Expert Systems With Applications 43 (2016) 298–311

Contents lists available at ScienceDirect

Expert Systems With Applications

journal homepage: www.elsevier.com/locate/eswa

An intelligent short term stock trading fuzzy system for assisting investors in portfolio management

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ARTICLE INFO

Keywords:
Fuzzy system
Stock market
Portfolio management
Technical analysis
Buy and hold strategy
Bull and bear market

ABSTRACT

Financial markets are complex systems influenced by many interrelated economic, political and psychological factors and characterised by inherent nonlinearities. Recently, there have been many efforts towards stock market prediction, applying various fuzzy logic techniques and using technical analysis methods.

This paper presents a short term trading fuzzy system using a novel trading strategy and an "amalgam" between altered commonly used technical indicators and rarely used ones, in order to assist investors in their portfolio management. The sample consists of daily data from the general index of the Athens Stock Exchange over a period of more than 15 years (15/11/1996 to 5/6/2012), which was also divided into distinctive groups of bull and bear market periods.

The results suggest that, with or without taking into consideration transaction costs, the return of the proposed fuzzy model is superior to the returns of the buy and hold strategy. The proposed system can be characterised as conservative, since it produces smaller losses during bear market periods and smaller gains during bull market periods compared with the buy and hold strategy.

1. Introduction

Stock market prediction is of great importance since, as Guresen, Kayakutlu, and Daim (2011) note, better prediction is always crucial for making better economic decisions. Recently, a variety of artificial intelligence techniques have been proposed (Dymova, Sevastianov, & Kaczmarek, 2012). The latter became a necessity since financial markets are complex non-linear systems (Manahov & Hudson, 2014), involving huge numbers of participants influenced by many interrelated economic, political and psychological factors (Ballings, Poel, Hespeels, & Gryp, 2015; Lan, Zhang, & Xiong, 2011). These factors cause many uncertainties in financial markets and accordingly have positive or negative effects on stock values.

It is reasonable to assume that since stock price data are affected by deterministic and random factors (Bao & Yang, 2008), stock market forecasting can be successful only with the use of tools and techniques that can overcome the problem of uncertainty, noise and nonlinearity of prices (Chang, Fan, & Lin, 2011). Vanstone and Finnie (2009) claim that soft computing are amongst these techniques, since they can handle such problems.

Fuzzy logic is one of the soft computing techniques, which are nonlinear in nature and are considered to be part of artificial intelligence (Kumar & Ravi, 2007; Melin et al., 2007; Russell & Norvig, 2014). Fuzzy systems have thus been used with success in many applications in the real world (Crespo, Cuadrado, Carrasco, Palacios, & Mezcua, 2012).

Technical analysis is used to forecast future stock prices by studying historical prices and volumes. Since all information is reflected in stock prices, it is sufficient to study specific technical indicators (created by a rather complicated mathematical formula) in order to predict price fluctuations and evaluate the strength of the prevailing trend (Bao & Yang, 2008; Cheng, Chen, & Wei, 2010). The combination of various technical analysis techniques is a difficult task and requires decisions by using subjective assessments (Dymova, Sevastianov, & Bartosiewicz, 2010). Some techniques can provide contradictory results, the evaluation of which demands specific human expertise, subjective assessments and appropriate justification (Majhi, Panda, & Sahoo, 2009). The development of fuzzy models can address such issues in a satisfactory manner.

The large majority of studies use the same technical indicators, such as moving average (MA) and moving average convergence/divergence (MACD) (da Costa, Nazαrio, Bergo, Sobreiro, & Kimura, 2015; Fang, Jacobsen, & Qin, 2014; Ince, 2014; Metghalchi, Chen, & Hayes, 2015; Murphy, 2000; Tan, Quek, & Yow, 2008; Ulku & Prodan, 2013). However, it is suggested that if a successful strategy predicting the stock market is found (and published), all researches which will follow (concerning future time periods) might not be successful anymore because the market will have adapted accordingly

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http://dx.doi.org/10.1016/j.eswa.2015.07.063
0957-4174/

(Black, 1993; Malkiel, 2003). This assumption has been investigated by various researchers (LeBaron, 2000; Mills, 1997; Sullivan, Timmerman, & White, 1999) using the same trading rules as in previous studies and found that these trading rules were not equally profitable for future periods. Others claim that despite the documented success of the technical trading rules, there is a widespread notion that their performance is temporal with prolonged alternating periods of success and failure, probably due to the increasing interest and use of these rules when market conditions are favourable. This ultimately drives their profits back down to zero (Taylor, 2014). Indeed, Neely, Weller, and Ulrich (2009) who examined the evolution over time of the excess returns of technical trading rules, assert that they decline over time and that by mid-1990 s profit opportunities from MA rules had disappeared. Thus, the need to try novel approaches becomes apparent and it is constant. One way to achieve this is by introducing new technical indicators or smart modifications of those who are well established, since each indicator has unique characteristics which might determine his profitability in various market conditions and therefore can be distinguished from others. Moreover, the above mentioned very common indicators are calculated by using only closing daily prices and, thus, important information contained in other daily price data such as open, high and low are not considered. Therefore, the choice of technical indicators that make full use of daily data with open, high, low and close, becomes apparent, since it broadens the information on which decisions are based.

It is common practice for various researchers (Chang & Liu, 2008; de Oliveira, Nobre, & Zárate, 2013; Lam, 2001; Patel, Shah, Thakkar, & Kotecha, 2015; Pereira & Tettamanzi, 2008; Pokropinska & Scherer, 2008; Wu, Yu, & Chang, 2014; Zhai, Hsu, & Halgamuge, 2007) to use many indicators, and combine them in an effort to achieve good performance, by disposing different ways to analyse price movements. However, each technical indicator has been created for specific purposes, they express different and uneven characteristics and therefore it is doubtful whether any combination of them can be functional. Their careful selection ensures that their characteristics will act cumulatively, otherwise a combination of dissimilar technical indicators may cause erratical results, since the indicators may negate each other.

The creation of intelligent system which can perform prediction tasks accurately and in a robust way, was always of immense importance for investors and financial analysts (Hafezi, Shahradi, & Hadavandi, 2015).

A trading strategy with technical indicators can be formulated with various ways. Momentum oscillators (i.e. trend-reversion indicators), indicate whether a market accelerates or decelerates (Araque, Salguero, Carrasco, & Martinez, 2008) and the underlying assumption is that when prices move too higher (or lower) than the average, then a reversal is eminent and accordingly a sell (or buy) signal is generated (Balvers & Wu, 2006; Zhang et al., 2015), while this style of investing is called contrarian strategy (Teplova & Mikova, 2015). Using technical trend indicators, one of the trading strategies is based on the assumption that when prices are becoming higher (or lower) than the indicator, then a buy (or sell) signal is generated, while this position is held till the opposite signal (Colby, 2003; Papailias & Thomakos, 2015; Powers & Castelino, 1991). This paper builds a novel trading strategy, based on this (classic) strategy with technical trend indicators, using it as a starting point and extends it with an observation made by Papoulias (1990) that when the space between the technical indicator and price shortens then the current move of the market is ending, and when this space broadens the current move is confirmed. Thus the proposed strategy is as follows. When prices are becoming higher (lower) than the technical indicator, then a buy (sell) signal is generated (*If Cl>Ti => Buy, If Cl<Ti => Sell*). This signal remains valid till the opposite signal is given. Moreover, when a buy signal is given and until the opposite signal of sell will be given, if a stenosis (narrowing) between the price and a technical indicator appears, this is an indication that the degree of certainty of the present order (buy) decreases and increases the possibility that the opposite order (sell) is imminent. Therefore the investor should reduce the portion of his capital which is invested in equities, (*If Cl>Ti Then If* Cl_t-Ti_t < Cl_{t-1}-Ti_{t-1} *=> Decrease buy position*). Similarly, if the distance between the price and a technical indicator increases, this is an indication that the degree of certainty of the present order (buy) increases as well and the possibility that the opposite order (sell) is delayed. Consecutively, the invested part of the portfolio in equities should be increased, (*If Cl>Ti Then If* Cl_t-Ti_t > Cl_{t-1}-Ti_{t-1} *=> Increase buy position*). On the contrary, when a sell signal is given and until the opposite signal of buy will be given, if a stenosis (narrowing) between the price and a technical indicator appears, this is an indication that the degree of certainty of the present order (sell short) decreases and increases the possibility that the opposite order (close short position or buy long) is imminent. Therefore the investor should reduce his position (*If Cl<Ti Then If* Cl_t-Ti_t > Cl_{t-1}-Ti_{t-1} *=> Reduce sell short position*). Similarly, if the distance between the price and a technical indicator increases, this is an indication that the degree of certainty of the present order (sell short) increases as well and the possibility that the opposite order (close short position or buy long) is delayed. Consecutively, the invested part of the portfolio in equities should be increased (*If Cl<Ti Then If* Cl_t-Ti_t < Cl_{t-1}-Ti_{t-1} *=> Increase sell short position*).

Unlike traditional trading strategies, this is not a merely mathematically objective strategy, but incorporates subjective factors and the fuzzy notion of certainty, which are implemented in later stages of the model, with the membership functions of the system.

The aim of this paper is to propose a model comprising of a small number of novel short term technical indicators and a novel trading strategy with an appropriately designed fuzzy system, which outputs the percent of the portfolio that should be invested on a daily basis.

This paper contributes to the literature in a number of ways. First, presents a novel "amalgam" of short term technical indicators. This research proposes the use of four technical indicators that have never been used before simultaneously in academic research. Bearing in mind that truly effective technical indicators are not published in academic journals, but are instead kept secret (Pinto, Neves, & Horta, 2015; Vanstone & Finnie, 2009), the technical indicators chosen as predictors in this study are an amalgam of various indicators with some novelty. Two of the indicators are very rarely or never used in research papers (Parabolic SAR and GANN-HiLo). A novel indicator is created by using the MA of a range of MA for different periods of time. Finally, the MACD indicator is also used, but since there are some reports suggesting that it cannot provide better returns than the buy and hold (B&H) strategy (Colby, 2003), it is used here with a different trigger. Furthermore, the calculation of the first two indicators, except daily closing prices, as is often the case, uses the high and low daily measures of price, while all technical indicators have been adjusted to perform better in short periods.

Second, it uses a novel trading strategy which differentiates it from previous studies in that connects the distance between the price and the technical indicator, with the subjectivity and fuzziness of the current order.

Third, explores the profitability of an intelligent stock trading fuzzy system, aiming to assist short term investors in their portfolio management, by combining within the system independent technical analysis signals which have been given outside of the system. These signals undergo a transformation within the system which is specific for every signal, in order to explore the limits of elasticity of the slope of the curve that maps appropriately their behaviour, between reaching the maximum performance and maintaining the fuzzy characteristics of the curve.

The model was tested in various market environments for a period of over 15 years and for 3.879 daily data, using the general index of