Analysis of an optimized investment strategy from the operations research perspective

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Abstract. The ultimate objective of any investor, trader or manager is to speculate, to generate profits in a consistent basis. In order to create a strategy that maximizes the profits and simultaneosly minimizing the risk some technical analysis must be done. The aim of this work is to comment on the optimization problem used in the research done by Chandrinos and Lagaros [1], in which the building of profitable portfolios using a complex strategy on the currecy market (FOREX) is discussed.

Keywords: Derivative-Free Optimization · Trend Analysis · Renko Bars

1 Problem Description

1.1 Context

In general terms, the value of an asset is speculated on an exchange market. When talking about FOREX markets, currencies are compared in pairs, giving more or less value to one or another currency. That said value is subject to the free market, and will vary depending on political, economic and other circumstances. Usually, prices in this type of markets move in trends, and the assumption that historical data can create patterns that repeat again in the future can be created. So, several approaches can be taken when examining the price variation on a currency pair. The core part of the strategy specified on the research [1] is adapting the Renko Bars representation [7]. Some modifications will have to be made, taking into account the past data, for each of the 8 selected currency pairs. With this *Modified* Renko Bars there exist some direct rules that have been proven profitable [Donchian [2]] for entering and exiting positions.

1.2 Approach

The problem in itself comes with defining the modification of the Renko Bars. For each currency pair, the objective is to maximize the profit when applying the rules. The main aspect of MRBs are 4 reference curves that have to be calculated

(X-MRB, Y-MRB with upper/lower bounds, respectively) (see Fig. 1). We also have to determine which is the optimal size of the "Renko Block" and the number of bricks in the Renko chart. Both values represent a variation in the value and risk in the investment. Further information in this topic can be found in the research by Shan [7]. When this curves are calculated (and optimal) for the currency pair, it's a simple matter of following the mentioned rules [2] to get a profit.

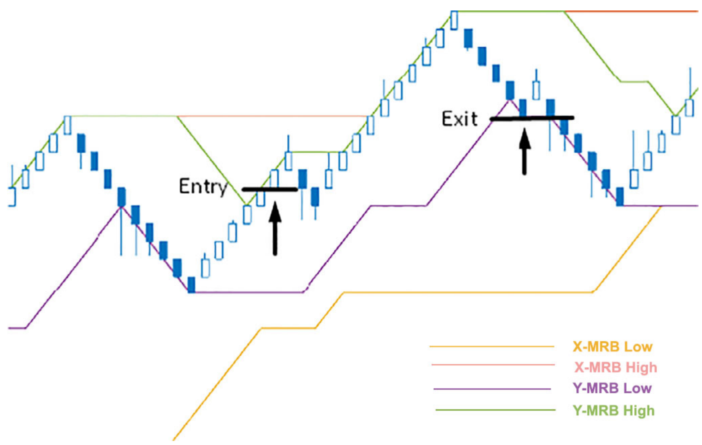

Fig. 1. Example trade applying the Donchian rules with the MRBs.

2 Problem Formulation

The proposed optimization problem is formulated as follows:

$$\begin{cases} \underset{x=[\text{Size,X,Y,D}]}{max} \mathrm{TR}(x) : \mathbb{R}^n \longrightarrow \mathbb{R} \\ s.t. \begin{cases} 5 \leq \text{Size} \leq 25 \\ 50 \leq X \leq 200 \\ 1 \leq Y \leq 49 \\ 1 \leq D \leq 25 \\ DrD_{\max} \leq 40\% \end{cases} \end{cases}$$

TR(x) stands for the total return value and DrD_{max}(x) for the maximum draw-down.

The derivative of the objective function TR(x) is not analytically available, thus, this is a *Derivative-Free Optimization* (DFO) problem. Subsequently, in the next section we'll use the appropriate algorithms for this kind of situations.

As we can appreciate, our optimization problem is based on 4 design variables: the size of the brick (Size), the value of parameter X for the MRB-X curve, the value of parameter Y for the MRB-Y curve, and the number of bricks that corresponds to 1% of the initial capital (D). Apart from the four *necessary* constraints imposed to the parameters of the trading strategy model, a single constraint that limits maximum (monetary) draw-down is implemented.

Besides, if any of the constraints is violated, a penalty, relative to the maximum degree of constraints' violation is applied. More information about the used formula can be found in the research by Lagaros and Papadrakakis [6].

3 Algorithms used

The optimization phase is performed using three optimization algorithms. For each currency pair, optimized values for the 4 variables are obtained implementing each of the 3 algorithms.

Direct and model-based algorithms are two types of DFO algorithms. Direct algorithms compute values of the objective function directly to determine search directions, while model-based algorithms construct a surrogate model of the objective function. DFO algorithms are also classified as local or global, deterministic or stochastic, depending on their search process.

The research [1] discusses three global search algorithms for the needs: Pity Beetle Algorithm (PBA), DIRECT, and Multilevel Coordinate Search (MCS).

1. The PBA is a metaheuristic algorithm, belonging to the class of particle swarm optimization algorithms, and inspired by the behavior of a beetle named Pityogenes chalcographus. This algorithm consists of three steps: initialization, host selection pattern, and update location of broods. (Kallioreas et al, [5]).
2. The DIRECT algorithm is a deterministic search algorithm and is an extension of Lipschitzian optimization. It also consists of three basic steps: initialization, identification, and division of potentially optimal hyper-rectangles. (Jones et al. [4]).
3. Finally, the MCS algorithm is a deterministic global search algorithm, which constructs a tree of grids that divide the search space. (Huyer and Neumaier [3]).

4 Obtained Results

The three algorithms were run for each currency pair. The tables with the results can be appreciated in detail in the research [1]. As a rundown, we can the extract following results:

- The *GBP/USD* currency pair with the the *PBA* algorithm obtained the highest return (280.84%) among all currency pairs, with the parameters: Size = 12 (pips), $X = 138$, $Y = 13$ and $D = 2$.

- The *MCS* algorithm achieved the best total return for four out of the eight currency pairs, *DIRECT* for three out of eight and *PBA* for the remaining pair.
- The *less* profitable pair given the obtained results was the *NZD/USD* currency pair (128.2% return). The *MCS* algorithm achieved it with the parameters: Size $= 5$ (pips), $X = 85$, $Y = 33$ and $D = 4$.
- All three algorithms achieved rather similar results concerning the value of the total return for each currency pair. This establishes that the problem is statistically significant.

5 Conclusions

In conclusion, our research presents an analysis of an optimized investment strategy for the currency market, with the aim of maximizing profits while minimizing risk. The strategy involves modifying the Renko Bars for applying direct rules for entering and exiting positions. Different algorithms were applied to find optimal solutions for each currency pair and for all of them a profitable strategy was found. Therefore, the importance of technical analysis and operation research in creating a profitable investment strategy should be highlighted.

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