Faculty of Economics and Business

Validation of Future Crude Palm Oil Futures (FCPO) Price Prediction

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

The implementation of Artificial Intelligence (AI) towards the price prediction process is undoubtedly crucial as the importance of accurate price prediction has increased over the last few decades. The lack of accurate price prediction tools in the past has always been a challenge for investors to predict future prices. Thus, investors tend to use technical indicators to improve their trading strategy. However, with the large amount of different technical indicators in the market, it is tedious and time consuming to identify which technical indicators works the best for them. Crude palm oil plays an important role in the upbringing of Malaysia's economy. It is the largest Gross Domestic Product (GDP) contributor for the agricultural sector in Malaysia and is exported globally. It is important to predict the price of Crude Palm Oil Futures (FCPO) as it could allow us to hedge against any unforeseen risks and price changes. This study aims to predict FCPO price and optimize various technical indicators using AI. Thus, this study predicts the future price of FCPO using daily historical data such as the opening, high, low, and closing price of FCPO from year 2010 to year 2019 using the Extreme Learning Machine (ELM) model in the Matlab R2020a software. Besides that, various number of hidden neurons and activation function have been used to train and test the ELM model to identify which parameter works best with the technical indicators to provide the most accurate results. The main result shows that the radial basis function has the highest training and testing accuracy as compared to other functions such as the sigmoidal function, sine function and radial basis function when tested against different number of hidden neurons. As for the optimisation of technical indicators, the Williams Percent Range indicator has the highest prediction accuracy as compared to other technical indicators such as Relative Strength Index (RSI), Exponential Moving Average (EMA), Moving Average Convergence and Divergence (MACD) and Stochastic

Oscillator. The predictability of FCPO prices using ELM shows that it is possible to predict future prices and thus disputing the weak form of Efficient Market Hypothesis (EMH) that stated it is nearly impossible to predict prices based on historical data. This study could potentially contribute to businesses related to palm oil as business owners can predict future prices and hedge against any unforeseen risks. Not only that, investors and technical analyst can also contribute from this study by identifying technical indicator that has the highest prediction accuracy based on their trading strategy. The implementation of ELM towards the price prediction process can also guide policymakers to adjust their strategies and help them to obtain more agricultural related grants.

Keywords: Artificial Intelligence, ELM, FCPO, prediction, technical indicator.

Analisis Peramalan Harga Crude Palm Oil Futures (FCPO) dan Pengoptimuman Petunjuk Teknikal dengan Teknologi Kecerdasan Buatan

ABSTRAK

Pelaksanaan teknologi kecerdasan buatan terhadap peramalan harga semaking penting kerana peramalan harga yang tepat dapat membawa manfaat kepada semua pihak. Kekurangan modal peramalan harga yang tepat merupakan salah satu cabaran yang sering dihadapi oleh pelabur. Oleh itu, ramai pelabur menggunakan petunjuk-petunjuk teknikal untuk meningkatkan prestasi pelaburan. Namun begitu, kepelbagaian petunjuk teknikal sering menjadi beban untuk pelabur. Minyak sawit Malaysia dieksport ke seluruh dunia dan merupakan penyumbang utama kepada GDP Malaysia terutamanya dalam sektor pertanian. Tujuan kajian ini adalah untuk meramalkan harga Crude Palm Oil Futures (FCPO) dan mengoptimumkan beberapa petunjuk teknikal dengan menggunakan teknologi kecerdasan buatan. Dalam kajian tersebut, Extreme Learning Machine (ELM) dalam Perisian Matlab R2020a telah digunakan untuk memproses data harian FCPO seperti harga pembukaan, tinggi, rendah dan penutupan dari tahun 2010 sehingga tahun 2019. Selain itu, pelbagai fungsi telah digunakan untuk melatih dan menguji ELM tersebut untuk mengenal pasti fungsi yang paling sesuai dan tepat. Kajian ini mendapati bahawa fungsi radial basis dan petunjuk teknikal Williams Percent Range menunjukkan hasil ramalan yang paling tepat. Peramalan harga FCPO dengan menggunakan ELM menunjukkan bahawa peramalan harga boleh dicapai. Kejayaan dalam peramalan harga ini menyangkal kenyataan Efficient Market Hypothesis (EMH) yang mengatakan bahawa peramalan harga berdasarkan data bersejarah adalah agak mustahil. Selain itu, kajian ini boleh menyumbang kepada perniagaan yang berkaitan dengan kelapa sawit. Pemilik perniagaan dapat meramalkan harga kelapa sawit dan membuat keputusan untuk membeli sebelum harganya meningkat.

Di samping itu, pelabur juga boleh mendapat manfaat daripada hasil kajian ini menerusi pemilihan petunjuk teknikal yang sesuai dan efektif untuk peningkatan prestasi pelaburan.

Kata kunci: *Kecerdasan Buatan, ELM, FCPO, peramalan, petunjuk teknikal.*

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Crude Palm Oil Futures (FCPO) is a Ringgit Malaysia (RM) denominated futures contract traded on Bursa Malaysia Derivatives. In simpler terms, it is a contract that allows buyer or seller to buy and sell crude palm oil at a prearranged price at a specific time in the future. FCPO is standardised with 25 metric tons for a contract with a minimum price changeability of RM 1 per metric ton. FCPO are usually traded by two types of investors, the hedgers and speculators. For oil-related businessman, they would enter a FCPO contract to hedge themselves against unfavourable price increase in the future. As for speculators, they are traders who trade FCPO to obtain leverage and to earn through price movement and spread of crude palm oil.

Financial market or financial market movements and price prediction has always been a hot topic among researchers and investors. Price prediction or forecasting of market return is a tedious process and might cause the price generating process to deviate over time (Politis et al., 2002; Timmermann, 2008). Traditional stock price prediction usually revolves around using publicly available information or past trend and patterns, which is also known as fundamental and technical analysis. Obtaining high profit had always been a dream of all investors. In the financial market, there are many types of financial instruments that investors can choose to invest. A few examples of it are the trading of bonds, stocks, futures, foreign exchanges, commodities and many more.

Trading in futures is also becoming increasingly popular amongst traders because such instrument allows users to obtain rapid and high profit within a short period of time, unlike stocks and bonds which are usually invested longer. Investors can obtain profit by buying and selling futures at the right time. The main idea is to find the perfect entry and exit timing base on the investor's personal trading strategy, risk tolerance and knowledge of that instrument. Finding the right timing to enter and exit the financial market could be tough for many investors, especially for investors that just started trading.

Due to the importance of financial markets, trading decisions or investment strategy is usually aided by some form of prediction. The two main types of prediction method are through fundamental and technical analysis. The combination of fundamental and technical analysis is often used by investors when determining the timing of buying and selling. Technical indicators are based on past prices and historical data. According to Yan and Zheng (2017), fundamental analysis is the process of analysing the market's basic financial level. It mainly deals with the financial ratios of a business. The second method of stock or futures prediction is through technical analysis. Huang et al. (2012) stated that technical analysis deals with the historical price changes and chart patterns to assist investors in making decisions. In other words, technical indicator is a sequence of data points obtained from past price movement which comprises of the opening price, high, low, and closing price of the security. Some indicators may only require closing price or other singular information. Technical indicators offer a different perspective for investors. There are numerous simple technical indicators such as moving averages, volume, and so on. There are also harder to understand indicators such as Fibonacci level, Stochastic and so on. Regardless of the difficulties of technical indicators, it acts as one of the most important tips for investors when predicting price movement. Some commonly used technical indicators

include Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), Exponential Moving Average (EMA), Williams Percent Range, Stochastic K and D.

Such massive amount of historical data could be a burden to investors and could also confuse investors. Therefore, data mining and AI have been frequently used to analyse such data and ease investors in predicting prices and investing. AI can be defined as the use of computer systems to perform tasks that could assist human in making certain decision. AI can range from speech recognition, facial recognition, translation, visual perception and many more. In simpler terms, AI is used to mimic the human brain and carry out tasks that are usually done by humans, therefore the possibility of AI is endless. In this study, AI will be used to optimize technical indicators related to Crude Palm Oil Futures (FCPO) and to aid investors in buying and selling futures. The primary objective of this study is to develop a novel decision support system using Extreme Learning Machine (ELM).

1.2 Background of the Study

Department of Statistics Malaysia, DOSM (2020) states that the top five commodity exports of Malaysia are refined petroleum, palm oil, crude petroleum, aluminium, and coconut oil. Asian countries account for approximately 85% of global palm oil exports with Malaysia being in second place with 32.6% market share, just behind Indonesia who controls around 51.7% global export share. The agricultural sector has contributed 7.3% (RM 99.5 billion) to the national GDP in the year 2018. Oil palm was the main contributor at 37.9%, followed by agriculture, livestock, and other activities. With an experience in palm oil industry for 100 years, Malaysia has a comparative advantage over other countries in terms of productivity and research and development.

According to Norhidayu et al. (2017), the role of oil, especially crude palm oil becomes increasingly important as it contributes significantly to the economy of Malaysia. Nambiappan et al. (2018) stated that crude palm oil prices are affected by various factors such as supply and demand of other crop oils, climate patterns, import policies of importing countries, changes in taxation and regulations. The occurrence of such event could affect the crude palm oil price adversely, thus leading to strong fluctuations. An example of FCPO yearly price trend in Malaysia can be seen in Figure 1.1.

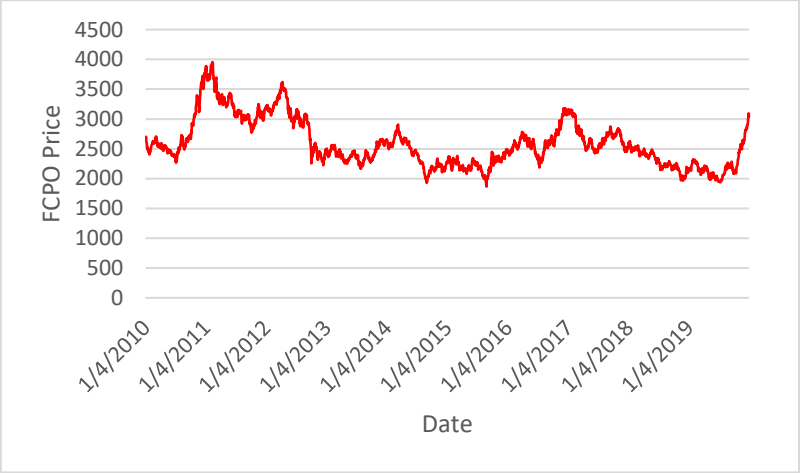

Figure 1.1: FCPO yearly price trend

Source: Fusion Media Limited (2020)

FCPO is a Ringgit Malaysia denominated futures contract traded on Bursa Malaysia. With an amazing track record of 30 years, FCPO derivatives in Malaysia acts as the reference point for market players in the oil palm business. Hedgers and speculators trade FCPO due to various advantages. Firstly, Bursa Malaysia (n.d.) states that FCPO is available globally as it is traded electronically on CME Globex, which is an international trading platform. Traders from all around the world could access to Bursa Malaysia Derivatives through the platform. Secondly, palm oil related businesses such as plantation businesses, millers, refineries, and exporters could use FCPO to hedge risks and manage uncertainties regarding

future price movement. Thirdly, speculators could also use FCPO to obtain leveraged exposure to CPO in the market. Besides that, managers, advisers and traders to get immediate exposure to an active commodity market.

FCPO price fluctuations in Malaysia depends on the supply and demand of it. There are various issues faced by the FCPO market such as the drop of demand for palm oil, economic growth, trade barriers, climate changes and many more. An example of issue faced by the FCPO market is the drop in demand for palm oil due to the COVID-19 pandemic, where many countries have implemented national lockdown, thus decreasing the consumption and usage of palm oil indirectly. The lack of new market catalyst could continue to diminish market sentiment, causing the price of CPO to dip further.

Financial market prediction has always been an important financial topic that has attracted the attention of researchers and analyst throughout the years. Kolarik and Rudorfer (1994) stated that prediction of the financial market often involves analysing past information and relate it to future price trend or pattern. An attempt to predict future prices is said to be opposing the Efficient Market Hypothesis (EMH). EMH stated that all publicly available information reflects the value of a particular financial instrument, therefore it is impossible to forecast future prices since the price already reflects all information.

Globalization and modernization of technologies has encouraged the emergence of Artificial Intelligence (AI) and allowing it to blend into individual's daily life. Besides that, the generation and accretion of financial data in this modern era allows engineers and programmers to maximize their potential. Financial data are complex and could be affected by economic factors, political factors, socioeconomic factors and many more. Ashour et al. (2018) have shown the effectiveness of artificial intelligence in solving financial data,

especially time series data. In their study, they manage to research the exchange rate fluctuation for the Egyptian financial market which was then under tremendous political pressure. In another socioeconomic study, Abdallah et al. (2020) found that implementation of artificial intelligence in solid waste management have shown positive results in tracking waste. Coccia (2020) on the other hand have found that the implementation of AI on cancer imaging have increase the effectiveness of better prognostication. As we know, the unceasing spike in such data creates problems that are complicated and might be tedious to be resolved by human beings. Jin et al. (2015) states that big data plays a significant role in our current era, and its application could be beneficial to our national development, industrial upgrades, and scientific researches, helping the society to better perceive the present and predict the future. This shows the importance of the need to solve such big data. Therefore, the need of developing automated systems that could solve such issues are highly recommended. As mention earlier, the emergence of AI has been a big step forward and could solve many complex issues. The use of AI has been incorporated into our daily life without us noticing through mediums such as smartphone applications, smart technologies, and wireless technologies and so on. Fintech which is the use of AI in the financial market has been one of the main priorities set by the government as economic wellness determines a country's performance.

According to various past studies, many forms of AI have been used to predict future prices and trends. Unlike traditional linear techniques, the adaptation of AI is said to be self-adaptive, non-linear and automated. Wang et al. (2019) have implemented machine learning in predicting price of air fare, whereas Rahim et al. (2018) and Aini et al. (2019) have used artificial intelligence methods such as fuzzy based rule and Artificial Neural Network (ANN)

in predicting future prices. These past studies have shown superiority over AI tools as compared to the traditional method.

Since the influential work of Fama, the role of technical indicators is still blurry, and the effect of such indicators are still debatable. Several prominent studies have shown that technical indicator does yield positive returns, while some concluded that technical analysis is not useful in predicting stock prices. Not only that, numerous studies have been carried out to determine the role of technical analysis on crude palm oil prices. M'ng et al. (2017a) has proposed an innovated technical analysis model using ANN to calculate the returns on crude palm oil futures. In another research conducted by M'ng et al (2016), neural network is used to enhance technical indicators to improve trading rule in Malaysia stock market. This studies shows that technical analysis could help to improve investor's decision-making process. According to Masry (2016), decision making is one of the most important factors during an investment process.

The study of technical indicators originated from a person named Charles Dow. Kirkpatrick II (2022) states that Dow started observing financial assets prices through charts and that Dow Theory have been introduced to the society in early 1900. Through his observation, he noticed that prices of the assets are reflected before information became publicly available. After years of studies, Dow concluded that prices move along a path which is predictable or recognizable. Such theory then evolved into Dow Theory. The emergence of computer then further enhances the role of technical indicators. In simpler terms, technical analysis could be defined as the prediction of future patterns through analysing graphs or charts. An example of technical analysis can be seen in Figure 1.2:

Figure 1.2: Technical Analysis on FCPO

Source: Fusion Media Limited (2020)

As shown in Figure 1.2, the red line indicates a downtrend whereas the green line indicates an uptrend. This trend could be recognized by identifying the general pattern of the price change. Study on technical analysis has been increasingly popular due to its simplicity and widespread of usage. Generally, technical analysis follows three rules which are the market includes all information, history will repeat itself and trends will remain the same until a reversal occurs. According to Hayes (2021), the market incorporates all information means that the prices of an asset is reflected through every information portrayed. The second rule which is history tend to repeat itself indicates that identical inducement from the past will encourage investors to respond similarly in the future. This shows that through the study of previous patterns and trend, it is possible for the particular trend to appear again in the future. The recurrence of such trend might not be totally identical as compared to the past, but it is sufficient for investors to identify the main crucial points. The third rule which is an existing trend remains until a certain reversal occurs means that a price movement is expected to move along its path if there is no reversal signal.

According to Wong et al. (2003a), technical analysis comprises detail scanning for recurring price patterns in stocks. This type of analysis is said to be created in the 16th century in Japan. Such analysis has evolved into Chartism in the 20th century. The change in technical analysis from the past to present is said to be due to globalization and the introduction of computer system and technology which makes complex mathematical nature of the technical indicators easier.

There are many different types of technical indicators catered to different situations. There are trend-based indicators such as Bollinger Bands, Exponential Moving Average (EMA) and many more. Oscillator indicators such as Relative Strength Index (RSI), Williams Percent Range, Stochastic Oscillators to indicate the overbuying or overselling of the security. There are also volume-based indicators such as the Chaikin oscillator, Volume and many more. With such a large number of technical indicators and data, it is difficult for traders to identify which is the most suitable indicator, and which indicator could predict future prices more accurately as compared to others. In order to master traditional technical analysis and to determine which indicator works better, it requires a lot of knowledge and time spent on analysing each and every indicator. The adoption of AI onto technical indicators may be able to reduce the burden on traders, thus allowing traders to identify the optimal technical indicator without much expertise.

Furthermore, the implication of technical analysis in trading has played a big part in investment decisions. Forecasting and predicting of prices have been studied by many researchers from various fields such as finance, engineering, computer science and others. Park and Irwin (2007a) stated that statistical models and AI such as Artificial Neural