STATISTICAL EVIDENCE ON A NEW METHOD OF TRADING THE FINANCIAL MARKETS[1]

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ABSTRACT

The concept - well known to practitioners - of moving average is recalled, and the one of adaptive moving average summarized. Then a new algorithm is introduced, and it is shown that statistical confidence limits are in favour of the thesys that such a method is able to make conistent profits on financial markets, specifically on future markets, where commissions are not important. This results are an obvious challenge to the efficient market hypothesis, if the necessity of another challenge should be felt.

MOVING AVERAGE

The concept of moving average is well known (Di Lorenzo 1993) (Murphy 1986). The simplest trading rule in technical analysis is: *buy when the moving average passes froma bove the price graph to under the price graph, and sell when the contrary happens*. Neftci (1991) has shown - using Markov exponents - that this is a consistent method to forecast the market and then, possibly, to make money on it.
It is also well known that when the moving average is too long, the buy and selle signal happen to be too late, so that any money cannot be done; the contrary happens when the moving average is too short: too many signals do appear, and most of the profit is eroded by commissions.
An adaptive moving average is a moving average that adapts its length to some characteristic of the graph: volatility is the more used parameter.
The problem then becomes that of designing the law that governs the dependence of the length from the choisen parameter. Here a new law is introduced and the results tested from a statistical point of view.

THE ALGORITHM

Suppose that in a time series a linear trend can be identified, and suppose that its equation is the following[2]:

$$P(t)=A*t$$

where *A* is a constant and *t* is time.
Let

$$M(n,t)$$

a moving average at *n* samples and at time *t*.
Then:

$$M(n,t)=[P(t)+P(t-1)+...+P(t-(n-1))]/n$$

in fact, for n=3:

$$M(3,t)=[P(t)+P(t-1)+P(t-2)]/3$$

Then, in this case:

$$M(n,t)=[At+A(t-1)+...+A(t-(n-1))]/n$$

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[1] Published in the *AF* journal, n. 24, December 1996
[2] This algortihm is due to Vincenzo Sciarretta; the rest of the paper is due to Renato Di Lorenzo

or:

$$M(n,t)=(A/n)[t+(t-1)+...+(t-(n-1))]=$$

$$= (A/n)\sum_{i=0}^{(n-1)}(t-i) =$$

$$= (A/n)nt-(A/n)\sum_{i=0}^{(n-1)} i =$$

$$=At-(A/n)[n(n-1)/2]=At-A(n-1)/2$$

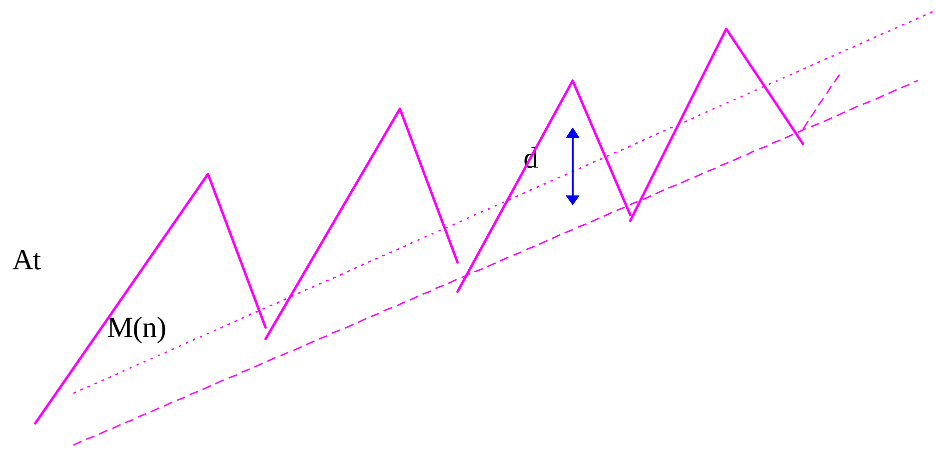
having used the well known sum of a geometric progression and a few simple passages.
Therefore the distance between the trend signal and the moving average is:

$$d=P(t)-M(n,t)=A(n-1)/2$$

Such formula can be solved for *n*:

$$n=2d/A+1$$

This formula tells us *how long* will have to be a moving average, in order to stay at a distance *d* from a straight trendline growing at a velocity *A*.
In practice one will have a time series with the notorious zig-zag aspect:



and he will want to use, for making selling and buying decisions, a moving average wich is at distance *d* from the *central* straight trendline such that it will be violated only when an actual change of the trend will take place, but it will **not** be violated by just a *zig* or a *zag*. The value of *d* will be obviously related in some way to the short-term volatility of the time series. The Sciarretta formula in principle solves this problem. The moving average that results may be classified as *adaptive* as its length veries during the course of events as both the velocirìty of the trend varies and its volatility.

RESULTS

After having illustrated the algorithm in detail, we have to show that the algorithm itself actually has a high probability to work, i.e. that the profit expectation is positive.

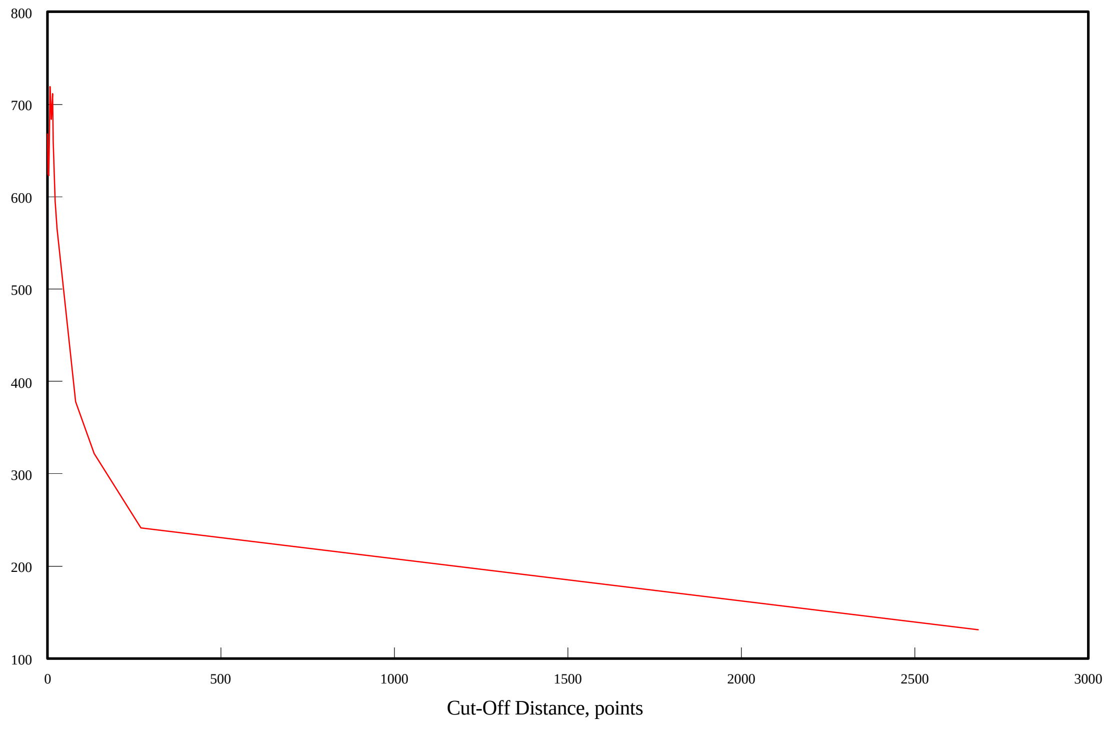
We will confine ourselves to a special type of market, namely the *futures* market, as it is characterized by a very high leverage effect (margin is almost anywhere 5%) and very low commissions (say 0.01%). This is done because, as a quite general rule, trading systems are not likely to work on markets where the commissions paied by *the average Jo* are set at a *normal* level; in fact trading systems generally induce a very high level of activity, thus making profit be engulfed by commissions. By the way, the simulations that follow have been made on the index of the Milan Bourse, treated as if it were a futures index.
We will never stay out of the market, we will always ne either long or short.
A choice that has to be made, is certainly how the velocity of the trend is measured; to do this there are available very different alternatives, some highly sophisticated, but here we will be content with a simple form: given a parameter, measured in days, that we will call the *velocity measurement distance V*, we will detect the price P_0 at the beginning of V, then the price P_1 at the end of V, and simply assume as the measure of the velocity:

$$(P_1 - P_0) / V$$

The other parameter that has to be chosen is what we will call the *cut-off distance*, i.e. the distance from the trend at which we will act (either buying or selling) if the adaptive line will be violated either from the downside or the upside. Again , very sophisticated alternatives are available, but here we will simply use a trial-and-error approach, as we just want to investigate the qualitative behaviour of the trading system under different conditions.
Here we show the first result:

Maximum Profit under CQT - Mib 1994

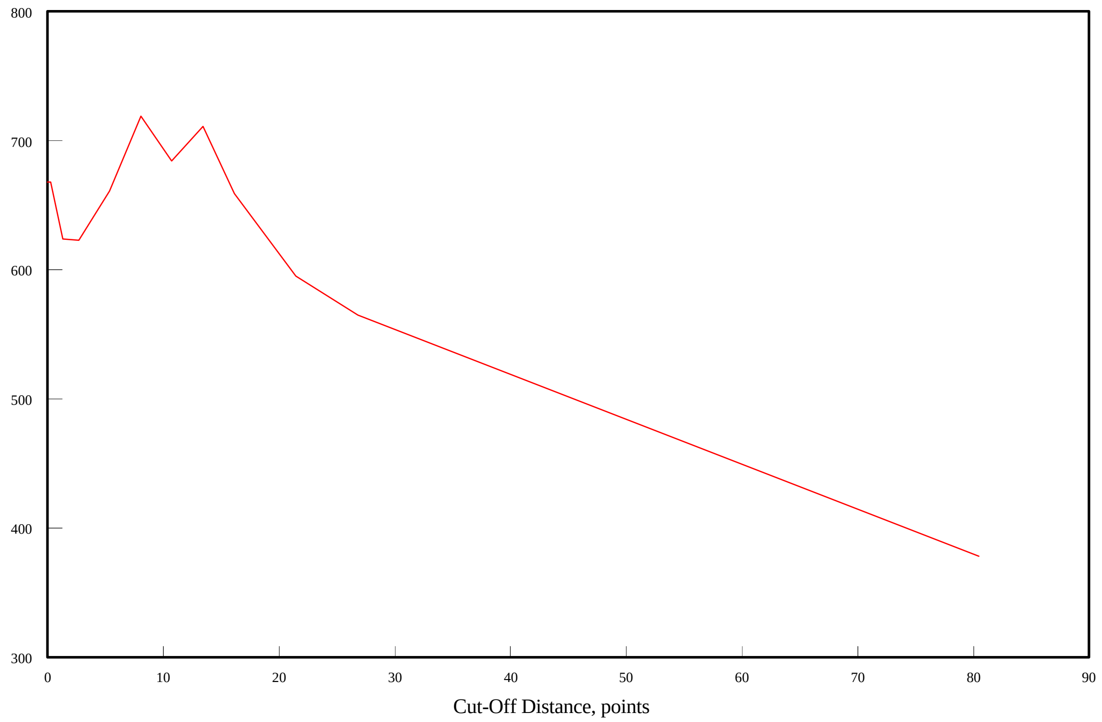
Velocity measured @ 21 days



As a first impression, with a velocity measurement distance of 21 days, the cumulated profit under CQT (Constant Quantity Trading) is a deacreasing function of the cut-off distance, but if we give a closer look at the intial part of the graph:

Maximum Profit under CQT - Mib 1994

Velocity measured @ 21 days

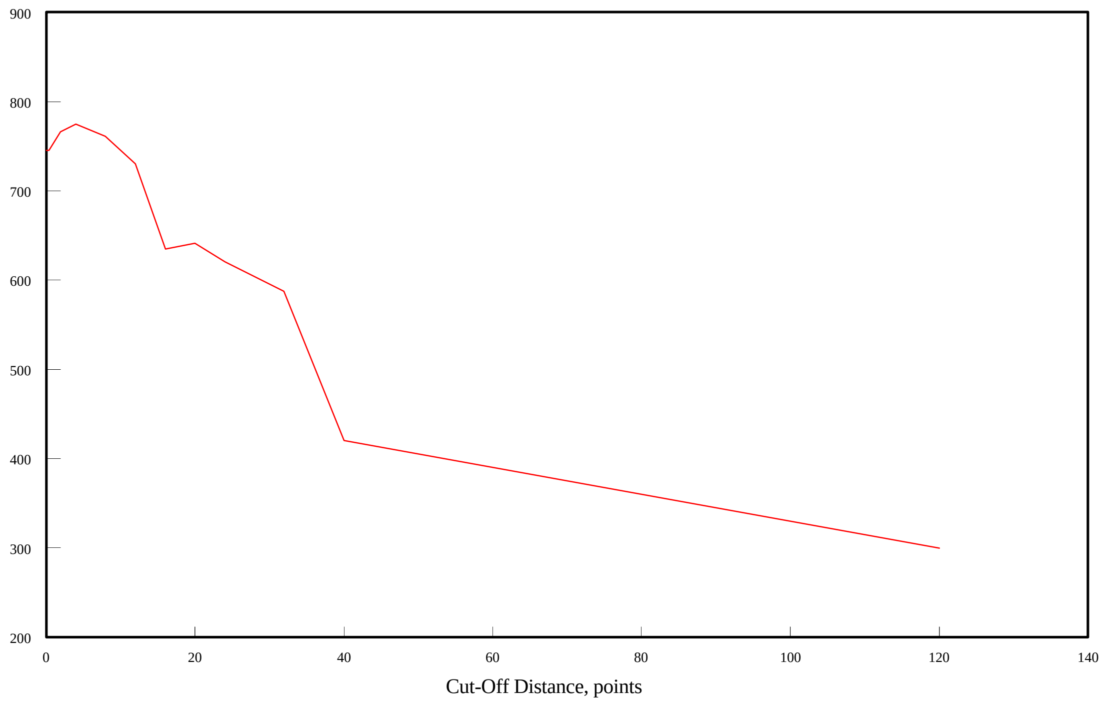


we discover that there is a relative maximum zone, i.e. that there is an optimum cut-off distnace; by the way in this case it amounts to more or less 8 points.

If we make the same simulations with a velocity evaluation distance of 10 days instead of 21 days, the result is:

Maximum Profit under CQT - Mib 1994

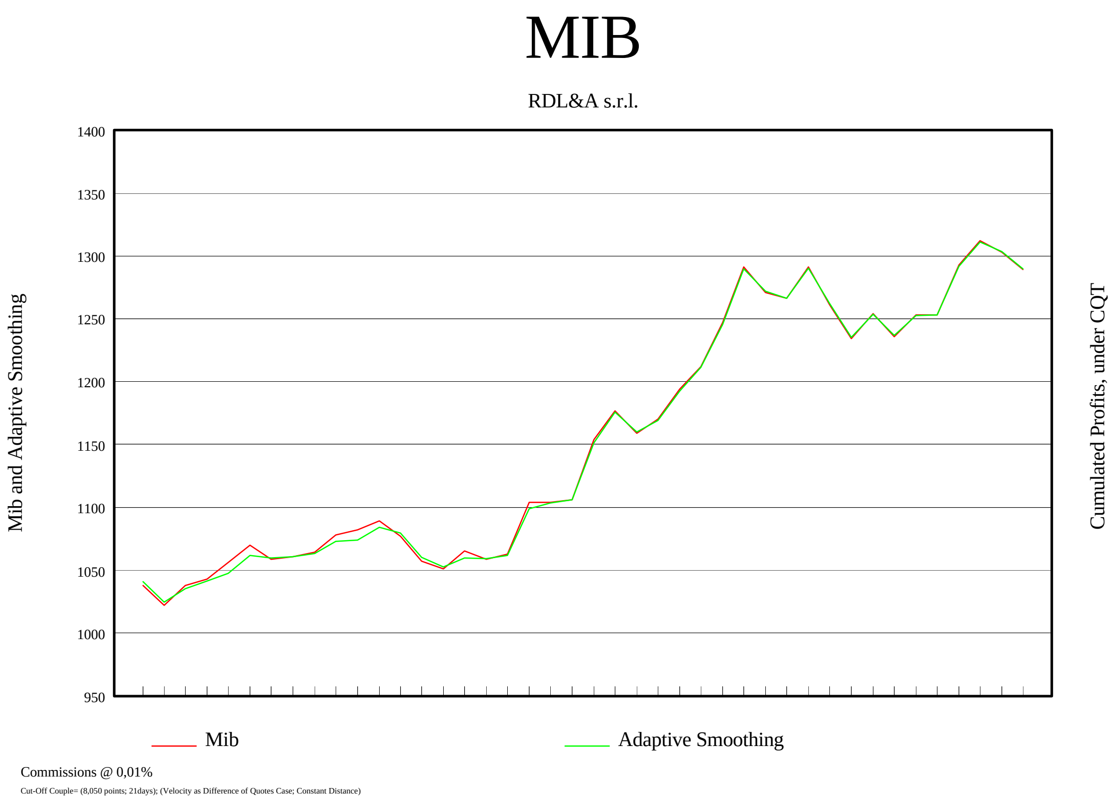
Velocity measured @ 10 days



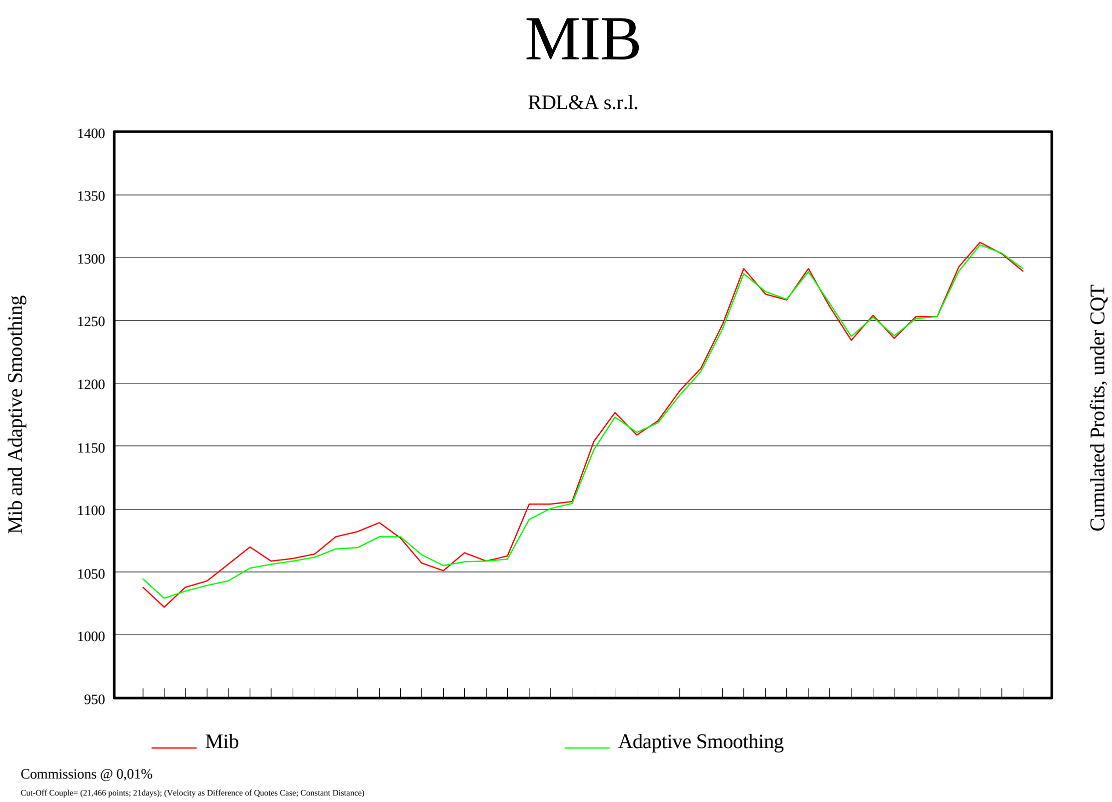
Maximum: Cut-Off Distance @ 4 Points

detecting a maximum at a lower cut-off distance than before: just 4 points.

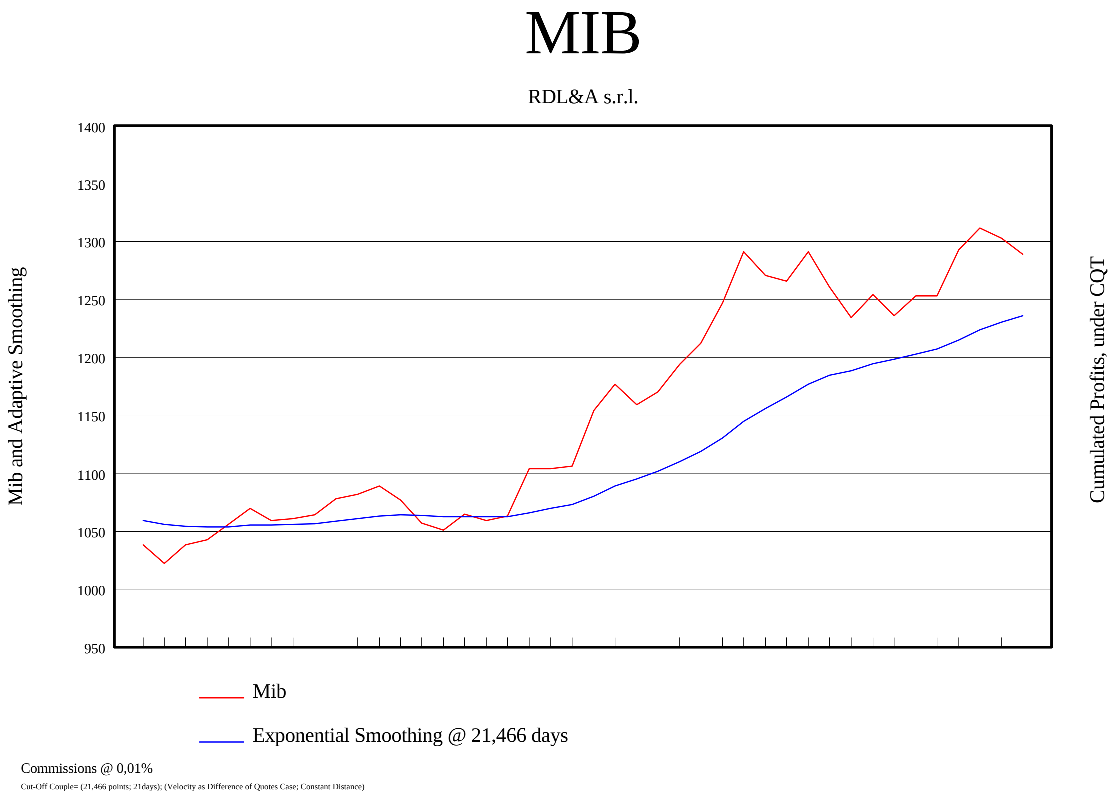
So a general conjecture may be set forth: namely i) that a relative maximum under CQT may exist, ii) which is at very short distances from the graph, thus inducing a high level of activity; iv) that such an optimum cut-off distance decreases as velocity is measured on shorter distances.
That the level of activity is ectic may be imagined by giving a glance at the following graph, which shows a section of the whole 1994 graph (see later):



and:

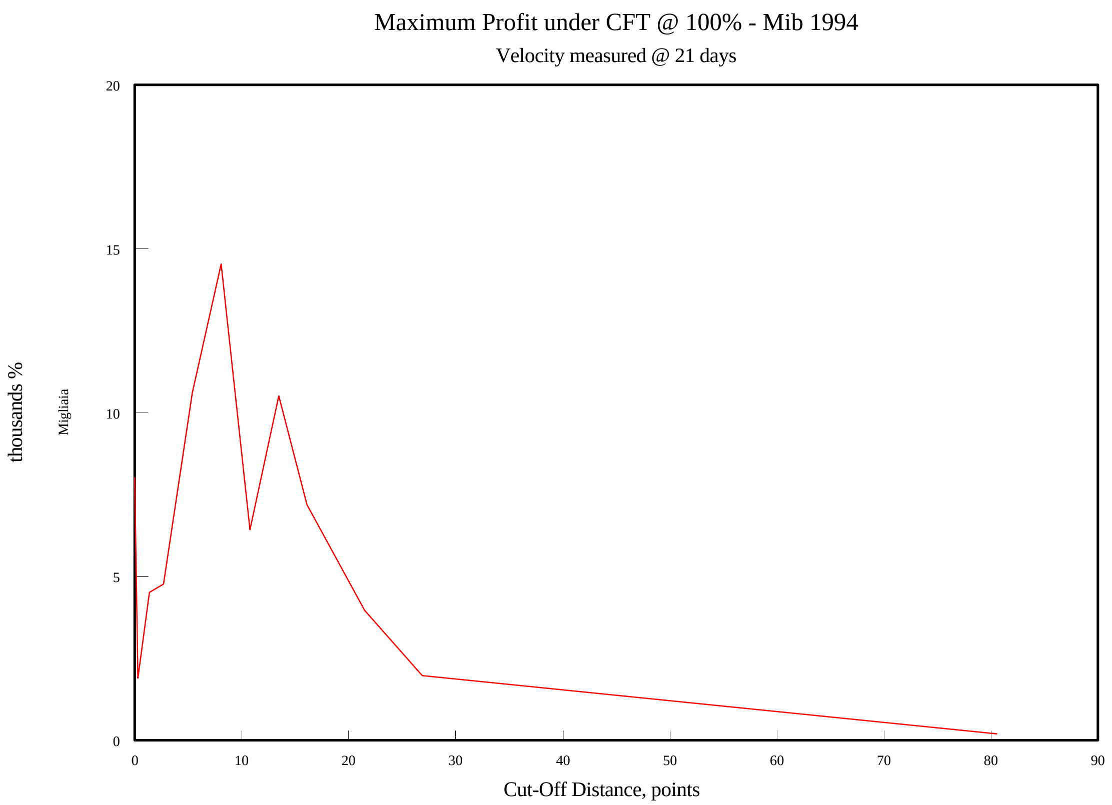


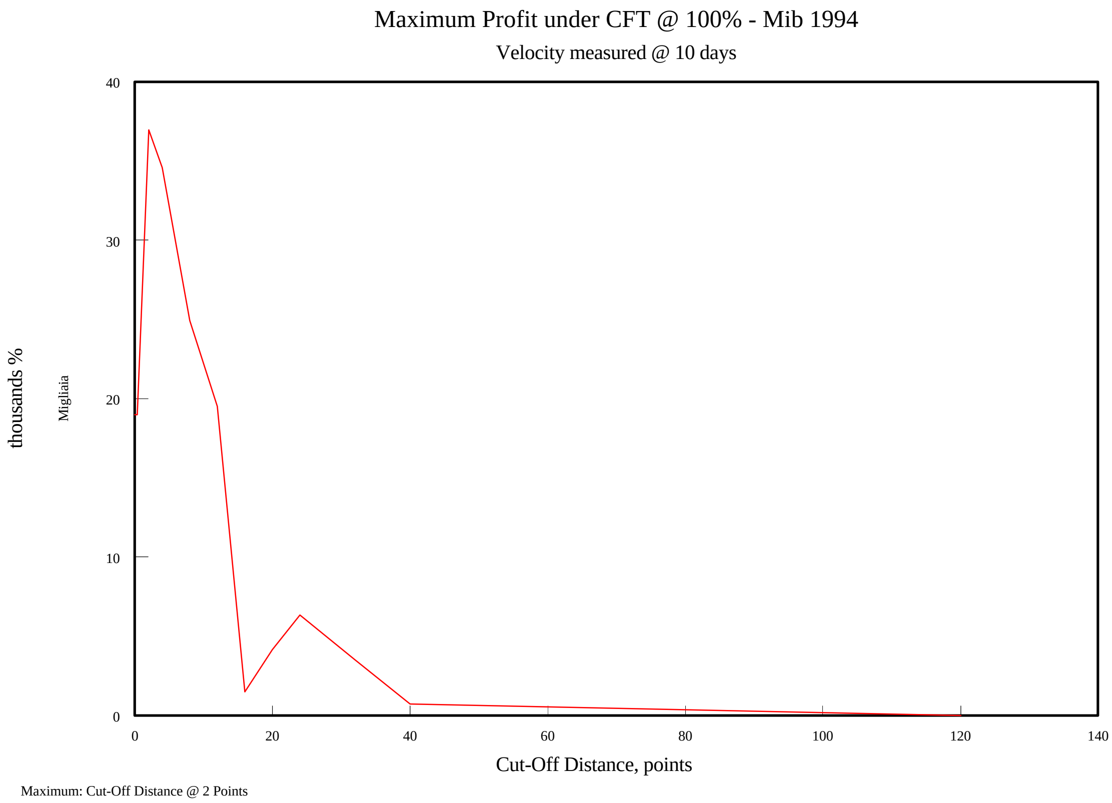
which has absolutely nothing to do with a common, say, exponential smoothing at 21.466 (for homogeneity) days:



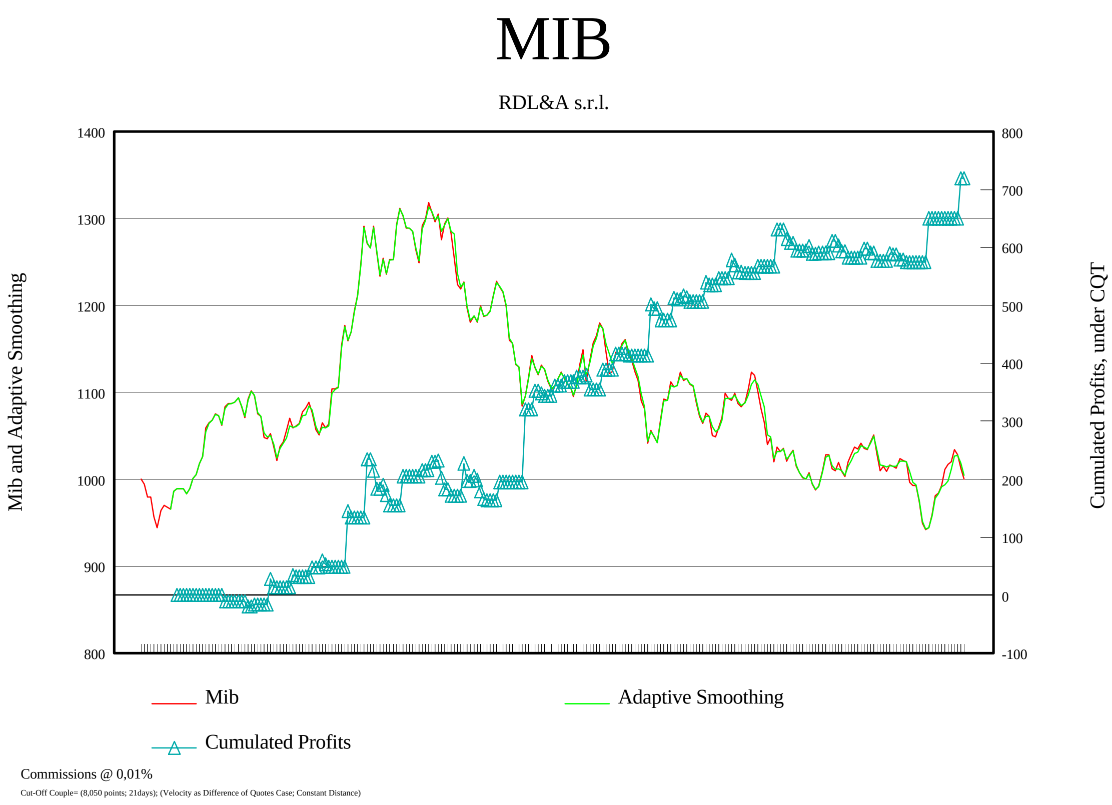
In the case of the adaptive line, such a line is so close to the graph that only a computer can efficiently handle the information to buy or sell.

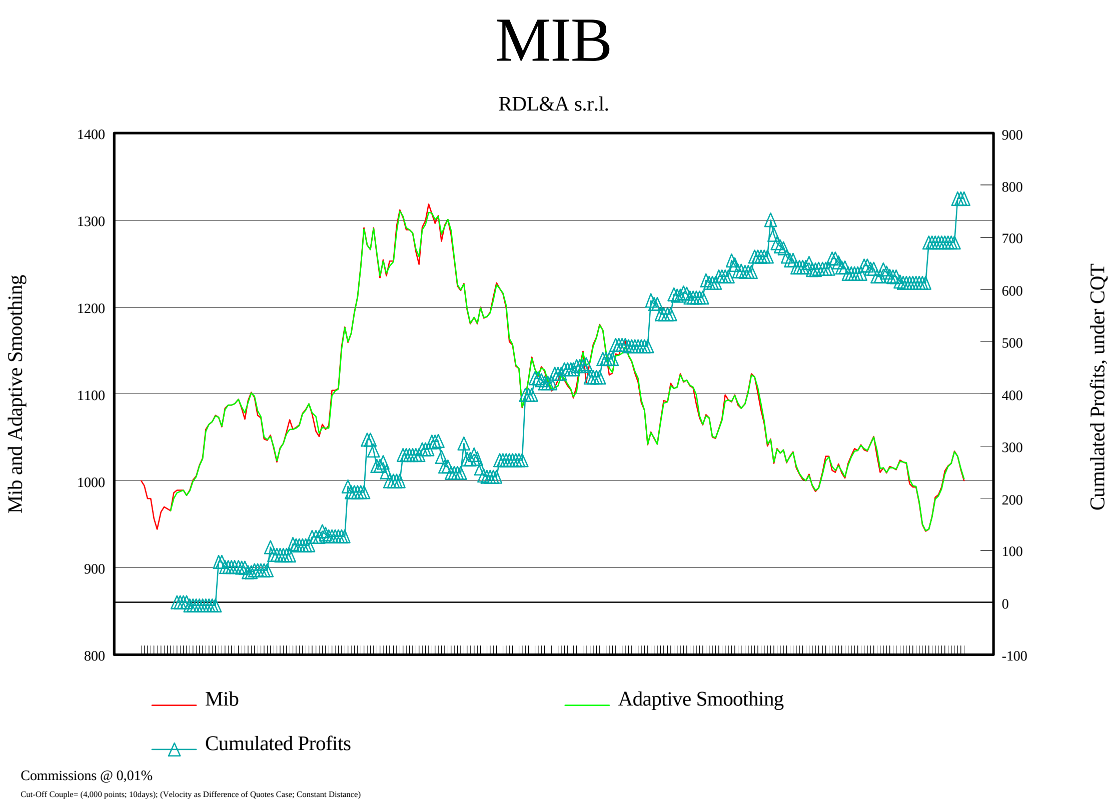
We did not mention the other possible strategy, CFT (Constant Fractional Trading), as it is more involved and potentially more dangerous; however also CFT shows a local maximum, very near to the one shown under CQT:





This is the whole picture fo the cumulated profits under Cqt in the two cases examined:





We have now to establish if the population of returns has a mean which is positive at a 95% confidence level. It has.
The results are in the following two tables, where standard statistics has been used.

PROFIT PER TRADE	Mib 1994	
-10,2156		
-0,2166	Total Profits	719,2674
-9,2175	Number of Samples	84
3,7812	Mean	8,562707

43,7852
-14,209
-0,2076
20,7903
-2,212
15,7862
11,7858
-6,2124
-4,2122
95,7778
-11,2329
100,7559
-20,2562
-30,2552
6,7485
-18,249
-17,2489
49,7444
10,7405
14,7401
1,7388
-30,258
-19,2569
-11,2577
55,749
-30,2424
8,7615
-7,2369
-19,2381
-13,2387
-2,2376
31,759
124,7683
31,7776
-3,2259
-5,2257
17,7766
7,7776
6,7775
3,7778
-25,2251
34,7689
26,7681
-2,229
87,78
-7,2105
-19,2117
37,7826
-2,2214
5,7778
-2,223
-7,2225
32,7815
-4,2148
11,7868
30,7849
-8,219
-12,2186
-2,2176
11,781
63,7862
-16,2058
-7,2049
-13,2043
7,7978
-13,2001
1,8014
19,7996
-7,2031
-10,2028
-11,2029
15,7944
-7,2079
-14,2072
12,7955
-1,2031
-9,2039
-4,2044
75,8036
68,8043

Standard Deviation	30,26862	
Minimum Mean Value		2,050778
Maximum Mean Value		15,07464
Maximum/Minimum		7,350692
Velocity Measurement	21 days	
Cut-Off Distance:	21,466 points	

and:

<u>PROFIT PER TRADE</u>

-6,1972
83,7938
-10,2156
-0,2166
-9,2175
3,7812
43,7852
-14,209
-0,2076
20,7903
-2,212
15,7862
11,7858
-6,2124
-4,2122
95,7778
-11,2329
100,7559
-20,2562
-30,2552
6,7485
-18,249
-17,2489
49,7444
10,7405
14,7401
1,7388
-30,258
-19,2569
-11,2577
55,749
-30,2424
8,7615
-7,2369
-19,2381
-13,2387
-2,2376
31,759
124,7683
31,7776
-3,2259
-5,2257
17,7766
7,7776
6,7775
3,7778
-25,2251
34,7689
26,7681
-2,229
87,78
-7,2105
-19,2117
37,7826
-2,2214
5,7778
-2,223
-7,2225
32,7815
-4,2148
11,7868
30,7849
-8,219
-12,2186
-2,2176
29,7792
70,7833
-28,2068
-17,2057
-5,2069
-4,2068
-15,2057
-7,2049
-13,2043
7,7978
-13,2001

Mib 1994

Total Profits		774,6265
Number of Samples		92
Mean		8,419853
Standard Deviation	31,12932	
Minimum Mean Value		2,023903
Maximum Mean Value		14,8158
Maximum/Minimum		7,320411
Velocity measurement		10 days
Cut-Off Distance:	10 days	

1,8014
19,7996
-7,2031
-10,2028
-11,2029
15,7944
-7,2079
-14,2072
13,7956
-6,2024
-7,2025
-1,2031
-9,2039
-2,2046
77,8034
83,8028

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