Design and Evaluate a trading algorithm

Electrical and Electronic Engineering
(general stream)
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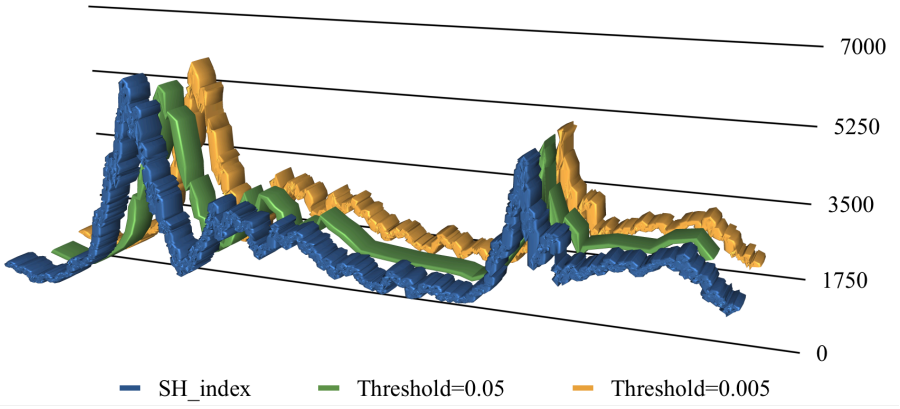
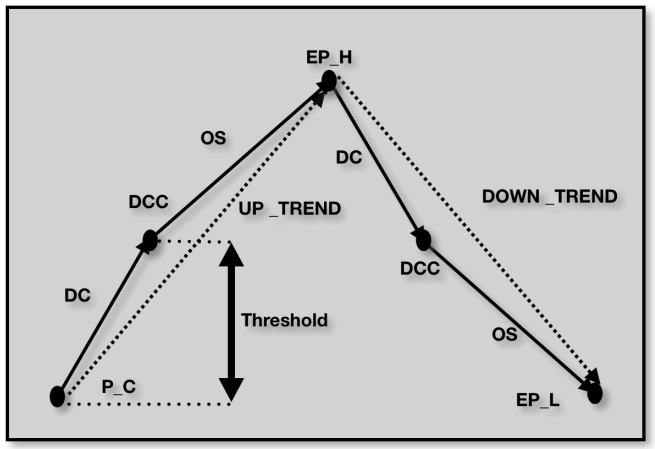
The basis of traditional financial research is time series, using fixed time points to record price changes. This algorithm is designed based on Directional Change framework. Directional Change framework is an event-based approach. The alternating Directional Change Event evolves the price into an alternating upward and downward phase. Directional Change framework can describe the extreme values in the price change and save some excessive price fluctuations, reducing the amount of data while leaving meaningful price changes.

Directional Change (DC) is an approach to summarizing market price movements. Under the DC framework, the market is cast into alternating upward trends, which we call uptrend, and downward trends, which we call downtrend. A trend is identified as a change in market price larger than, or equal to, a given threshold. This threshold, named theta, is set by the observer and usually expressed as percentage. A trend ends whenever a price change of the same threshold, theta, is observed in the opposite direction. For example, a market downtrend ends when we observe a price rise of magnitude theta; in this case, we say that the market changes its direction to an uptrend. Similarly, a market's uptrend ends when we observe a price decline of magnitude theta, in which case we say that the market changes its direction to a downtrend.[1]



The following figure shows several important points and processes in the DC framework. EP_H is the highest extreme point and EP_L is the lowest extreme point. DCC in upward trend is the point where the index is larger than, or equal to, a given threshold. DCC in downward trend is the point where the index is shorter than, or equal to, a given threshold. OS (overshoot) is the transition period between DCC and extreme point.



DC:Directional Change
OS:Overshoot
P_C: Current Point
DCC:Directional Change Confirmation Point
EP_H:Extreme Point_High
EP_L:Extreme Poi

Algorithm 1 Simple DC algorithm:

Algorithm 1 is a simple DC-based trading algorithm. That is, long at DCC of upward trend, and short at DCC of downward trend. However, purely DC-based algorithm trading will be slow, with a certain degree of delay. Because each transaction begins after a threshold, that is, short after the index has fallen below a threshold, or long after the index has risen above a threshold. It will result in a decline in earnings, or even a loss. The algorithm that combines DC with time series has the opportunity to avoid this loss.

Algorithm 2 DC_Time algorithm:

According to a statistical properties observation in foreign exchange [2], the time period for index to reach DCC is roughly half of the time period of an overshot, that is, assuming that the time to reach DCC is t, the index may reach extreme points in 2*t. Therefore, the algorithm short at the DCC point of downward trend or long at the DCC point of upward trend. After 2*t time, it re-detects the current state. If the trend doesn't change, there is no transaction. The next transaction is executed when the trend changes.

Algorithm evaluation

Assuming the initial capital is $100,000, Feed Algorithm 1 with the data of SH index from 27/10/2004 to 27/11/2018.For the threshold of 5%, long74 times, short74 times, the final asset is 843987, and the rate of return is 7.4399 times. For the threshold of 0.5%, long557 times, short557 times, the final asset is 158,342, and the rate of return is 0.5834.

Bring the data into Algorithm 2, when the threshold is 5%, long15 times, short15 times, the final asset is 449889, and the rate of return is 3.4989 times.

Evaluation					
Algorithm1			Algorithm2		
threshold	Final asset	rate of return (final-start)/start	threshold	Final asset	rate of return (final-start)/start
0.07	227004.8230	1.2700	0.07	417880.9694	3.1788
0.06	294679.6939	1.9468	0.06	859208.9358	7.5920
0.05	843987.9423	7.4399	0.05	449889.5625	3.4989
0.04	187130.2691	0.8713	0.04	241183.2504	1.4112

In the two algorithms, the smaller the threshold is, the more frequent the transaction. But the profit did not increase as the number of transactions increased.

Algorithm optimization

There are still many problems that the algorithm needs to improve.

1. Since the daily market fluctuations are not stable enough, we can use the moving average window to get a five-day or ten-day moving average, which will be more effective in determining trends.

2. The selection of the threshold is also related to the selection of the sample period. The shorter the sample period is, the more sensitive the average cumulative return to changes in the threshold. Therefore, in practical applications, it is necessary to adjust the selection of the threshold according to the length of the sample time.

3. Transaction costs. Transaction cost is also an important factor. When the frequency of transactions increases, the transaction costs are also increasing. How to match the highest rate of return is a problem to be considered.

[1]. A. Bakhach, V.L.R. Chinthalapati, E.P.K. Tsang & A.R. El Sayed, Intelligent Dynamic Backlash Agent: a trading strategy based on the directional change framework, Algorithms, MDPI Open Access Publishing (ISSN 19994893), 11(11), 2018

[2]. Glattfelder, J.B., Dupuis, A. & Olsen, R. Patterns in high-frequency FX data: discovery of 12 empirical scaling laws, Quantitative Finance, Volume 11 (4), 2011, 599-614