Trend Following Algorithms in Automated Stock Market Trading

by

Tai Kam Fong, Jackie

Master of Science in E-Commerce Technology

2011

Faculty of Science and Technology
University of Macau

UNIVERSIDADE DE MACAU
仁義禮知信
澳門大學

Trend Following Algorithms in Automated Stock Market Trading

by

Tai Kam Fong, Jackie

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science in E-Commerce Technology

Faculty of Science and Technology
University of Macau

2011

Approved by _____
Supervisor

_____

_____

_____

Date _____

UNIVERSIDADE DE MACAU
仁義禮知信
澳門大學

In presenting this thesis in partial fulfillment of the requirements for a Master's degree at the University of Macau, I agree that the Library and the Faculty of Science and Technology shall make its copies freely available for inspection. However, reproduction of this thesis for any purposes or by any means shall not be allowed without my written permission. Authorization is sought by contacting the author at

Address: Room N410, FST University of Macau Av. Padre Tomas Pereira Taipa, Macau

Telephone: 66858880
Fax: 28838314
E-mail: JackieTai@gmail.com

Signature _____

Date _____

UNIVERSIDADE DE MACAU
仁義禮知信
澳門大學

University of Macau

Abstract

Trend Following Algorithms in
Automated Stock Market Trading

by Tai Kam Fong, Jackie

Thesis Supervisors: Dr. Simon Fong
Master of Science in E-Commerce Technology

Unlike financial forecasting, trend following[1] does not predict market movement, instead of prediction, it follows market trend. Once a trend is recognized, just jumps in and rides on it, taking benefit from both sides, enjoying the profits from ups and downs of the markets. Trend following trade has a long and successful history[2], it has been wildly used by professional traders, and can be applied to various markets. There are many forms of trend following, the traditional trading method is by human judgment and following trade strategies rules. That is the human spots out a trend, identifies the trade signal and places an order accordingly. Beyond rules and strategies, human judgment becomes the core element, it requires rational discipline and emotional control to stick with a trend, following precise rules through the market movements of upward and downward. However, as emotions are part of the human nature, this self-discipline is not always carried out. Therefore many trend traders failed to make profit. Today with the growth of computer power and Internet technology, trend following trade can be programmed and automated. Transaction executions that used to be performed by human could be replaced and automated by an automated trading system. Trade decisions that used to be made by human judgment, now are replaced by algorithms. Algorithms are free from human emotions, they execute precisely as how the codes instruct to trade so.

Financial forecasting is always a hot topic in academic research, there many scholars who work on this field, plenty of research works are carried out. In general, there are two domains, one is the financial field, using economics models that rely on mathematical, statistical, time series forecasting to address the problem; this one belongs to the economics finance, models from this area use little of computer

algorithm. The other is computational field, using scientific models that base on intelligent algorithms such as machine learning, artificial neural network, expert system…etc[3], that attempt to find an optimal solution for the problem. This is the area that researcher have been studying on. Among this computational domain, the adoption of this kind of algorithm or model somehow is not particularly popular in today financial market place. But on the other hand, there are very few academic researcher studies about trend following, yet the use of this technique is everywhere, and is widely applied on various of financial markets. So there must be some reasons behind this. In my opinion, models or algorithms that base on machine learning or neural network…etc, are something I refer as black-box processing (e.g. tuning some internal weights), which means that we know what data input to the black-box, and what outcome will be the output, but how it produces, is not transparent and parameters setting is difficult to control. Perhaps these uncertainties are not favorable in financial trading practice.

Most of the researchers, who work on this topic, tend to focus on predictive model because of intellectual endeavour. In this thesis study of major in e-commerce, we propose five trading algorithms that are based on a different type of model; we call it "Reactive Model". The first one is derived from the concept of basic trade strategy, in which all trend followers try to systematize their trades. The basic premise is that the most profit is gained when a trade is synchronized to an enduring trend. The rules of this algorithm are statically formulated as the trade parameters remain unchanged once they have been defined.

Based upon this initial concept of trading algorithm, some variants are introduced with incorporation of technical analysis concept. Technical analysis makes trade decision through technical indicators such as RSI, STC, and EMA …etc, these indicators are changing dynamically according to the market situation. By adopting one or more of these indicators and by studying how they react to the market, we can form rules that are able to inherit this dynamic nature. By following these rules during

trade session, we update the trade parameters with the latest dynamic values attribute too.

For improving the performance, we introduce fuzzy logic into our trade system, which forms our third and fourth versions of trading algorithms. The properties of these trading algorithms are generally built upon the experiences of previous trading algorithms, such as the membership definition and fuzzy sets generation. All these trading algorithms are later verified on Hang Sang Index futures market in a simulated environment, and the result is encouraging.

These trading algorithms showing an outstanding performance in the wild bullish and bearish markets between the years of 2007 to 2009. However, during the year of 2010, they seem to be under performing, as they are no longer generating great profits. This is due to the large flip-flop changes of the market. It was observed that frequent market trend fluctuations deter trend following algorithms.

To resolve this limitation, we present our last trading algorithm, namely “Trend Recalling", it is considered to be adaptable to market behavioral changes. The concept of financial cycle was taken into account of our algorithm. This trading algorithm is also verified on Hang Sang Index futures contracts in simulated environment, and the result is inspiring.

In this thesis we discuss on the design of an automated trading system, which incorporates these trend following algorithms, which is a core element of the system, and the application of this type of system in financial market. We also investigate how the market fluctuation can affect the overall performance, and bring new perspective to handling the financial cycles.

One of our goals is to build up this automated trading system, which primarily operates on financial derivative market[4], such as the Hang Sang Index Futures Contract that trade on HKFE (Hong Kong Future Exchange) or the Dow Jones Industrial Average Index Futures Contract that trade on CBOT (Chicago Board of

Trade). In this thesis "Hang Sang Index Futures" is selected as the primary simulation market, although the system can be applied on any market theoretically.

By using only historical market data, the system is able to react according to real-time market state, and make trade decision on its own. To reduce the overnight risk and cost-of-carry, trade will be performed on a daily basic only, which means no contracts will be carried overnight. The P&L (Profit and Loss) on each trade will be recorded and accumulated as the total of ROI (Return on Investment), which is a common indication for the performance of an investment in financial world.

Contributions of this thesis research are summarized as follow:

- Developed an automated trading system prototype, which provides a cornerstone for future development, and experimental platform for evaluating trading algorithms and programmed.
- Proposed some innovative trading algorithms based on trend following concepts.
- Provided an alternative view and comparative of two kinds of trading algorithms (Predictive model vs. Reactive model).

UNIVERSIDADE DE MACAU
仁義禮知信
澳門大學

UNIVERSIDADE DE MACAU
仁義禮知信
澳門大學

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

HKFE	**Hong Kong Futures Exchange**
CBOT	**Chicago Board of Trade**
HSI	**Hang Seng Index**
P&L	**Profit and Loss**
ROI	**Return on Investment**
SMA	**Simple Moving Average**
EMA	**Exponential Moving Average**
RSI	**Relative Strength Index**
MTM	**Momentum Oscillator**
STC	**Stochastic Oscillator**
MACD	**Moving Average Convergence Divergence**
ETF	**Exchange Traded Funds**
ATS	**Automated Trading System**
API	**Application Programming Interface**
ER	**Entity Relationship**
UI	**User Interface**
FCL	**Fuzzy Control Language**
IB	**Interactive Brokers**

ACKNOWLEDGMENTS

I am very grateful to my thesis supervisors, Dr. Simon Fong, who gave me a lot of encouragement and support. He always gave me valuable guidance and suggestions all the time.

I would like to give thanks to Mr. Johnny Leong who gave me much technical support. Moreover, I would like to give my appreciation to Dr. Angus Wong for his advices and insightful comments.

Finally, I would like to acknowledge my family and friends' support during my thesis research.