DEVELOPMENT OF AN OPTIMIZED INTELLIGENT MACHINE LEARNING APPROACH IN FOREX TRADING USING MOVING AVERAGE INDICATORS

[1]*Aru O. E. and [1]Okechukwu C. C.

[1]*Department of Computer Engineering, College of Engineering and Engineering Technology,*
Michael Okpara University of Agriculture, Umudike.
Corresponding Author: okezearu@yahoo.com

ABSTRACT

This research presents the development of an optimized intelligent machine learning approach in Forex trading using two variants of Moving Average indicators. The main aim of the Expert Advisor (EA) development is to introduce a new intelligent model for automated execution of trades in the Forex market, reducing potential losses due to human errors and sentimental factors in trading Forex. In developing this trading model, Momentum strategy was used since it takes advantage of market swings, along with Machine Learning - Genetic algorithm, being a type of supervised learning used in training the past historical data based on selected trading parameters in a Meta Trader 4 (MT4) platform. The new Expert Advisor –Exponential Moving Average (ESMA) was built using the MQL4 language which is based on C++ for programming specific trading strategies and easily facilitates automated trading. The result is an optimized intelligent trading system that implements the intersection of the two moving averages at various periods, to execute trades autonomously with a profit pass rate of 75% visible from the Optimization chart of the MetaTrader 4 (MT4) platform

Keywords: *Expert Advisor, Forex Trading, Genetic algorithm, Machine Learning, Moving Averages, Meta Trader.*

INTRODUCTION

The recent interest of Forex analysts and traders in financial institutions and academic communities in the area of intelligent trading systems, otherwise known as Expert Advisors (EA's), has led to the intensive research on the development of various types of Forex trading systems. This is relatively due to its captivating techniques to outrun the financial market.

Many attempts have been made to come up with a consistently profitable system and inspiration has come from different fields ranging from Technical analysis, fundamental analysis, econometric modeling of financial markets, to machine-learning,. Few efforts were profitable and those that appear most promising often could not be utilized in trading real markets due to related practical disadvantages. Among others, these included large draw-downs in profits and excessive switching behaviour resulting in very high transaction costs (Dempster and Romahi, 2002). Proficient traders do usually consider those automated systems as being highly risky in contrast to the returns they themselves were capable of delivering. Even though a trading model was publicized to generate an acceptable risk-return report on the historical data, there is no guarantee whatsoever that the system would still be effective in the future. It would cease working precisely at the moment it became unable to adapt to the changing market conditions, (Moody and Saffell, 1999).

These developed intelligent systems are able to trade financial markets most times, better than humans (profit, risk management) and most are fully autonomous, Martinez (2007). Many concepts, divided into technical analysis and fundamental analysis are implemented into the systems, but the tweaks making them successful remain unidentified,

shrouded in mystery. Different individuals have strived to overcome this by coming up with different trading approaches that can protect them from the inhospitable downfalls of the market, as well as still allowing them to access the profitable nature of the market. This has led to some strategies, such as market timing approach utilizing the moving averages from technical analysis becoming exceedingly prevalent, (Greene and Gerald,2008). Machine learning techniques are applied to train the moving averages indicator over a historical data generated from over a given period of time for the sake of gaining long-term profits, (toptal.com, 2018). The trading approach is to ensure that currency pair values and positions are monitored during the daily trading sessions, where this action is either buy or sell based on the prediction obtained. The prediction problem is viewed as a binary classification task, and not as trying to predict the actual exchange rate between two currencies, but rather, if that exchange rate is going to rise or fall. Each day there are four observable rates, namely; the "Open", "Close", "Low" and "High" in the Forex market which are duly monitored, (Forexboat.com, 2015).

METHODOLOGY

The following materials were used in the development of this software-based research work. They include:

- **Meta Trader 4 (MT4):** This is a downloadable electronic trading platform that is used to enable online retail foreign exchange speculative trading. It is utilized in the development of this new trading model to see live streaming prices and charts, to place trading orders, and to manage the trading accounts. Being software licensed to the Forex broker, it consists of both a client and server component. The server component is run by the broker- InstaForex

Trader (IFX) from InstaForex trading company and the client software is installed into the computer which is used to monitor the performance of this newly developed model.

- **InstaForex (IFX) MetaTrader 4 (MT4):** For this research work, this platform is used as an Integrated Development Environment (IDE). It is also used for the optimization of the developed model using Genetic Algorithm.

- **MetaQuotes Language 4 (MQL4):** The new developed model is built using the MQL4 language which is based on C++ for programming specific trading strategies and easily facilitate automated trading as well as customize technical indicators, libraries and scripts.

- **3G/ 4G LTE Modem**: A fast internet enabled connection with speeds from 500Kbps- 1Mbps from a reliable ISP Internet connection is used to ensure an uninterrupted internet signal for speedy execution and closing of trades.

- **Tickstory Utility package**: This computer software is utilized in the conversion of the imported Historical data into a .CSV format readable and compatible with the Meta Trader 4 platform.

- **HP 6530b Laptop Personal Computer**: This computer system with RAM size of 4GB, Processing speed of 2.8 GHz, Windows 7, 32 Bit Operating System and a Hard Disk Drive of 320GB is used for all the Online scripting / development of the project , monitoring of live trades and documentations.

- **Constant Power supply:** This is to ensure uninterrupted testing, training and trading sessions.

 Data Collection

Acquiring historical data were crucial for the model training and testing of the developed trading system. In the quest for obtaining a quality, verifiable data, various sources of historical Forex data was sourced for, which varied wildly in quality and price. This option of data collection was equally used to source for historical data and it was found that the data delivered is of high quality and format. This proved to be the fastest way to obtain high-precision, wide-time span historical data suitable to train the developed ESMA model. Since InstaForex Trader (IFX) does not provide long term historical data, the historical data was gotten from OANDA broker from OANDA trading company; because it has a reputation of offering high-quality historical data feeds with periodicity of one tick.

However, OANDA does not offer historical data in a format compatible with MetaTrader 4. To get a compatible format of the historical data needed for the training of the developed model in this study, Tickstory utility is used. This utility software is needed to convert the historical data into a MetaTrader 4 (MT4) compatible format and then imports it into the trading platform (MT4) for the required Optimization, training and testing of the ESMA model.

Design Methodology – The Moving Average Systems

Simple Moving Average (SMA) trading system

According to BabyPips.com (2015), The "Simple Moving Average", or "SMA", indicator is one of the oldest and most common indicators used across all financial markets, including the Forex market. Its origins are unknown, but its use was designed to smooth out the effects of price volatility and create a clearer picture of changing price trends. Financial currency traders use an SMA, sometimes in conjunction with another SMA of a different period, for signal confirmation of a change in price behavior. The SMA indicator has only two variables involved in its computation – "period" and "price". The period can be chosen, but values over "20" are normally better when dealing with longer trend lines. Price can be set at open, close, high, or low. Since the SMA is so popular, it can often form a support or resistance line, depending on the type of trend that traders respect in their decision-making process, BabyPips.com (2015). Period can be in Minutes, hours or even days dependent on the market timeframe where the ESMA model is implemented.

Calculating the Simple Moving Average (SMA)

The SMA indicator is common on Metatrader4 trading software and the calculation formula smoothes pricing information by averaging as follows:

1. Choose a "period" setting – assume "10" for example;

2. Choose a "price" setting – assume "closing price";

3. Add up the sum of the last "10" closing prices and divide by "10"

4. Repeat the same process when the next closing price is posted.

SMA for 10 Periods = (X1+X2+X3+X4+X) / 10

$$\text{(1)}$$

Where X1-X10 represents the different Period values

Exponential Moving Average (EMA) Trading System

The Exponential Moving Average (EMA), indicator was developed to counter the lagging weakness of the SMA indicator by weighting more recent prices more heavily. Its origins are unknown, but its use

was designed to smooth out the effects of price volatility and create a clearer picture of changing price trends. Traders use an EMA, sometimes in concert with another EMA for a different period, to signal confirmation of a change in price behavior, Forexboat.com, (2015).

The EMA indicator uses "period" and "price", as does the SMA, but fresher prices are given more weight to make the indicator respond more quickly to market changes. Since it reacts more quickly, it is prone to generate more false signals. The EMA works well in tandem with another EMA in strong trending markets, but the use of an EMA in a sideways market is not recommended. Since the EMA is so popular, it can often form a support or resistance line, depending on the type of trend that traders respect in their decision-making process. BabyPips.com (2015); Forexboat.com, (2015)

Formula for Calculating EMA

BabyPips.com (2015) stated that the EMA indicator is common on Metatrader4 trading software. The calculation formula is more complex than for an SMA and follows these steps:

Choose a "price" setting – assume "closing price";

Choose a "period" setting – assume "10" for example;

Calculate the "Smoothing Factor" = "SF" = 2/(1 + "10");

New EMA value = SF X New Price + (1- SF) X Previous EMA value   **(2)**

Software programs perform the necessary computational work. Two EMA lines are presented below calculated using two different periods (Red = 12, Blue = 26). Software platforms generally

place the EMA indicators alongside the existing candlestick formations as depicted in the diagram. The EMA "Blue" line with a longer period setting follows the upward trend, lagging below and forming an angled support line until the trend begins to reverse its direction. The "Red" EMA line, with period setting 12, reacts more quickly and is embedded inside the candlesticks, Forexboat.com, (2015).

Block diagram for the Developed ESMA model

The block diagram as illustrated by Fig. 1, demonstrates the presence of a reversible communication of information between the Broker Server (InstaForex) with the rest of the market participants. It sends the current market state information to the client's terminal, which in turn, receives orders from it. This communication with the market participants here is dependent on the Internet connection of the trader. A very stable Internet connection is crucial for a timely order execution and for obtaining the most current market information.

The client interface contains the program environment, a set of parameters with information about the market state and about the relations between the trader and the Broker Server. These parameters include the information about the current prices, the limitations on the maximum and minimum order size, the minimum distance of stop orders, the allowance and prohibition of the automated trading, and many other useful parameters characterizing the Current state. The program environment is updated when new ticks are received by the interface through the instructions input.
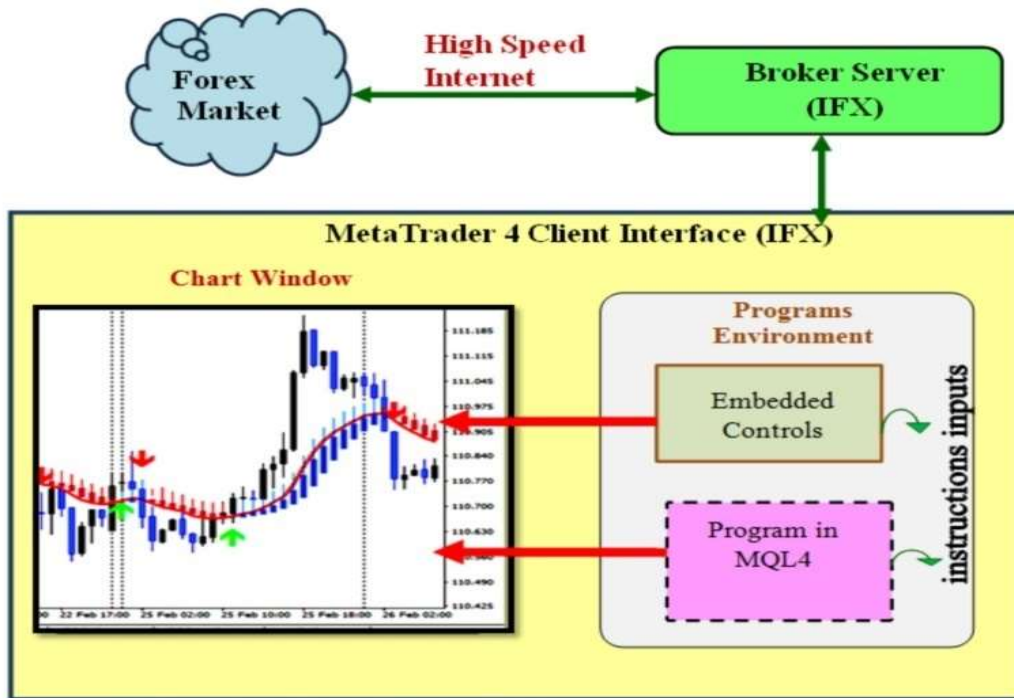
Fig. 1: Block diagram for the developed model

The embedded controls allow the trader to conduct a technical analysis of the market and to execute manual trading management. The trader's actions with the built-in trading management tools result in a formation of trade orders, which are sent through the interface to the Broker server.

Mode of operation of the developed ESMA Trading System model

The newly developed system is an addition to the family of moving average technical indicators designed to execute trade in only Forex markets running on Meta Trader 4 platforms. This developed Moving average technical indicator is aimed at solving two common shortcomings associated with the existing moving averages namely: responsiveness and smoothness. It is a well-known observed fact that a short-term moving average (10) is more responsive, but has the high tendency of giving fake signals. Alternatively, a long-term moving average (100) is said to be smoother, but is deficient in terms of responsiveness, meaning that

price already makes a significant move before the longer term (smoother) moving average catches on. So traders are generally caught between a fast and responsive but prone to false signals moving average, or bear with the long term smoother moving average which is often delayed when it comes to signals.

The developed system is a typical example of a momentum strategy driven by moving averages technical indicators. Crossovers are reflection to signal momentum change in the markets. A period when the main indicator crosses a predefined signal line, the trader will interpret this as a warning sign that something is changing with respect to either momentum of the price action, or its direction. The signals generated by a crossover can be useful in a ranging or trending market, such as the intersection of a particular EMA of a given Period over an SMA of a given period. It is observed that moving average crossovers occur when a faster moving average rises above or falls below a slower one. For example, when a 13-day SMA (simple moving average) rises

above a 100-day SMA, or when a 14-day EMA falls below a 50-day SMA, but here, the developed system will be using a lower variable period of SMA (simple moving average) over a similar lower variable period of EMA (Exponential moving average) such as (4, 8) in implementing the moving average crossover. In this type of crossover, trade is automatically triggered based on the strength and training undergone by the developed system. In developing this trading model, Momentum strategy and Machine learning strategy are used since it takes advantage of market swings. When short/ long - term positions are taken in the defined currencies that are either going up or down, until they show signs of reversal, Ganesh &Rasheed, (2012). When implementing the Exponential & Simple Moving Average (ESMA) model, the two variants of moving average indicators with varying periods of candles sticks and varying values are used to see where the best moment for action is. When the moving averages intersects at a set value from below up, indicating a high or positive momentum, the current price moves higher than the one before and the ascending trend is about to show, that should be your signal to buy. Similarly, when the moving average intersects at a set value from the top down, indicating a low momentum, also showing falling in the current price and the trend is bearish, then the signal is to sell.

In Machine Learning based trading, algorithms are used to predict the range for very short-term price movements at a certain confidence interval. Genetic algorithm, being a type of supervised learning, is used in training the past data specified by the data classes/labels. This method helps to detect a pattern in the data and make predictions, Gerding et al, (2014). It creates a large and random collection of digital Forex currencies and tests their performance on historical data. It then picks the best performers

and uses their style/patterns to create new trading system parameters. This process is repeated multiple times and until the developed model can fully operate on its own. The bottom line is to trigger either to buy low or sell high autonomously.

The strategy implemented in this developed model is the combination of Momentum strategy and Machine learning strategy. The decision to adopt these two strategies was because, momentum is also known as trending motion strategy best suites the distinctiveness of the technical indicators that is being used in the development of the system. Machine learning strategy is also implemented in the training of the data to make the trading system behave intelligently in its activities during the trading sessions.

RESULTS AND DISCUSSIONS

Results

The development of the ESMA trading model was carried out using the MetaTrader 4 environment, the results of the tests carried out using the historical data acquired, Training and Optimization of the model in the Meta Trader4 environment, the discussions on the outcome of the tests are discussed as seen in Figures 2 and 3.

Optimization of the ESMA model and Training Parameter settings

Optimization is testing different values and combinations of input parameters to obtain the best result. Optimization denotes successive passes of the same expert with discrete inputs applied on the same data. Hence, the parameters can be said to make the expert efficiency maximal. During the selection of the parameters, One has to select expert the parameters of which should be optimized in the "Tester – Experts" window.
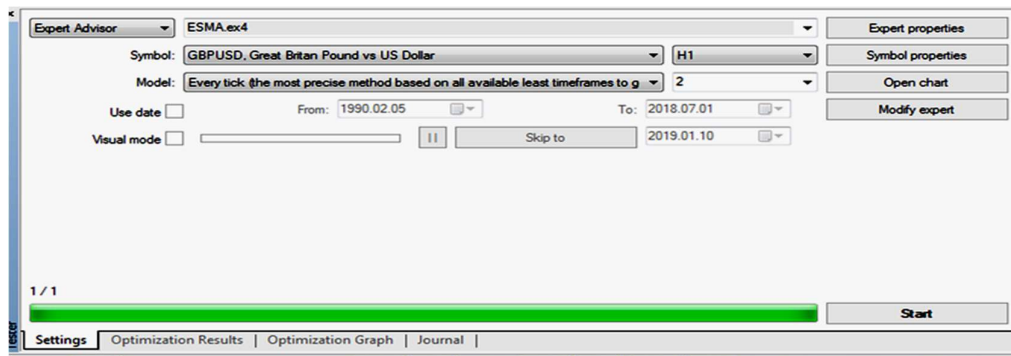
Fig. 2: The "Tester" environment for testing of the ESMA model

Not any expert file can be selected in this field, but only those that are obtainable in the client terminal. For this, they must be compiled and located in the /EXPERTS folder.

Having all the necessary data available, the training is initiated. MetaTrader 4 (MT4) offers an option to use a genetic algorithm for the optimization. This is very useful, as it can decrease the amount of required parameter configuration performance measurements from billions down to about 10000 usd. Another method to accelerate the processing is by setting an optimization limit.

When the limit is reached, the measurement is stopped and the result is discarded.

As all the trainings will be run with an initial balance of 10000 usd, it is decided that a suitable limit for stopping of the test should be the balance dropping below 9000 usd. Before any training is conducted, all the parameters must be set carefully. This includes the model, training start and end, timeframe (period), spread, optimization, initial deposit and its currency, allowed position types, optimized parameter, genetic algorithm, input parameters ranges and optimization limits. After the expert has been selected, one has to make an additional setup and set the inputs. This can be done by pressing of the "Expert properties" button.
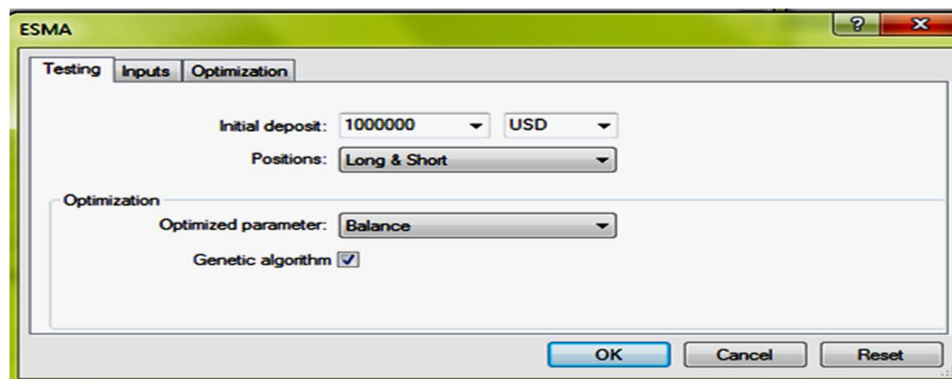

Fig.4: ESMA Expert Model Testing

As deduced from Fig.5 above, the number of trades executed and their corresponding profits for the five weeks testing on a demo trade with account balance of 10000 USD, the profit margin (%) was cumulatively found to be around 75%, which is visible at its selective trade execution based on the entry input/parameters.
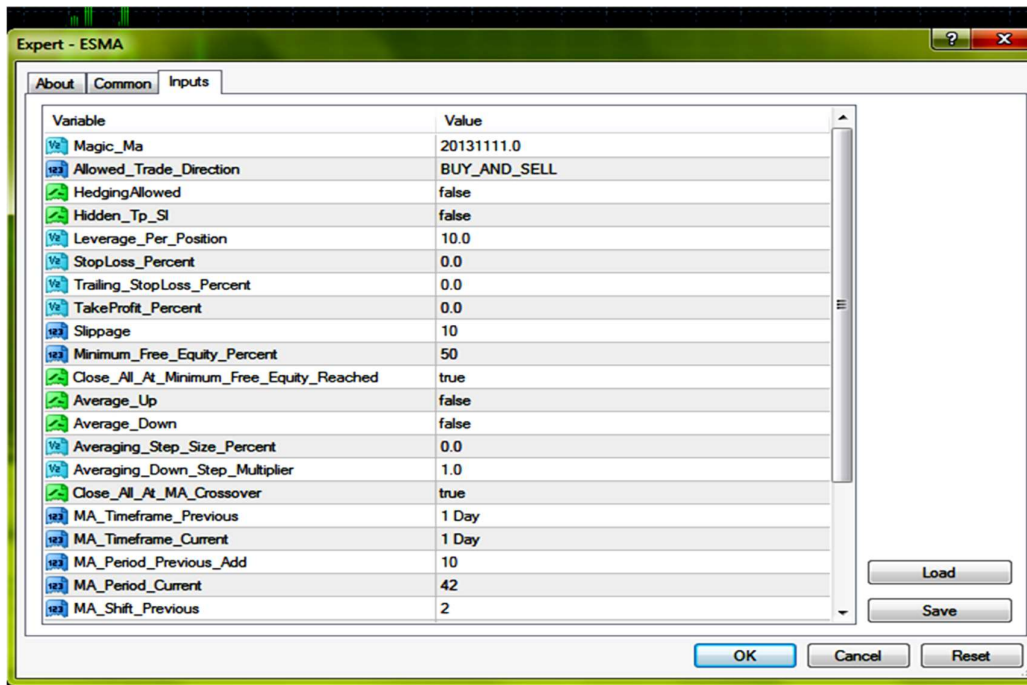
Fig.4: ESMA Expert Model Inputs

Fig 5: A screenshot showing some of the executed trade results for the ESMA Expert Model

Discussion from the Charts

It was observed that in Fig. 6, the values of the respective periods of both the Exponential and Simple Moving Averages set at (25,15), with 1 hour time frame, gave less number of automatically triggered trades. This is observed to be due to no clear bars indicating the crossover, which leads to false signal and trades end in losses.

Similarly in Fig. 7, the values of the Exponential and Moving Average periods are set at lower values (4, 8), with 30 minutes time frame. With these favourable settings, the ESMA Expert system was able to open more profitable trades of positions because of the clear signal bar that leads to triggering of the trade at the labeled positions (1), (2), (3) respectively.

Fig. 6: Chart showing varying periods of Exponential and Simple Moving averages with the ESMA model

Fig. 7: Chart showing varying periods of Exponential and Simple Moving averages with the ESMA model

CONCLUSION

The new Expert System Model (ESMA) was analyzed with reference to its performance. The analysis was based on Model learning and evaluation, which consists of training and testing, carried out with the historic data and the ensuring testing of the parameter configurations resulting from the model training. Having obtained the testing data, it was discovered that the One-week model significantly outperformed the one-month model. Similarly, it was observed that the ESMA Model performed better with shorter time frames such as (15 minutes, 30 minutes), and also lower values in the periods of the Moving Averages used, where trending market data is responded to swiftly during trading.

In addition, the ESMA - Expert System Model can be further modified by the use of external library files in order to eliminate the constraints posed by Meta Quotes Language 4 (MQL4) in the Meta Trader 4 (MT4) platform. This will enable development of a Forex Trading Expert system outside an MT4 environment. Also, ensuring that the designed Intelligent Expert trading system is hosted on the MT4 trading server of a Broker will increase its reliability and spontaneous reaction to market trends.

REFERENCES

BabyPips.com (2015)- Trading Insights and Market Analysis - BabyPips.co, available at: https://www.babypips.com/trading

Dempster M.A.H., Payne T.W., Romahi Y.S. and Thompson G.W.P. (2001). Computational learning techniques for intraday FX trading using popular technical indicators. Special issue on Computational Finance, IEEE Transactions on Neural Networks 12744-754.

Forexboat.com, (2015). Algorithmic Trading Archives - ForexBoat Trading Academy, available at: https://www.forexboat.com.

Ganesh Bonde and Rasheed Khaled (2012). Stock price prediction using genetic algorithms and evolution strategies. International Conference on Genetic and Evolutionary Methods (GEM), pages 1–6,.

Gerding Enrico Booth, Ash and Frank McGroarty (2014). Automated trading with performance weighted random forests and seasonality. Expert Systems with Applications, 41:3651–3661.

Greene, Gerald E. (2008) Turning Losing Forex Trades into Winners: Proven Techniques to Reverse Your Losses. New Jersey: John Wiley & Sons, Inc. 224 p. ISBN 978-0-470-18769-2.

Moody J. and Saffell M. (1999). Minimizing downside risk via stochastic dynamic programming. 6th International Conference Computational Finance 1999 Edited by Abu-Mostafa Y. S., LeBaron B., Lo A. W. and Weigend S., MIT Press, Cambridge, MA. 403-415.

Martinez, Jared F. (2007). The 10 essentials of Forex trending. 1st ed. The McGraw-Hill Companies, New York, 218 p. ISBN 0-07-150873-2.