit and loss balance:

$$P_{total} = \frac{1}{2}\left(P_{LONG} + P_{SHORT}\right)$$

- The open/close price quotes are adjusted for splits and dividends. Note: The adjusted close prices are taken from Yahoo! Finance, and the adjusted open is obtained by multiplying the open price by the adjusted close, divided by the corresponding close price.
- In the case shown the strategy generated a profit of 3.24%

Day		LONG:	Buy At	Sell At	P/L	SHORT	Sell Short At	Buy At	P/L	Accum. Balance
07/30/08	DAY	ETR	108.55	109.38	0.76%	EXC	79.53	79.54	-0.01%	0.38%
	NIGHT	EXC	79.54	79.22	-0.40%	ETR	109.38	108.51	0.80%	0.58%
07/31/08	DAY	ETR	108.51	106.15	-2.17%	EXC	79.22	78.09	1.43%	0.21%
	NIGHT	ETR	106.15	106.40	0.24%	EXC	78.09	78.51	-0.54%	0.06%
08/01/08	DAY	ETR	106.40	103.37	-2.85%	EXC	78.51	74.93	4.56%	1.03%
	NIGHT	EXC	74.93	75.02	0.12%	ETR	103.37	104.00	-0.61%	0.78%
08/04/08	DAY	EXC	75.02	72.95	-2.76%	ETR	104.00	102.09	1.84%	0.34%
	NIGHT	EXC	72.95	73.28	0.45%	ETR	102.09	102.93	-0.82%	0.15%
08/05/08	DAY	EXC	73.28	74.06	1.06%	ETR	102.93	103.15	-0.21%	0.58%
	NIGHT	ETR	103.15	103.40	0.24%	EXC	74.06	73.98	0.11%	0.75%
08/06/08	DAY	EXC	73.98	74.38	0.54%	ETR	103.40	103.68	-0.27%	0.89%
	NIGHT	ETR	103.68	103.40	-0.27%	EXC	74.38	73.78	0.81%	1.16%
08/07/08	DAY	EXC	73.78	74.58	1.08%	ETR	103.40	103.24	0.15%	1.79%
	NIGHT	ETR	103.24	104.23	0.96%	EXC	74.58	74.92	-0.46%	2.05%
08/08/08	DAY	EXC	74.92	73.99	-1.24%	ETR	104.23	102.05	2.09%	2.50%
	NIGHT	ETR	102.05	102.10	0.05%	EXC	73.99	74.21	-0.30%	2.37%
08/11/08	DAY	ETR	102.10	102.70	0.59%	EXC	74.21	73.40	1.09%	3.24%

Causes of Failure

Unfortunately, under actual trade the algorithm does not generate any profit.

The reason is that the ***open*** price can not be obtained

3 Conclusion

Devising a profitable strategy is a difficult even if the strategy actually works for reliable historical data.

The second example demo