

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This study of the literature concentrates on the definition of all variables, such as the price of crude oil, the price of palm oil, and microeconomic factors such as the Islamic Stock Market, and the Conventional Stock Market. Then the methods that will be used in our study are Johansen Cointegration test and ARDL methods to check the cointegration of all variables. Then we will apply Long Short-Term Memory (LSTM) method for forecasting. The empirical research on the influences of commodities, microeconomic and the gold price is then given. This analysis of the literature focuses on earlier studies of the problem. The authors carefully analyzed the literature to have a better understanding of the topic. The definitions are clear and succinctly presented to aid readers in understanding them. The presentation in this chapter begins with definitions of each variable before moving on to the techniques used to forecast each variable.

Literature has long acknowledged the role that nation's gold price plays on microeconomic and commodity determinants, and other studies have approved with this statement. The gold price has a significant role in the economy because they influence the direction of the microeconomics and commodities determinant by improving the policy context, market conditions, and key driving forces (Chai et al., 2021). Meanwhile, gold acts as a diversified portfolio, aiding investors in recovering from significant losses. Regardless of where gold works, due to its unique chemical characteristics, it cannot be emptied and remains in existence forever. As a result, the foundation of the gold price is eroded. According to the research study we have been looking at, gold prices have less impact on macroeconomic issues than commodity factors do (Michael Bromberg, 2023).

As a result, this research will acquire the best approach, which are Long Short-Term Memory (LSTM) model and Vector Autoregression (VAR) to forecast gold prices. In addition, this research learns about the strengths and weakness of knowing each variable's relationship to gold price by using Johansen Cointegration test, Granger Causality and Autoregressive Distributed Lag (ARDL). Therefore, this research applies them wisely and carefully to avoid utilizing the forecasting method and receiving inaccurate results. In order to apply contemporary methods in accordance with the most recent time distribution, we may also avoid underrated or out-of-date ways.

2.1.1 Gold Price

For centuries, gold has been a significant precious metal. It is a significant financial asset for nations and an important part of the world's monetary reserves for trading and currency hedging (Capie, 2005). Gold is important in investing as well, particularly as a buffer against unfavourable financial occurrences. In fact, the prices of precious metals typically move in the other way during periods of financial unrest that cause stock indices to decline. For investors, mining ventures, connected businesses, and generally for any person who views gold as a leading indicator of the future performance of the global economy, anticipating gold price fluctuations is a crucial issue (Jabeur et al., 2021).

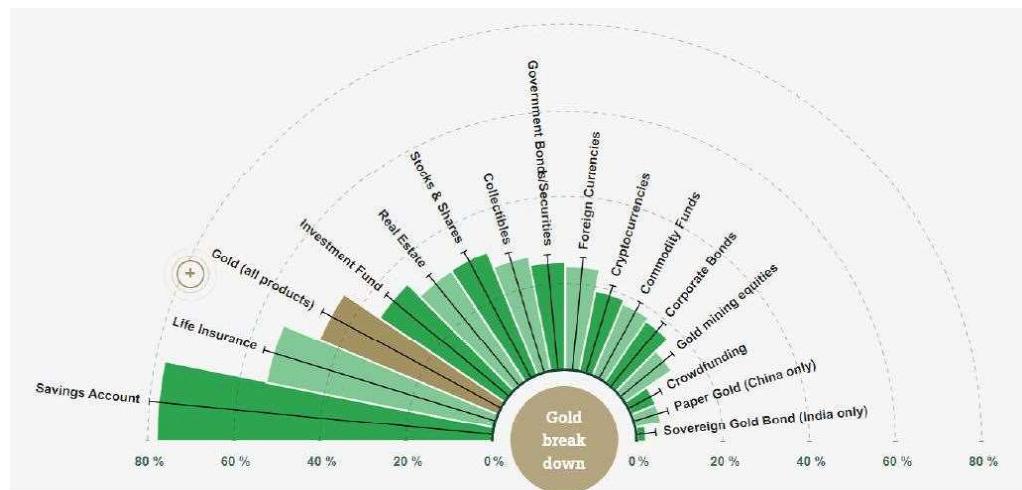


Figure 2.1 Percentage of Investors That Have Ever Bought Each Product (World Gold Council, 2019)

According to the figure above, the World Gold Council study, the annual increase in the demand for gold as an asset and investment has been roughly 15% since 2001 (Chai et al., 2021). In terms of investment products that investors have purchased, gold ranks third with 46%, behind savings accounts (78%) and life insurance (54%), according to the most recent gold retail market survey study from 2019. In the global market, gold is rapidly becoming a commonplace financial strategy. The total amount of gold bought by central banks in 2019 was 651 tons, up 74% from the previous year. This marked the highest level of gold purchases by central banks since the Bretton Woods system collapsed in the 1970s. The world's central bank bought 374.1 tons of gold in the first half of 2021, an increase of 57% compared to the same period last year. The demand for gold from central banks has been rising. In reserve assets, gold is more significant.

The question of whether gold may be used as a safe haven or hedge has been the subject of a lot of recent research. The risk of investing in gold has increased over the past few years due to frequent price swings, and at the same time, outside factors like wars and economic crises have further impacted the price of gold. To reduce the risk associated with gold investments, it is crucial to understand the gold price's volatility characteristics, especially the fundamental regularities. According to Wen (2017), the worldwide gold market price mechanism is quite complicated. Multiple factors operating at multiple levels, such as the price of oil and stock market, affect it with a fluctuation period of around three months (Wen et al., 2017). However, some researchers found that the gold price shows long-term mean-reverting behaviour, as proven that the gold price period takes around seven years (Boubaker et al., 2020). Thus, war and economic crises have a more obvious impact on the price of gold, and the fluctuation cycle is often shorter when these events occur.

2.1.2 Palm Oil Price

Another name for the oil palm tree is *Elaeis Guineensis* Jacq. It was created in West Africa. This plant was brought to Malaya (now Malaysia) by the British in the 1870s as one of the agricultural plants for the growth of the agricultural industry. In the agricultural sector of Malaysia, palm oil has historically contributed more than other plantations like those for rubber and timber. Approximately 570,000 individuals were employed in this industry alone in 2009 (Basiron, 2009). In addition, Malaysia is the world's second-largest volume exporter of palm oil after Indonesia, and people from 150 different nations currently use goods made from Malaysian palm oil. This evidence from the Department of Statistical Research in 2022 shows that in 2020, palm oil exports were close to 16.2 million metric tons, about five times the amount consumed domestically. It helped to emphasize the value of Malaysia's palm oil sector. Malaysian palm oil is used in two different industries: biofuels and food. Malaysia has long advertised palm oil as a healthful and nutritious food source because it is the world leader in palm oil production. Nearly 80% of Malaysians were of the belief that palm oil is healthier than soybean oil. It was proved that this had an impact on the population (Statista Research Department, 2022).

The price of palm oil itself is a sign of the sector's full development, together with other indications. The stakeholders and the nation's income from export earnings would both gain from an increase in the price of palm oil, and vice versa (Zaidi et al., 2021). Therefore, it is extremely important for stakeholders and policymakers to comprehend how the price of palm oil is changing (Karia & Bujang, 2011). According to Hayati et al. (2011) analyses research, Malaysia's palm oil sector has clearly contributed significantly to both the growth of the global palm oil market and the country's economy. The fact that there is a successful the cointegration test between the price of palm oil and its production in Malaysia (Hayati & Rahman, 2011). Therefore, this indicates that this country's production of palm oil can affect the price level of this commodity.

According to several earlier studies, there is a connection between the price of palm oil and gold. Based on You-How Go and Wee-Yeap Lau's (2017) research paper,

the price of crude palm oil (CPO) will increase in the future if gold prices continue to climb. Investors can long CPO futures contracts to hedge against a high inflation rate and bet on the rise in CPO prices. Second, when the price of CPO is anticipated to decline, a decline in the price of gold would be a signal for investors to invest in short selling activities (You-How Go, 2017).

However, some studies claim that there is no connection between the price of palm oil and the price of gold. According to Norhafiza Nordins (2014) research, neither the price of gold nor price of palm oil appeared to have a significant impact on stock market performance. This is due to that the fuel prices are subsidized in Malaysia, which is one reasonable explanation for the oil price's insignificant outcome (Nordin et al., 2014). Thus, the subsidized price may eliminate or reduce the impact of changes in the price of oil on Malaysian businesses. In other words, firms are somewhat protected from the negative effects of changes in the price of oil. For instance, if oil prices rise, they might only see a small impact. The data don't support earlier research (Wang, 2010), which established a connection between gold price and oil price.

2.1.3 Crude Oil Price

Malaysia's oil industry began over a century ago when the first oil well was discovered by Shell in Sarawak in 1910. This industry contributes significantly to the Malaysian economy as it is Southeast Asia's second-largest oil producer and the world's third largest exporter of liquefied natural gas (LNG). Oil production and consumption is one of the most widely used economic indicators. The price of oil is volatile and sensitive towards world oil price fluctuations as it is a commodity with the highest volume of trade. According to Md Anuar et al., 2010 the increase in oil price causes the other prices to increase due to the significant role of price in determining other prices. Oil price fluctuations impact also varies across countries depending on the economic performance of oil producing countries and non-oil producing countries. The oil price fluctuation will have an impact on several economic sectors such as agriculture, transportation, and manufacturing.

A considerable amount of research has focused on the relationship between gold and oil prices. These include studies by Satish Kumar (2017) who highlights the evidence that gold prices are relatively more sensitive to increasing oil prices. Furthermore, Ahmad (2019) examines the cointegration and the causation of both gold and oil and finds that long run relationship equilibrium exists, and oil price is highly significant influencing gold price. In other country, study such in Mexico (Shelly, Sangita and Pratap, 2019) finds that gold prices positively affect the stock price of Mexico while oil on the other hand, affects them negatively. Nonetheless, based on the previous study highlighted there is still lack of studies in specifically in Malaysia regarding the causality and relationship between gold and crude oil price (Ahmad, 2019).

According to Ibrahim et al. (2018) while gold is traditionally used as a hedge against inflation, crude futures tend to be supported during periods of high inflation. This positive cointegration has often meant higher oil prices have coincided with higher gold prices even though one does not directly affect the other. Meanwhile, study conducted by Chikri & Hamiche (2020) proves that due to influences of common factors, many empirical studies indicate that crude oil and gold prices are positively associated and have risk-related movement mechanisms. Also, in their study supporting Zhang et al (2008) and Ewing and Malik (2013) research find that fluctuations in gold prices can affect volatility of crude oil prices and occasionally produce relationships between them. One of the reasons for this is that both gold and crude oil are regarded as top commodities in the world and are traded in the U.S on the global market.

2.1.4 Islamic Stock Market Price

There is a nearly common characteristic among gold, Islamic stock, and commodity markets, all of which have been commercialized as inflation hedges. Ibrahim et al., (2018) in their research about whether the price of gold follows or lag the Islamic stock market and other markets found that the price of gold fails to keep up with the Islamic stock market in Malaysia. It also has been proved that gold and

Islamic stock markets are not able to offer a hedge against inflation and instead serve as multifariousness with the price of crude oil, crude palm oil and the Islamic stock market because they move in opposite directions. They also found that the price of crude oil and crude palm oil affects the Islamic stock market and gold mark as the one variable which moves independently contrary to other variables.

The Islamic Financial System (IFS), on the other hand was designed with several unique features based on the Shariah principle prohibiting interest and investment in Shariah-prohibited activities. The Islamic finance industry has evolved significantly in recent decades, and it now offers investors a diverse range of investment choices. Over the years, the Islamic capital market has accounted for more than 60% of Malaysia's capital market, as the Islamic finance industry has expanded fast. (S Birruntha, 2022).

Based on previous research and studies such as Yahya et al., (2013) and (Chikri & Hamiche, 2020) there is no direct relationship or significant cointegration between Islamic stock market and the gold price. The studies however do highlight the existence of significant cointegration between Islamic stock market index with the oil price. Recent study from Walid (2022) also supports other studies where there is negative, or absence relationship uncovered between gold market and Islamic stock markets hence indicating that the gold can be hedge and safe haven during extreme market conditions.

Recent study by Bahloul & Khemakhem (2021) verified that the dynamic connectedness and between return and volatility of commodity and Islamic stock markets equals 67.5% and 66.1% covering the entire period data. The information of this study was gathered during Covid-19 and yet after the outbreak, the connectedness between both commodity and Islamic stock market rose to up to 71.6% and 68.8% respectively. This research's finding of a directional connection suggests that whatever the period is, commodities are the biggest source of shocks for Islamic stock markets.

Conventional Stock Market.

The Islamic stock market is parallel to the Conventional stock market but with different value-based system. It complies to the rules and regulations of Islamic shariah that are ignored by the conventional market efficiency theory. Md. Mahmudul et al, (2017) they also stated that the outcomes of current financial crisis, it is suggested that market should be run by a system that ensure efficiency, justices and fairness as to which Islamic stock market could offer or as the alternative. In addition, the Financial Services Authority of Indonesia classifies stocks as shariah compliant do not involve any sort of non-halal activities such as gambling, trading with non-deliverance of goods or service or with counterfeit offering and demand, conventional banks, conventional leasing companies, bribery, and others.

Mohd Yahya et. al (2013) studied the link between gold price, oil price and Islamic stock market in Malaysia. Their research discovered that Islamic Share prices (FBMES) do not have a significant long run relationship with crude oil price and Kijang gold price. This study also proves that both commodities are not valid indicators to predict changes in Islamic share prices in Malaysia specifically in long run. Beyond that, another study empirically shows that there is positive relationship between oil and Islamic stock market indicating the existence of financialization process of the crude oil price. Contrarily, gold has a negative relationship with Islamic equity market. However, gold highlights the role as strong hedge for Islamic market volatility (Chkili, 2022).

2.1.5 Conventional Stock Market Price

Kuala Lumpur Stock Exchange (KLSE) is conventional stock market price in Malaysia and now known as Bursa Malaysia. It is fully automated and one of the largest exchanges in the Association of Southeast Asian Nations. The Conventional Financial System is primarily a debt- and interest-based system that generates excessive debt and leverage via the credit multiplier. The assets are risk-bearing, and their risk-reward trade off is determined by the degree of risk they hold. (S Birruntha, 2022).

The long run cointegration value from cointegration test equations confirms the inverse relationship between stock and gold prices. This finding lends credibility to the belief that gold is a safe haven for Turkish investors seeking to protect their investments (Tursoy & Faisal, 2018). Furthermore, the Granger causality proves the interaction between stock prices and gold prices. The causality provides evidence for gold prices influencing stock prices in the short, long, and joint runs. As a result, the commodity prices such as gold and oil influence the stock market price in Turkey. These global prices (oil and gold) are effective indicators for investors to revise their portfolios or investments based on these indications.

Naliniprava (2016) investigates the integration between gold price and stock market price by using monthly time series data from July 1990 to April 2016. This study finds that there is no causal relationship between gold price and stock market price in the short run. However, they are cointegrated in the long equilibrium relationship and they move together. Another study conducted in India, Anil Kumar and Ajit (2018) examining the direction and the cointegration and causal relationship between gold prices and the stock market which known as NSE Nifty returns. The study evidence the same result as the previous study where there is a long- run equilibrium relationship between the gold and stock prices yet there is no causal relationship between those two.

The gold and the stock market have many different characteristics. One of them is, gold is perceived as a commodity that has been able to remain and even rise in value despite adverse circumstances (Mukhuti & Bhunia, 2013) whereas the stock market is not, as it is regarded as a return of value (Syed Wajahat Haider, 2018). Many investors prefer to invest in both the stock market and gold in order to reduce or avoid systematic risk. Investing in gold is also considered risk insurance, as is using gold as a hedging tool (Hammad et al., 2018).

Moreover, changes in the gold price have a positive significant effect on Indonesia Stock Market's fluctuation (Syahri & Robiyanto, 2020). People are concerned about their investments as a result of the crisis period during the COVID-19 pandemic. There is evidence that stock investors on the Indonesia Stock Exchange

are skeptical in response to changes in the gold price, making them hesitant to invest in gold. The public are getting more interested in investing in gold due to the printed and electronic social media reports claiming that gold is the safest investment during a pandemic.

2.2 Research Methodology

2.2.1 Cointegration and Causality Relationship of Gold Price on Oil Price and Stock Market

Cointegration theory is clearly the advancement in theoretical econometrics that has caught economists' interest the most during the past ten years. The definition in the straightforward scenario of two time series, xt and yt , which are both integrated of order one ($I(1)$), which denotes the presence of a unit root in the process) (Bent E. Sørensen, 2019). Moreover, it combines nonstationary variables in a linear way (Stevans, 2012). Hence, the results of the cointegration test show that there is a long-term relationship among the chosen variables, and they also look at long-term equilibrium relationships (Abbas et al., 2017).

Causality refers to when two sets of events (the effects) follow one another directly, this relationship between them. Besides that, this method using which one can infer causal linkages from data is known as causal inference. Since determining causal connections is one of the main goals of science, there has been much discussion on this subject in the fields of philosophy, statistics, and the sciences (F. Daniel Hidalgo & Jasjeet S. Sekhon, 2009). Until now, the causality test showed a one-way relationship between one variable and another, to put it simply. Moreover, this test can define the long-term and short-term causal relationships between each variable (Abbas et al., 2017).

2.2.2 Granger Causality Test

The Granger Causality test is used to check individual variable direction and relationships with another individual. It is also an econometric test employed to verify the usefulness of whether one variable can accurately predict another (Zach, 2021). A variable is a granger cause if it influences in the forecasting of another variable and is a failed granger cause if it does not. Two indicators that cause the variable to fail Granger are i) when the lags are not statistically in the equation for another variable and ii) when the past values are not significant in predicting the future value of another. The use of granger causality signifies the forecasting ability rather than the actual causal relationship between two variables.

According to Friston et. al, (2014) link between variable showed from Granger causality test on autoregressive model can become unreliable when underlying dynamics is dominated by unstable model such as present of substantial measurement noise. It is however, Granger causality test is widely employed due to its ability to characterize oscillatory and multivariate data (Patrick et. al, 2017).

According to Le, Thai-Ha and Chang (2011), using the granger causality test, there is causal relationship between rising oil price and the demand for gold that hence pushes up the price of gold price. The same method was used in a study conducted by Zuriyati (2019), where it reveals that the gold price granger causes the oil price. However, the oil price does not granger cause the gold price. The causation is found from the gold price to the oil price and not another way round. Another study conducted in Czech Republic where from Granger Causality testing that have been carried out, it was found out that a change in oil prices precedes the development of gold prices by one month. Causality was not demonstrated in the opposite direction (Stoklasová, 2018). Kumar (2017) on the other hand, in his study, found evidence that there is unidirectional Granger causality from oil prices to gold prices in both short- and long- run. A study carried out by Yap Wai Weng (2011) on relationships between oil prices, gold price and stock indices using the same method proves that the stock market and commodity market are interrelated among each other. He also suggested

that if the policymakers who attempted to stimulate the stock market during stock market crises should consider including the commodity market.

In addition, findings of Granger Causality test in a study of M. E. Bildirici & Turkmen, (2015) proves that in the balanced situation for positive and negative fluctuations in crude oil profit in the short- long run and strong cointegration, there are unidirectional causalities extending from oil profits to gold profits. They also revealed that there is significant causal relationship for gold returns and all three indices employed in the study which are oil price, Islamic and conventional stock market indices.

According to Yahya et al., (2013) as result of granger causality analysis, there was bi-directional causality relationship between the Islamic stock market with oil prices. Gold on the other hand was not causal of the Islamic stock market and vice versa. A variable is a granger cause if it influences in the forecasting of another variable and is a failed granger cause if it does not. Two indicators that cause the variable to fail Granger are i) when the lags are not statistically in the equation for another variable and ii) when the past values are not significant in predicting the future value of another. The use of granger causality signifies the forecasting ability rather than the actual causal relationship between two variables.

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According to Yahya et al., (2013) as result of granger causality analysis, there was bi-directional causality relationship between the Islamic stock market with oil prices. Gold on the other hand was not causal of the Islamic stock market and vice versa. Granger causality is an econometric test that is used to verify the causation of variables and usefulness of one variable to forecast another. The output from this test is either a variable is granger cause or failed to granger-cause another variable.

Granger Causality test starts with:

1. State the null hypothesis and alternate hypothesis.

$$H_0: x(t) \text{ does not granger-cause } y(t)$$

$$H_1: x(t) \text{ granger-causes } y(t) \quad (3.2)$$

2. Choose lags i and j .

3. Find the f- value.

$$y(t) = \sum_{i=1}^{\infty} \alpha_i y(t-i) + c_1 + v_1(t) \quad (3.3)$$

$$y(t) = \sum_{i=1}^{\infty} \alpha_i y(t-i) + \sum_{j=1}^{\infty} \beta_j x(t-j) + c_2 + v_2(t) \quad (3.4)$$

4. Calculate the F- statistics using the equations below.

$$F = \frac{\frac{EES_R - ESS_{UR}}{q}}{\frac{ESS_{UR}}{n-k}} \quad (3.5)$$

5. Reject null hypothesis if the F- statistics is greater than f- value.

2.2.3 Johansen Cointegration Test

Cointegration can be calculated using various methods that have been described in past literature. In this study, we used the Johansen Test to calculate cointegration. Maximum likelihood is used in the Johansen test and its estimation strategy. When there are more than two variables, the test can be used to estimate all cointegration. Besides that, the test facilitates the estimation of all cointegration vectors with multiple variables that may contain at least two cointegration vectors. Time series analysis is used in the Johansen test.

The ADF test is based on an autoregressive model, which regresses a value from a time series on previous values from the same time series. When there are multiple variables, you can still write the relationship between current prices as a linear function of past prices in an autoregressive model, but this model is referred to as the Vector Error Correction Model (VECM). This test is intended to evaluate the existence of cointegration and determine the cointegration between equity returns from various

stock markets and changes in price of gold and crude oil price in the long or short term of period (Vveinhardt et al., 2018). If cointegration is not approved, it clearly shows that there is no long-term relationship between the economic indicators. Cointegration tests are used to see if two variables are highly related to one another and how sensitive they are to a certain average price over a period.

Based on the past study by (Thakolsri, 2021), the findings indicate that all price series in the Thai stock market, foreign exchange market, international gold market, and crude oil market have a significant long-run relationship. The results of the Johansen cointegration test proved the presence of a cointegration relationship, as well as the assumption of a long-term relationship between the commodities studied. It prevents the difficulty of selecting a dependent variable as well as the problems that arise when errors are carried from one step to the next. As a result, the test can detect multiple cointegrating vectors.

According to Stoklasová, (2018), by using the Johansen cointegration test, it proves that there is a relationship between the price of gold and oil over a long period of time. The reason for employing this approach is that some research findings in finance and economics have used this Vector Autoregression (VAR) budgeting method in addition to economic research methods.

Johansen Cointegration test is said to be more powerful than the Granger Causality method due to the accessibility number of variables in the model. Johansen test can estimate the cointegrating relationship of more than two variables compared to Granger test. The Johansen cointegration test is based on the regression parameters test, whereas the Engle-Granger method is based on the residual test. According to Gao et al., (2018), the potential endogeneity of the regressors is not taken into account by the Engle-Granger method because it assumes that one variable is endogenous, and the other is exogenous.

The Johansen cointegration test will be employed in order to determine whether a long run equilibrium exists between gold prices, oil price, and stock market. This method creates cointegration between series of similar orders by constructing a

cointegration equation and can be applied using R. There are two Johansen cointegrating tests: the trace test and the maximal eigenvalue test.

H0 = There is no Cointegration among variables.

H1 = There is Cointegration among variables.

We will reject null hypothesis if the test statistic is bigger than the critical value at 0.05. That means, the cointegration variables have existed in the model. The Johansen testing procedure consists of two general steps:

1. Estimate the Vector Error Correction Model (VECM) model using maximum likelihood under the following conditions:

- Consider with and without a trend.
- Consider with and without a constant.
- With a variable number of cointegrating vectors, k.

2. Using likelihood ratio tests to compare the models.

It is a likelihood ratio test comparing an unrestricted VECM to a restricted VECM with k cointegrating vectors, where k=m-1.

$$\Delta y_t = \Gamma_0 D_t + \Pi Y_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j} + \varepsilon_t \quad (3.6)$$

$t = 1, 2, 3$

Where;

$$\Pi = \sum_{i=1}^p A_{i-1} \quad \text{and} \quad \Gamma_j = \sum_{k=i+1}^p A_{j-1} \quad (3.7)$$

‘ yit ’ = time series of each independent variable,

“ Dt ” = Vector of deterministic variables

Γj = matrices for each differenced lag

$\Pi = \Upsilon A'$ long run impact matrix; A and Υ are $m \times k$ matrices.

“ A ” = coefficient matrix for the first lag

In conclusion, prior research has widely used the correlation analysis and feature engineering methodologies used in this study, indicating their applicability and efficacy in analysing financial datasets. These strategies enable in the discovery of underlying patterns and linkages, which improves the predictive capacity of models used to anticipate financial measures. These methods are reliable, but they also depend on a number of presumptions, including the linearity of relationships and the accuracy of the input data. Thus, in order to get accurate and dependable findings, it is imperative that the data preprocessing stages are carefully carried out.

2.2.4 Autoregressive Distributed Lag (ARDL)

According to Singhal (2019), the ARDL technique provides a number of benefits over the Johansen Cointegration test (Le and Chang, 2016) when examining the long-term relationships between gold prices, stock market prices, and crude oil prices. Besides that, ARDL model established by (M. Hashem Pesaran et al., 2001), who employs an error correction model and a linear transformation to include short-term modifications into the long-term equilibrium. Then, ARDL bound can be employed regardless of whether the study's variables are stationary variables $I(0)$ and non-stationary variables $I(1)$ in same estimation (Othman & Masih, 2018). To perform the ARDL bound test, however, the series must not be $I(2)$. The bound test approach of ordinary least squares may be used to verify cointegration after the model's lag order has been determined (OLS). Lagged variables are employed in the ARDL technique, which helps in avoiding the endogeneity problem.

Roberts and Whited (2013) stated that endogeneity is defined as a cointegration between the explanatory variables and the error term in a regression (Roberts & Whited, 2013). The absence of explanatory factors in the regression that may lead to endogeneity, which would violate a basic element of ordinary least squares (OLS) regression analysis by causing the error term to be correlated with the explanatory

variables. It could also be carried on by one or more explanatory variables that are impacted by the dependent variable, which in turn is influenced by one or more explanatory factors (Abdallah et al., 2015).

M. Ali et al. (2022) tried to develop and compare an ARDL model and a non-linear ARDL model that can examine the relationship between the price of gold, oil, and renewable energy on South African carbon emissions (Ali et al., 2022). According to that article, the study concludes that ARDL is for linear data whereas non-linear ARDL is for non-linear data. The data must first be examined for linearity using a simple regression method, for example, in order to verify linearity. Therefore, the study will use the ARDL model to analyze the cointegration between the gold price since most of our data is linear. The general ARDL (p, q_1, q_2, \dots, q_k) Model is as follows:

$$\Phi(L)y_t = \varphi + \theta_1 L(L)x_{1t} + \theta_2 L(L)x_{2t} + \theta_k L(L)x_{kt} + \mu_t \quad (3.8)$$

The lag polynomial $\Phi(L,p)$ is easily defined by applying the lag operator L to each element of a vector, $L^k y = y_{t-k}$. The ARDL models may be estimated by ordinary least squares as long as the error term μ_t is assumed to be a white noise process, or more specifically, is stationary and independent of x_t, x_{t-1}, \dots and y_t, y_{t-1}, \dots

The ARDL model established by Pasaran et al. (2001) employs an error correction model and a linear transformation to include short-term modifications into the long-term equilibrium (ECM). The gold price model is present as below:

$$y_{it} = \beta_0 + \beta_1 y_{it-1} + \dots + \sum_{n=1}^N \alpha_n \Delta y_{it} + \varepsilon_t \quad (3.9)$$

Where ε_t as random disturbance term or error term.

In conclusion, ARDL may be considered as an appropriate technique to ascertain the link between the variables. Researchers must consider the cointegration relationships between the variables in order to determine which factors contribute to the dependent variable most cointegration. However, there are a few assumptions that

must be considered while using this approach, and it can only predict outcomes reliably for linear processes.

2.3 Gold Price Forecasting Model

The Long Short-Term Memory (LSTM) and Vector Autoregression (VAR) network has been chosen to estimate the price of gold because it has a track record of successfully identifying complicated patterns and long-term dependencies in time series data. Recent research has shown that LSTM and VAR models are more effective in financial forecasting than more conventional methods like ARIMA. A study by (Azreen et al., 2017) stated that VAR model outperform ARIMA model in predicting the economic growth in term of lowest forecasting accuracy measurement. The model provides more precise forecasts than univariate time series models and theory-based, complex simultaneous equation models. VAR model forecasts are extremely adaptable since they can be conditioned on the anticipated future courses of specified variables. The findings from (Fritzer et al., 2002) showed that ARIMAs have smaller forecasting errors at shorter horizons, whereas VARs perform better at longer horizons. Besides that, Phaladisailoed and Naruetharadhol (2019), for example, discovered that LSTM networks outperformed traditional models in their ability to predict gold prices. Furthermore, Kristjanpoller et al. (2021) demonstrated how the integration of several data sources in LSTM model was enhanced by a large margin when sentiment analysis was added. Additionally, Chen et al. (2020) improved the model's ability to capture both short- and long-term trends by combining a hybrid LSTM model with wavelet transformations.

2.3.1 Long Short-Term Memory (LSTM) Model

The effectiveness of long short-term memory (LSTM) networks in time series forecasting has drawn a lot of interest lately, especially in the financial sector where gold price prediction is concerned. LSTM networks are well-suited for forecasting volatile and non-linear financial measures like gold prices due to their distinctive

architecture, which enables them to capture complex patterns and long-term dependencies in time series data.

The accuracy of LSTM networks in gold price predictions has been supported by recent research. For example, Phaladisailoed and Naruetharadhol's (2019) study used LSTM networks to estimate gold prices and discovered that LSTM performed better than more conventional models such ARIMA and exponential smoothing techniques. Their findings showed that LSTM networks may more accurately predict gold prices by efficiently capturing the temporal relationships in the data. In order to improve predicting performance, the study emphasised how important it is to properly preprocess data and choose the right LSTM hyperparameters.

Recent literature has examined further developments in LSTM architectures and their applications in gold price predictions. To increase the precision of gold price predictions, Chen et al.'s 2020 study presented a hybrid model that combines wavelet transform and LSTM networks. The original time series data were broken down into various frequency components using the wavelet transform, and these components were then supplied into the LSTM model. This strategy made it possible for the model to more successfully identify both short- and long-term patterns in the data. In comparison to solo LSTM models and conventional forecasting methods, the hybrid model performed better.

In addition, cutting-edge studies have concentrated on combining sentiment analysis and LSTM networks to improve the predicted gold price. In order to forecast gold prices, a study by Kristjanpoller et al. (2021) included sentiment analysis of social media data and financial news into the LSTM model. In order to increase the predictive power of the model, sentiment scores were added to the other input characteristics in addition to historical gold prices. The findings showed that the addition of sentiment analysis considerably improved forecast accuracy since it offered insightful information about investor behaviour and market sentiment.

On the other hand, Jena et al. conducted an exhaustive investigation in 2022 of several deep learning models, including LSTM, for financial time series forecasting.

According to their research, LSTM models perform consistently better in terms of accuracy and resilience for predicting the price of gold than other deep learning models like GRU (Gated Recurrent Unit) and CNN (Convolutional Neural Network). In addition to investigating hybrid approaches that integrate LSTM with other machine learning techniques, the authors highlighted the need for additional study on enhancing the interpretability and scalability of LSTM models.

In conclusion, the research from 2019 to 2023 gives strong evidence that LSTM networks are exceptionally effective in forecasting gold prices. An effective technique for financial forecasting, LSTM can manage non-linearities in time series data and capture long-term dependencies. Due to recent developments in the field of financial time series forecasting, such as the incorporation of sentiment analysis and hybrid models, LSTM networks are now a preferred option for researchers and practitioners due to their improved predictive accuracy.

2.3.2 Vector Autoregression (VAR) Model

Vector Autoregression (VAR) is a forecasting algorithm that can be utilized when two or more time series influence one another, i.e., when the relationship between the time series is interdependent (Christiano, 2012). In his paper, introduced the VAR model by modelling the causal relationships and joint dynamics of numerous macroeconomic variables. It is said to be one of the most successful and flexible models for the analysis of multivariate time series.

Aydin & Cavdar (2015), use VAR model to test the relationship between different variables to predict financial distress or stock market crashes. (Guglielmo et al., 2013) examines the nature of the relationships between stock market prices and exchange rates in six developed nations which are the US, the UK, Canada, Japan, the euro area, and Switzerland. Muhammad Akbar et al (2019) used VAR model in examining the dynamic linkages among gold price, stock prices, exchange rate and interest rate nexus. All these studies share the same methodology for analysing the relationship between macroeconomic variables.

Taha Abdullah (2022), utilized VAR model in analysing the relationship between time series as well as forecasting the oil price and gold price. In the research of (Rajab et al., 2022) VAR model shows a high level of accuracy in forecasting the spread of the COVID-19 infection. Numerous other fields, such as finance, tourism, and commodity prices, have also utilized vector autoregression.

2.4 Research Gap

Firstly, the research not enough attention to non-linear interactions and multivariate relationships. The complicated and non-linear interactions between various economic indicators, such as the price of crude oil, palm oil, and stock market indexes (both Islamic and conventional), may not have been sufficiently captured by earlier research, which frequently concentrated on univariate time series analysis or more straightforward multivariate models. The complex relationships and time-varying impacts among these variables are often ignored by conventional models like ARIMA or even simple multivariate regression. Further exploration of these multivariate interactions is made possible by the Long Short-Term recollection (LSTM) and Vector Autoregression (VAR) model, which can handle non-linear relationships and recollection of past states. However, the use of LSTM models and VAR to simultaneously analyse the combined impact of these several economic factors on gold prices is still underexplored. This gap highlights the need for research that uses LSTM and VAR capabilities to understand how these variables interact and influence gold prices over time, potentially discovering hidden patterns and better predicting future trends.

Secondly, lack of comprehensive studies comparing with conventional studies Models. Although LSTM and VAR model and other advanced machine learning models have been proposed for financial forecasting, there is a notable lack of comprehensive studies that compare the performance of LSTM and VAR models against traditional econometric models such as the ARDL and GARCH in the context of predicting gold prices that are impacted by crude oil, palm oil, and stock market prices. The majority of research that is currently available either emphasises the overall

superiority of machine learning models or the specific uses of these models without a strong comparative analysis. Therefore, a full comparative analysis would aid in understanding the practical benefits and limitations of LSTM and VAR models in comparison to previous approaches. These studies could give researchers and practitioners significant insight into the selection and use of models by showing scenarios in which LSTM models perform better than traditional models and which points out situations in which traditional models may still be more advantageous because of their well-established theoretical underpinnings and ease of interpretation.

Finally, the studies lack of research on the effects of policy changes and macroeconomic shocks, such as the COVID-19 epidemic, major geopolitical events, or policy changes, have not been thoroughly examined using LSTM and VAR models in regard to how commodities prices and stock markets relate to one another and, in turn, to gold prices. These shocks can cause significant volatility and system disruptions, which traditional models cannot capture. LSTM and VAR models, with their capacity to adapt to shifting patterns and integrate exogenous variables, offer a unique chance to model these effects more effectively. However, there is a lack of research that incorporates macroeconomic shocks and policy changes into the LSTM and VAR framework for forecasting gold prices. To close this gap, models would be developed that not only predict price changes under regular conditions but also respond to extraordinary events, resulting in more flexible and strong forecasting tools. In dynamic economic contexts, this method has the potential to greatly improve the prediction accuracy and dependability of models utilised by policymakers and investors.

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