

CHAPTER

11

**APPLICATION OF HIGH-ORDER
FUZZY TIME SERIES
FORECASTING ON PRICE OF
CRUDE OIL DATA**

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11.1 INTRODUCTION

United States (US) is one of the biggest oil producers in the world (United State Energy Information Administration, 2019). Since crude oil is very fragile and influenced by the U.S. economy, it is considered one of the significant stocks in the investment sector. In addition, other variables make the stock price of crude oil unpredictable or uncertain. Typically, the price of crude oil will rise sharply in a short time due to inadequate stock, such as pirate attacks on the ship for oil suppliers (Hellenic Shipping News, 2018).

Crude oil prices have emerged as an emergent sector of global economic transformation, and crude oil price shocks significantly impact financial markets. There are numerous advantages to having a good understanding of oil price movements. These benefits include industrial progress, financial stability, personal income, energy policy, and even governmental regimes are among these benefits (Malin Song, 2021). As a result, oil price predictability must be given serious

consideration. Mastering oil price trends is, without a doubt, a requirement for investment decision-making and planning.

Underlying variables such as economic crises, geopolitics, and unforeseen occurrences may influence the price of crude oil over time. People lost faith in the markets due to the US-Iraq war and the 2008 financial crisis, resulting in lower commodity demand and consumption of oil goods. In 2008, structural shocks appeared, as did massive changes in crude oil prices. The crude oil supply chain has experienced significant variations due to sporadic events such as abrupt, harsh weather. As a result, crude oil prices have nonstationary, nonlinear, and complicated characteristics, which makes modelling crude oil prices difficult (Ranran Li, 2021).

Crude oil is a vital commodity for both industrialised and developing countries' economic development (Yanhui Chen, 2018). In addition, crude oil has a crucial role in the growth of the global economy in general and the Nigerian economy, necessitating a greater effort to forecast its price volatility and irregularity for policymaking purposes. Oil price fluctuations affect a wide range of commodities and services that directly impact the economy, posing a macroeconomic risk to importing and exporting countries (Busari & Lim, 2021).

11.2 PREVIOUS STUDY ON FORECASTING CRUDE OIL

Making accurate crude oil future price projections can help the private sector develop better-foresighted marketing tactics, resulting in significant revenue (Tomas Balezentis, 2021). Therefore, it is important to forecast crude oil data especially by using machine learning models such as fuzzy time series model.

Fuzzy time series is a concept to deal with historical data and linguistic variables (Gülçin Büyükoçkan, 2021). Previously, some forecasting study has been conducted by applying fuzzy time series, such as future university enrolment (Song & Chissom, 1993), rainfall distribution (Azahari & Othman, 2017), and others. Therefore, this

paper suggests the fuzzy time series forecasting approach to resolve uncertainties.

It is necessary to have a maximum forecast value that is less than or equal to the actual maximum value and a minimum forecast value greater than or equal to the actual minimum value. Otherwise, investors will face a deficit in the stock market related to the projected value. In short, the more reliable and sensitive forecasted value is advantageous for investors to increase their profits (Jabeur, 2021).

Malaysia ranked sixth in the world for both oil and liquefied natural gas exports in 2019 and was the second-largest producer of both in Southeast Asia. In 2018 and 2020, it produced an average of 1.7 million and 596,000 barrels of oil per day, respectively. Oil and gas production has increased Malaysia's Gross Domestic Product (Zakaria & Shamsuddin, 2017). As an exporter of oil and gas, Malaysia profits from rising global oil prices, and the reverse is also true (Jalil et al., 2009).

A natural disaster, such as COVID-19, is another factor influencing the fluctuation of crude oil prices. Because of its global spread, the disease has been declared pandemic since 2020. This disease has a big influence on Malaysia's and the rest of the world's economies. International travel restrictions and the Movement Control Order (MCO) have both led to oil market demand shocks. Global oil consumption fell to 19.9 million barrels per day in April 2020, down from 20. However, beginning in the second quarter of 2020, global oil demand will gradually climb again (International Energy Agency, 2020).

11.3 FUZZY TIME SERIES

Application of fuzzy time series (FTS) forecasting model was first implemented (Song & Chissom, 1994), where student enrolments at the University of Alabama were forecasted. Seven linguistic variables, namely "not many", "not too many", "many", "many many", "very many", "too many", and "too many many" were used to fuzzify the data. However, this led to high computational complexity due to max-min composition operation. Therefore, simple arithmetic operations