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# TRAITS: evidence-based trading

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April 28, 2009

## 1 About TRAITS

TRAITS is a fully-automated computer program for stock trading that learns continually. It monitors millions of candidate trading strategies in parallel, and uses an evidence-based approach to decide which are currently credible. Periodically it generates further candidates based on its past experience. Credible strategies are only used to select long or short entries, limit orders handle the exits.

Any strategy is only trusted once it has acquired a good record of being right, according to hindsight, and has made almost no mistakes. The wins must be spread over a significant period rather than being bunched up, and there must also have been many opportunities to be wrong. If a trusted strategy starts to make errors it will never again be used, but its constituents may still contribute towards building different candidates in the future.

Risk is controlled in several ways:

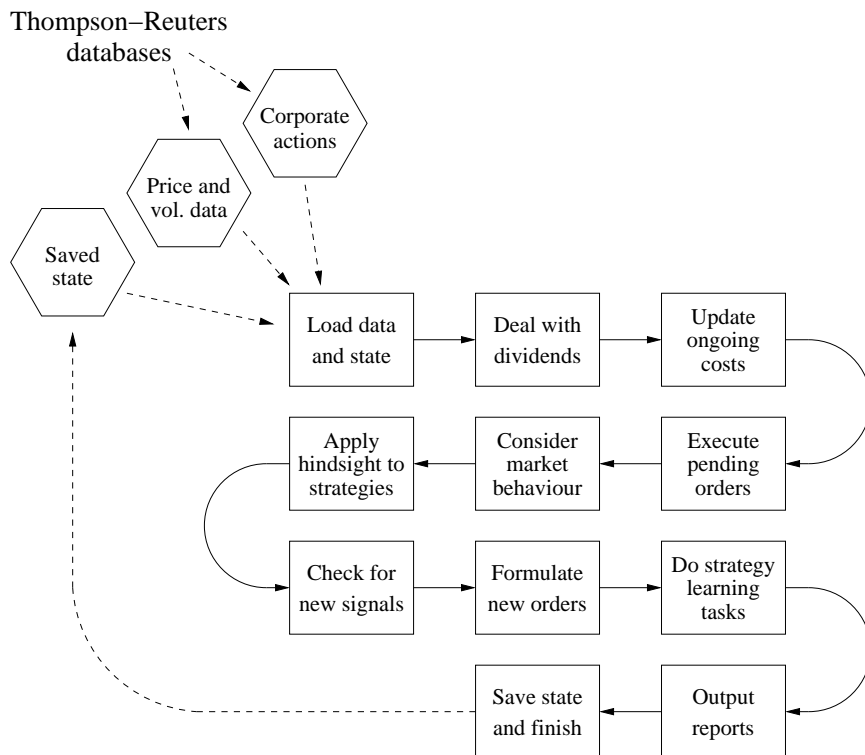
- TRAITS only trades very highly liquid stocks;
- there are limit orders for every open position, which are revised daily;
- there is a maximum leverage of 2, and the level is usually significantly lower;
- at most a small fixed percentage of current financial resources can be devoted to any single open position;
- position sizes are limited by volume thresholds;
- TRAITS also monitors the overall market and may decide to embargo any new longs or shorts for a period of time.

Two different versions of the system have been running unattended, each for over a year, as a paper-trading exercise. Version 1.5 was started on Oct 23 2007 and version 2.0 was started on March 11 2008; the differences between them and the results from both are reported below. Both versions are currently configured to trade UK and European equity CFDs, which can be marginally lower cost in the UK if positions are not open too long. Transaction costs, financing costs, stock-borrowing costs etc are included in the system's internal accounting.

We have also studied the effects of various levels of slippage. In practice the limit order levels would depend on observed slippage levels, but our studies suggest that the levels of performance reported below are reasonable for across-the-board slippage of up to 0.5% per trade.

## 2 About the two versions

The daily cycle of activity is shown below. Each version exists on two computers, in separate locations.



The main differences between the versions are:

	<i>Version 2.0</i>	<i>Version 1.5</i>
<i>Run started:</i>	March 11 2008	October 23 2007
<i>Universe:</i>	351 stocks	157 stocks
<i>Max possible:</i>	ca 10,000 stocks	ca. 200 stocks
<i>Limit orders:</i>	7 types	6 types
<i>Learning:</i>	includes pre-processing	no pre-processing
<i>Market monitor:</i>	gradual exits	abrupt exits

The next page gives a side-by-side comparison of their performance over the period from Jan 2005 to April 27 2009. All the data in this period is out-of-sample data, not used for tuning or configuration.

Version 2.0:

Portfolio Summary Statistics											
1:	Portfolio Summary Statistics										
2:	-----										
3:	Start Date:	03-01-05				Benchmark					
4:	End Date:	27-04-09				FTEU300.L					
5:	Num of Trading Days:	1126									
6:	Cumulative Return:	+131.72%				BM Cumulative Return:	-22.33%				
7:	Return in Last 3 Months:	+4.85%				BM Return in Last 3 Months:	+3.56%				
8:	Annualised Return:	+21.49%				BM Annualised Return:	-5.68%				
9:	Annualised Volatility:	10.21%				BM Annualised Volatility:	20.73%				
10:	Sharpe Ratio:	1.91				BM Sharpe Ratio:	-0.51				
11:	Base Currency:	EUR				Annualised LIBOR rate:	3.45%				
12:	-----										
13:	Year-By-Year Returns and long/short wins/losses										
14:	-----										
15:	Portfolio										
16:	Long positions				Short positions						
17:	Annual returns	Bnchmrk	nW	nL	Win%	AvgRet	nW	nL	Win%	AvgRet	
18:	-----										
19:	-----										
20:	2009 YTD:	5.78%	-2.16%	3	2	60.0%	+1.85%	35	46	43.2%	-0.22%
21:	2008:	16.03%	-44.79%	14	20	41.2%	-1.16%	102	70	59.3%	+2.25%
22:	2007:	6.48%	1.62%	77	72	51.7%	+0.38%	18	25	41.9%	+0.20%
23:	2006:	43.23%	15.68%	171	84	67.1%	+2.59%	9	6	60.0%	+1.50%
24:	2005:	23.71%	21.76%	114	73	61.0%	+1.72%	15	20	42.9%	-0.10%
25:	-----										
26:	-----										
27:	Daily Returns Profile [from daily NAV data]										
28:	-----										
29:	Average Daily Return:	+0.08%				Worst Daily Return:	-3.46%				
30:	Standard Deviation:	0.63%				Best Daily Return:	+3.29%				
31:	-----										
32:	-----										
33:	Weekly Returns Profile [from daily NAV data with 1-week rolling window]										
34:	-----										
35:	Average Weekly Return:	+0.38%				Worst Weekly Return:	-9.40%				
36:	Standard Deviation:	1.42%				Best Weekly Return:	+8.23%				
37:	Number of winning weeks:	145				Number of losing weeks:	80				
38:	Avg gain in winning weeks:	1.17%				Avg loss in losing weeks:	-1.03%				
39:	Winning weeks percent:	64.44%									
40:	-----										
41:	-----										
42:	Monthly Returns Profile [from daily NAV data with 1-month rolling window]										
43:	-----										
44:	Average Monthly Return:	+1.65%				Worst Monthly Return:	-10.01%				
45:	Standard Deviation:	2.62%				Best Monthly Return:	+14.32%				
46:	Number of winning months:	37				Number of losing months:	13				
47:	Avg gain in winning months:	2.79%				Avg loss in losing months:	-1.20%				
48:	Winning months percent:	74.00%									
49:	-----										
50:	-----										
51:	Annual Returns Profile [from daily NAV data with 1-year rolling window]										
52:	-----										
53:	Average Annual Return:	+23.52%				Worst Annual Return:	+3.89%				
54:	Standard Deviation:	12.92%				Best Annual Return:	+51.66%				
55:	-----										
56:	-----										
57:	Position Summary Analysis										
58:	-----										
59:	Long positions			Short positions			All positions				
60:	-----										
61:	Number of trades:	630				346				976	
62:	Number of winners:	379				179				558	
63:	Number of losers:	251				167				418	
64:	Win percent:	60.16%				51.73%				57.17%	
65:	Avg return per trade:	1.60%				1.14%				1.44%	
66:	Avg days in trade:	18.27				10.63				15.56	
67:	Avg num open positions:	10.50				3.57				14.07	
68:	Max num open positions:	34				27				38	
69:	Avg % of NAV:	51.40%				12.28%				63.69%	
70:	-----										
71:	-----										
72:	Position Return Detailed Analysis										
73:	-----										
74:	Long positions			Short positions			All positions				
75:	-----										
76:	Num	Avg Rtn	Num	Avg Rtn	Num	Avg Rtn	Num	Avg Rtn	Num	Avg Rtn	
77:	-----										
78:	Stop loss:	25	-11.58%	102	-9.59%	127	-9.98%	27	-9.39%	27	-9.39%
79:	Trailing stop:	240	+1.17%	53	+3.23%	293	+1.55%	187	+3.13%	31	+2.46%
80:	Chasing stop:	146	-2.50%	61	-2.66%	207	-2.55%	0	+0.00%	0	+0.00%
81:	Volatility stop:	37	-8.38%	2	-8.11%	39	-8.36%	8	-6.74%	2	-13.99%
82:	Max days:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
83:	10-day rule:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
84:	Entry agent bad:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
85:	Switch to phantom:	0	+0.00%	0	+0.00%	0	+0.00%	67	-1.80%	44	-0.85%
86:	Agent triggered:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
87:	Profit target:	182	+9.30%	128	+10.79%	310	+9.92%	26	+9.43%	56	+10.75%
88:	External command:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
89:	End of run:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
90:	-----										
91:	-----										
92:	Drawdown Analysis										
93:	-----										
94:	Worst Drawdowns										
95:	Drawdown	From	To	Days to Break Even							
96:	#1	11.10%	07-02-2007	05-03-2007	72						
97:	#2	5.96%	17-03-2008	02-04-2008	132						
98:	#3	5.00%	16-11-2006	28-11-2006	17						
99:	#4	4.94%	01-06-2007	08-06-2007	166						
100:	#5	4.46%	09-03-2009	23-03-2009	15						
101:	-----										

Version 1.5:

Portfolio Summary Statistics											
1:	Portfolio Summary Statistics										
2:	-----										
3:	Start Date:	03-01-05				Benchmark					
4:	End Date:	27-04-09				FTEU300.L					
5:	Num of Trading Days:	1131									
6:	Cumulative Return:	+124.19%				BM Cumulative Return:	-22.33%				
7:	Return in Last 3 Months:	+9.02%				BM Return in Last 3 Months:	+3.56%				
8:	Annualised Return:	+20.56%				BM Annualised Return:	-5.68%				
9:	Annualised Volatility:	12.83%				BM Annualised Volatility:	20.72%				
10:	Sharpe Ratio:	1.45				BM Sharpe Ratio:	-0.50				
11:	Base Currency:	EUR				Annualised LIBOR rate:	3.35%				
12:	-----										
13:	Year-By-Year Returns and long/short wins/losses										
14:	-----										
15:	Portfolio										
16:	Long positions				Short positions						
17:	Annual returns	Bnchmrk	nW	nL	Win%	AvgRet	nW	nL	Win%	AvgRet	
18:	-----										
19:	-----										
20:	2009 YTD:	8.36%	-2.16%	2	0	100.0%	+10.79%	30	19	61.2%	+1.90%
21:	2008:	17.29%	-44.79%	5	8	38.5%	+0.41%	49	31	61.2%	+2.96%
22:	2007:	0.88%	1.62%	36	32	52.9%	+0.85%	6	5	54.5%	+0.53%
23:	2006:	32.30%	15.68%	83	34	70.9%	+2.59%	3	4	42.9%	-1.07%
24:	2005:	32.25%	21.76%	58	30	65.9%	+3.05%	9	4	69.2%	+2.38%
25:	-----										
26:	-----										
27:	Daily Returns Profile [from daily NAV data]										
28:	-----										
29:	Average Daily Return:	+0.07%				Worst Daily Return:	-3.82%				
30:	Standard Deviation:	0.80%				Best Daily Return:	+5.55%				
31:	-----										
32:	-----										
33:	Weekly Returns Profile [from daily NAV data with 1-week rolling window]										
34:	-----										
35:	Average Weekly Return:	+0.37%				Worst Weekly Return:	-6.86%				
36:	Standard Deviation:	1.79%				Best Weekly Return:	+9.90%				
37:	Number of winning weeks:	156				Number of losing weeks:	70				
38:	Avg gain in winning weeks:	1.20%				Avg loss in losing weeks:	-1.45%				
39:	Winning weeks percent:	69.03%									
40:	-----										
41:	-----										
42:	Monthly Returns Profile [from daily NAV data with 1-month rolling window]										
43:	-----										
44:	Average Monthly Return:	+1.64%				Worst Monthly Return:	-8.80%				
45:	Standard Deviation:	4.18%				Best Monthly Return:	+21.36%				
46:	Number of winning months:	37				Number of losing months:	13				
47:	Avg gain in winning months:	3.38%				Avg loss in losing months:	-2.85%				
48:	Winning months percent:	74.00%									
49:	-----										
50:	-----										
51:	Annual Returns Profile [from daily NAV data with 1-year rolling window]										
52:	-----										
53:	Average Annual Return:	+18.18%				Worst Annual Return:	-7.47%				
54:	Standard Deviation:	16.17%				Best Annual Return:	+48.63%				
55:	-----										
56:	-----										
57:	Position Summary Analysis										
58:	-----										
59:	Long positions			Short positions			All positions				
60:	-----										
61:	Number of trades:	288				160				448	
62:	Number of winners:	184				97				281	
63:	Number of losers:	104				63				167	
64:	Win percent:	63.89%				60.62%				62.72%	
65:	Avg return per trade:	2.28%				2.24%				2.24%	
66:	Avg days in trade:	26.60				6.61				19.46	
67:	Avg num open positions:	6.59				1.05				7.64	
68:	Max num open positions:	25				14				25	
69:	Avg % of NAV:	56.82%				10.32%				67.14%	
70:	-----										
71:	-----										
72:	Position Return Detailed Analysis										
73:	-----										
74:	Long positions			Short positions			All positions				
75:	-----										
76:	Num	Avg Rtn	Num	Avg Rtn	Num	Avg Rtn	Num	Avg Rtn	Num	Avg Rtn	
77:	-----										
78:	Stop loss:	0	+0.00%	27	-9.39%	27	-9.39%	27	-9.39%	27	-9.39%
79:	Trailing stop:	187	+3.13%	31	+2.46%	218	+3.04%	187	+3.13%	31	+2.46%
80:	Chasing stop:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
81:	Volatility stop:	8	-6.74%	2	-13.99%	10	-8.19%	8	-6.74%	2	-13.99%
82:	Max days:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
83:	10-day rule:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
84:	Entry agent bad:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
85:	Switch to phantom:	67	-1.80%	44	-0.85%	111	-1.42%	67	-1.80%	44	-0.85%
86:	Agent triggered:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
87:	Profit target:	26	+9.43%	56	+10.75%	82	+10.33%	26	+9.43%	56	+10.75%
88:	External command:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
89:	End of run:	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%	0	+0.00%
90:	-----										
91:	-----										
92:	Drawdown Analysis										
93:	-----										
94:	Worst Drawdowns										
95:	Drawdown	From	To	Days to Break Even							
96:	#1	10.59%	01-06-2007	12-09-2008	346						
97:	#2	7.79%	21-11-2008	09-02-2009	62						
98:	#3	6.98%	15-02-2007	14-03-2007	69						
99:	#4	6.17%	13-11-2006	22-12-2006	67						
100:	#5	5.									

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### 3 Discussion

Version 2.0 show a slightly higher annualised return than version 1.5 (see line 8), and an appreciably better Sharpe ratio (line 10). In general version 2.0 has better annual returns (lines 20-24) although a lower return in the current year to date (line 20).

The summary of the number of long and short positions per year, in lines 20-24, shows that version 2.0 is much more active – its universe is about twice the size of the version 1.5 universe. The version 2.0 universe was chosen purely on the basis of availability of data about highly liquid stocks. Reuters was able to provide a list of UK and European stocks with high average daily volumes, and from this we selected all those for which Reuters could provide an adequate amount of history without major gaps. Version 1.5 had a smaller universe because of memory limitations; we were able to overcome this in version 2.0 by modularising some of the memory-intensive tasks.

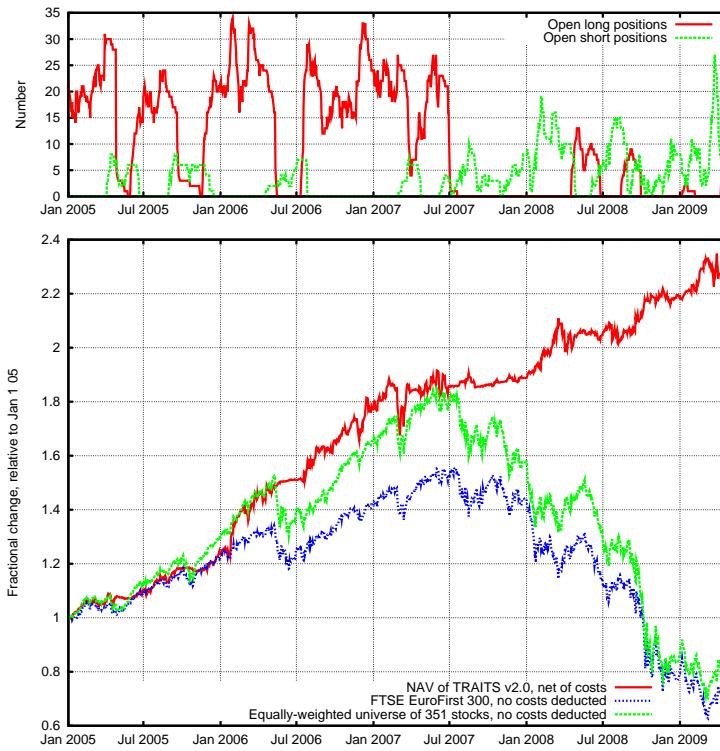
The drawdown analysis (lines 94-100) shows that the two versions had a comparably-sized worst-case drawdown. However, for version 1.5 the worst-case drawdown lasted for more than a calendar year (346 trading days) whereas version 2.0 was able to recover fully in under three months. The bulk of the loss was unavoidable for a system that uses only end-of-day data; the market slumped suddenly with the bursting of a speculative bubble in China. Note that version 2.0 has also coped well with recent events, taking only 15 days to recover from the drawdown in March 2009 whereas version 1.5 has still not broken even from that drop.

Why, then, does version 1.5 appear to be performing better in the very recent past? The graphs on the next page provide useful information about this. There are two plots for each version; the smaller, upper plot shows the number of open long positions (red line) and short positions (green line) per day. Version 2.0 has been doing significantly more shorting during the credit crunch – both versions have obeyed FSA restrictions on shorting activity. The lower, larger plot for each version shows the fractional change in value of three quantities since January 2005:

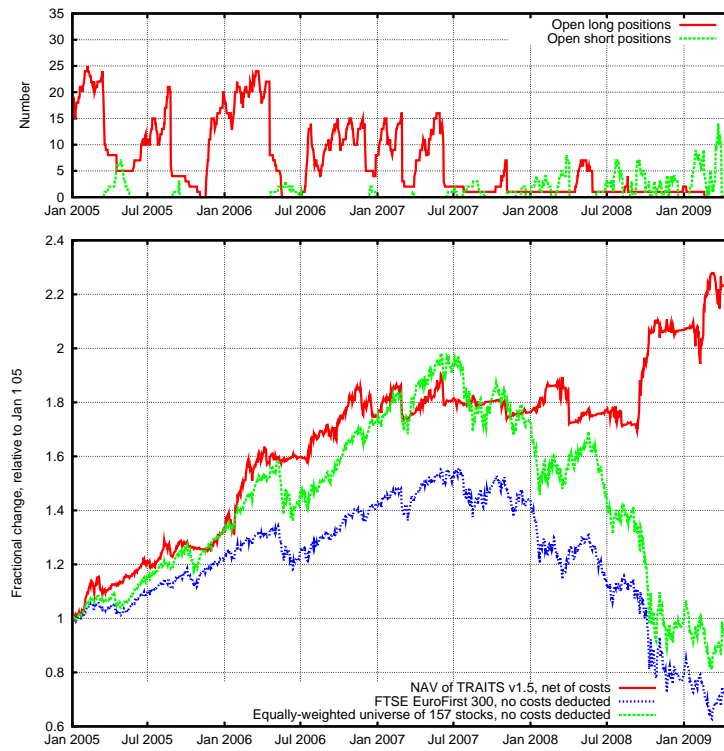
- the NAV, net of all costs (red line);
- the FTSE Eurofirst 300 index (blue line, the same for both versions), whose constituents overlap significantly with both universes;
- the value of a portfolio consisting of an equal-value investment, as at January 2005, in every member of the universe and subsequently held (green line).

One of the key distinctions between the two versions is that version 2.0 shows a steadier growth in the NAV over time. When the market shows a significant and relatively abrupt change of direction, version 1.5 substantially withdraws from the market for a time and its performance flattens. Version 2.0 maintains profitable open positions, although with a tighter rein, and so exhibits a somewhat smoother performance. The apparent recent outperformance by version 1.5 is because it had withdrawn from the market for a time and so had more cash resources to invest in profitable positions upon re-entry and was able to ‘accelerate’ more to try to catch up.

Version 2.0:



Version 1.5:



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## 4 In conclusion: the rationale for TRAITS

There are several reasons for developing a system like TRAITS:

- it is completely unemotional about managing its portfolio.
- it uses a purely evidence-based approach to evaluating possible entry strategies. It is of course possible for a strategy to ‘expire’ very shortly after becoming trusted, but TRAITS does not rely on any one strategy, even for a single stock. It discovers different strategies for each stock in its universe.
- it has a very low operational overhead. We simply check the orders that it generates each day, to be sure that they make sense. The daily output includes a detailed spreadsheet showing the progress of each open position and a full record of past positions.

TRAITS represents a useful step beyond the familiar way of deploying computer-based strategies. Typically, a strategy is developed by a process of back-testing and refinement and is then used until it no longer seems to work. The user of such an approach needs to make a value judgement about the continuing efficacy of the strategy, and the labour cost of developing a replacement strategy encourages the developer to seek relatively simple approaches that can be applied unchanged to many stocks. TRAITS’ evidence-based strategy comfortably monitors many millions of stock-specific candidates at a time, and does so continually.

In practice, if it were managing a real-money portfolio, there would be occasions when a trade failed for some external reason, or occasions when the price obtained was significantly different from the system’s expectation. There is a facility that allows us to communicate such events back to the system so that its own internal ‘picture’ never diverges significantly from the reality.