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The Effects of Crude Oil Prices, Exchange Rates, and Inflation on the Level of Investment in Indonesia

La Ode Saidi

Department of Mathematics, Universitas Halu Oleo, Kendari 93232, Indonesia

***Corresponding author** Email: laodesaidi2023@gmail.com

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Abstract

Purpose: The level of investment in a country can be influenced positively or negatively by factors such as crude oil prices, exchange rates, and inflation, all of which are closely tied to its economic conditions. Therefore, this study aims to examine the long-term and short-term effects and determine the contribution of crude oil prices, exchange rate, and inflation on investment in Indonesia.

Design/methodology/approach: Annual time series data from 1990 to 2023 were utilized to assess the effects. Accordingly, the data were analyzed using an autoregressive distributed lag model, which revealed both the long-term and short-term effects.

Findings: The results obtained from the statistical analysis, carried out using ARDL and ECM-ARDL models, showed that exchange rates had a significant influence on investment in the long term. However, crude oil prices and inflation did not affect investment. The depreciation of the IDR/USD exchange rate also decreased investments. Crude oil prices and exchange rates affected investment in the short term, and were not influenced by inflation. The most significant independent variable impacting investment was the exchange rate, followed by crude oil prices and inflation. The study result is significant because it can be used as a consideration or material for policy decisions by the government. The result provides a quantitative framework that can significantly improve governmental and corporate decision-making processes under macroeconomic uncertainty. This offers a valuable tool for strategic investment planning as a core concern of Decision Sciences.

Practical implications: All the findings in this investigation hold significant policy implications for the government as decision-makers. Accordingly, government decisions related to these policy implications include taking actions such as establishing domestic crude oil price policies and implementing government monetary and fiscal measures to stabilize exchange rates and control inflation, which were considered crucial steps for promoting investment.

Originality/value: This study represents the initial empirical investigation examining the long and short-term influences of the above factors on investment in Indonesia because, based on observation, a similar investigation has not been carried out in Indonesia. Furthermore, it presents a ranking of the contributions of each independent variable (crude oil price, exchange rate, and inflation) to investment, addressing a gap that has not been covered in previous explorations.

Keywords: Crude oil price, exchange rate, inflation, investment, ARDL model.

JEL Classifications: C12, E22, E31, F31.

1. Introduction

Investment is an aspect that has been found to play a crucial role in fostering economic development and growth, with the primary aim of enhancing the quality of life within communities, particularly in developing countries (Wale, 2015). Given its importance, investment has drawn significant attention from academics and policymakers. Presently, numerous studies have reported factors affecting finance in a limited manner (Čipčić, 2021), including political economics (Mizutani & Tanaka, 2010), economic growth, and interest rates (Diabate, 2016), as well as inflation and exchange rates (Ayeni, 2020). Accordingly, this study focuses on crude oil prices, inflation, and exchange rates as factors that can significantly influence investment.

According to previous research, crude oil plays a critical role in the global economy, serving as an indispensable energy source required by all nations for various purposes such as generating electricity, powering machinery in production industries, and fueling vehicles (Adam, et al., 2018b; Yin & Yang, 2023). Considering the significance of this commodity, fluctuations in its prices can exhibit a significant influence on several other economic activities. In this regard, numerous previous studies have explored the repercussions of crude oil price changes on various macroeconomic variables. These variables comprised economic growth (Elneel & Almulhim, 2022), inflation (Aharon, et al., 2023), poverty rates (Adam, et al., 2018a), unemployment levels (Wang, et al., 2022), company investments (Wu & Wang, 2021), and stock prices (Gohar, et al., 2022). Regarding the impact of crude oil prices on investment, Wu and Wang (2021) asserted that the effect leaned negatively when observed through the lens of the cash flow channel theory. By this theory, crude oil functions as a production factor, and thus, when its prices surge, production costs rise, leading to a subsequent reduction in investment. This consequence has been particularly pronounced in countries heavily reliant on oil imports. However, crude oil prices can positively influence investment from the perspective of the sentiment channel theory. According to this theory, a positive market sentiment can spur company managers to engage in more investment activities.

Investment dynamics are intricately influenced by exchange rates and inflation, generating either advantageous or detrimental outcomes. As posited by financial perspectives, the depreciation of the domestic currency can potentially diminish investment activities. However, trade-oriented viewpoints assert that this depreciation can stimulate exports and investments (Banerjee, et al., 2022). The nexus between exchange rates, inflation, and investment finds explication in alterations to interest rates. By the tenets of the uncovered interest rate parity theory, domestic currency depreciation may precipitate an elevation in domestic interest rates (Pilbeam, 2023). The central bank, in response, may subsequently decide to increase domestic interest rates to curtail inflation exceeding anticipated levels (Muthalib, et al., 2025; Rosnawintang, et al., 2021). It is essential to establish that this augmentation in interest rates can invariably amplify the cost of capital, thereby exerting a diminishing effect on investment, as observed in the works of Wuhan and Adnan (2015) and Saidi, et al. (2019). Despite these disadvantages, an escalation in interest rates can also positively impact investment, particularly in developing nations. According to a previous study, this affirmative impact materializes when access to foreign financing for numerous projects is constrained, necessitating reliance on domestic savings, as discussed by Greene and Villanueva

(1990). The government should carefully consider the policy decision to increase domestic interest rates because, according to Sethi, et al. (2018), low inflation can also increase unemployment rates.

The study on the influence of crude oil prices, exchange rates, and inflation on investment using the ARDL analysis model is a compelling topic. This is mainly because its results can inform policy decisions and offer valuable empirical contributions to the existing body of literature. This exploration contributed significantly to the existing literature on the subject matter in three key ways: (1) It offered insights by investigating both the long and short-term impacts of crude oil prices on investment, (2) It enhanced the analysis model by incorporating inflation variables, which are potential determinants of investment, to mitigate estimation biases, (3) The study utilized the ARDL model, which provided a distinct advantage as it accommodates variables with differing orders of integration, a feature not found in other analytical models and (4) It utilized domain analysis to determine the ranking of each independent variable.

In recent decades, numerous studies have explored the impact of crude oil prices on various economic indicators, including economic growth and stock prices. However, relatively limited academic attention has been dedicated to examining the relationship between crude oil prices and investment (Chen, et al., 2020), with significant exceptions such as the work of Chen, et al. (2022) and Evans (2023).

Previous investigations have often relied on analytical models such as multiple regression, traditional panel data, or dynamic panel data. However, these models could not fully unveil the long-term and short-term effects of crude oil prices on investment. Based on observations, studies on the long-term and short-term effects of crude oil prices, exchange rates, and inflation on investment are still rare. This was evidenced by the literature review, where only two studies were found to have explored the subject matter, one of which was conducted by Mallick, et al. (2017) in India and another by Čipčić (2021) in Croatia.

Furthermore, to the best of my knowledge, there was no existing research to comprehensively uncover the long-term and short-term effects of crude oil prices on investment within the specific context of Indonesia. Therefore, the present study represents the first of its kind in the country. It is also important to establish that, unlike previous literature, the report provides a ranking of the contributions of crude oil prices, exchange rates, and inflation to investment. This analysis has not been conducted before.

Besides crude oil prices as the primary independent variable, exchange rate and inflation variables were considered as the controls. This addition aimed to prevent estimation bias in data analysis (DATAtab-Team, 2025). Furthermore, the addition of these two variables is also known to be important for their impact on investment.

As a developing nation, Indonesia relies heavily on crude oil as a vital commodity for its economic advancement. Despite being an exporter of crude oil, this nation was still classified as a net importer (Wang, et al., 2013a). This import activity was considered necessary primarily because the domestic production rate fell short of meeting the domestic demands. Based on this understanding, it can be seen that any fluctuations in crude oil prices can substantially impact the nation's macroeconomic variables. Therefore, the questions addressed during the study were formulated as follows: (1) Do crude oil prices, exchange rates, and inflation affect long-term and short-term investment? (2) What is the ranking of the contributions of each independent variable to investment? In relation to the formulated questions, the primary objective of this study was to examine the enduring and immediate effects of crude oil prices, exchange rates, and inflation on investment within Indonesia. It also aims to determine the ranking of the contribution made by each variable to investment. Therefore, the results are expected to provide quantitative insights, enhancing decision-making processes related to government and corporate policies in dynamic macroeconomic conditions. In addition, valuable tools are provided for strategic planning as a central focus of decision science.

The study was structured as follows. The second section provided an overview of pertinent findings from previous research, while the third explored the methodology and data utilized. Accordingly, the fourth section provided a detailed discourse of the results and their implications, and the fifth section presented the conclusion.

2. Literature Review

2.1. Theoretical Framework

According to the sentiment theory, crude oil prices can positively impact investment in oil-importing countries. According to this theory, a positive market sentiment can spur company managers to engage in more investment activities (Wu & Wang, 2021). Another theory is the wealth transfer effect. According to this theory, crude oil exports lead to a transfer of wealth from oil-importing to oil-exporting countries. This reduces purchasing power and increases global savings supply, lowering interest rates and improving investment (Brown & Yucel, 2002; Dogrul & Soytas, 2010).

The effects of exchange rates and inflation on investment can be examined through the domestic interest rate channel. According to the interest rate parity theory, a depreciation in the domestic exchange rate raises the corresponding interest (Pilbeam, 2023). An increase in interest rates increases the cost of capital and reduces investment. Meanwhile, a country's central bank enhances domestic interest rates to suppress inflation through monetary policy when the concept rises beyond a predetermined threshold. In developing countries, interest rates can increase investment when access to foreign financing is inadequate (Greene & Villanueva, 1990).

2.2. Review of Relevant Previous Empirical Research

Crude oil is a crucial commodity in the global economy. Apart from serving as a raw material for power plants, production machinery, and transportation equipment (Adam, et al., 2018a; Yin & Yang, 2023), this natural resource also acts as a benchmark asset in derivative markets, including spot oil and futures oil trading. It is important to comprehend that long-term increases in crude oil prices, particularly in spot and futures markets, have gained significant attention among academics (Lean, et al., 2010), as these price changes can influence investor preferences or sentiment towards investing (He, et al., 2019) and affect macroeconomic variables (Alekhina & Yoshino, 2018). For instance, Hamilton (1983) pioneered studying the impact of crude oil prices on macroeconomic variables, explicitly focusing on output, unemployment, money supply (M1), workers' compensation, and import prices in the United States. Based on observations, the work of Hamilton has inspired subsequent studies by more recent scholars, including Yıldız, et al. (2021) and Mukhamediyev, et al. (2024). It has also facilitated various studies on investor preferences concerning the risks associated with rising oil prices, where crude oil served as the underlying asset for oil spots and futures. Some of these studies include Wang and Wissel (2013) and Lean, et al. (2015).

In the context of the relationship between crude oil prices and investment, several empirical studies have explored the impact of crude oil prices on investment in various countries. For instance, Drakos and Konstantinous (2012) investigated Greece, Mallick, et al. (2017) examined India, Kandemir Kocaaslan (2021) focused on Turkey, and Wu and Wang (2021) explored China. Drakos and Konstantinous (2012) utilized a random effect panel model with data from 21 manufacturing industry companies in Greece from 1994 to 2005. This investigation found that an increase in crude oil prices led to a decrease in investment. Conversely, Mallick, et al. (2017) adopted an ARDL model to analyze annual time series data from 1980 to 2014 in India, and their results suggested that crude oil prices positively influenced domestic investment in the long term but had no short-term impact. Kandemir Kocaaslan (2021), in the case of Turkey, used quarterly time series data from 1998:q1 to 2019:q2 and the model developed by Kilian and Vigfusson (2011). The obtained results from this endeavor indicated that rising crude oil prices were associated with decreased investment. Furthermore, Wu and Wang (2021) conducted their research in China by analyzing time series data from 2000 to 2018 using a panel data model. Their findings showed that crude oil prices positively impacted company investment.

Currency, particularly foreign currency, including the US Dollar, is a critical medium of exchange in international trade, including in goods, capital, and derivatives markets (Rumbia, et al., 2023). Typically, fluctuations in exchange rates can significantly impact prices and investor preferences across all market types, making this a key area of interest for academics and policymakers. The study results can inform policy decisions regarding exchange rate stabilization. Several investigations have explored the relationship between exchange rate fluctuations and various economic and financial variables, including those conducted by Tang, et al. (2016), Archer, et al. (2022), Imane, et al. (2023), and Maydybura, et al. (2023).

In the context of the relationship between exchange rates and investment, Golberg (1993), on the other hand, adopted an error correction model to scrutinize the impact of exchange rates on investment in the United States. Using quarterly time series data spanning from 1970. I went to 1989.IV, the study showed that a depreciation in the USD exchange rate correlated with a decrease in investment. Harchaoui, et al. (2005) performed an investigation that centered on the impact of exchange rates on investment in Canada. The research included the participation of 22 manufacturing companies and utilized time series data from 1981 to 1997. In this regard, the results obtained using a panel data model indicated that the depreciation of domestic exchange rates positively affected investment. Sadath and Acharya (2022) also explored the relationship between domestic exchange rates and investment in India, utilizing a sample of 863 companies. A dynamic panel data model was adopted for the analysis, and their findings revealed that the effect of exchange rates was positive when considered through the export channel but negative when assessed through the import channel.

Multiple studies have also investigated the impact of inflation on company investment, offering insights into this relationship. For instance, Binz, et al. (2023) conducted a study using annual time series data from 2004 to 2015. Their sample consisted of one company from each of the 21 countries under examination. Through a panel data regression model, it was found that inflation exhibited a positive effect on company investment. Similarly, Farooq, et al. (2023) extended this exploration to six countries within the Gulf Cooperation Council (GCC). By employing a panel data model, their results indicated that inflation also positively influenced company investment within these nations. Following this, Bambe (2023) investigated the influence of inflation targets on domestic investment across a global dataset of 62 countries spanning from 1990 to 2019. The investigation included using a proxy variable for inflation targets and a panel data model, which showed a positive influence of inflation on domestic investment. This positive relationship between these two variables was also observed by Swift (2006) in Australia. The analysis in this regard was conducted using annual data from 1988 to 2001, and the findings revealed a similar trend in which inflation positively impacted investment.

Numerous investigations have also concentrated on the interplay between exchange rates, inflation, and private or domestic investment, offering valuable insights into these dynamics. For instance, Wale (2015) scrutinized the impact of exchange rates and inflation on private investment in Ethiopia. The exploration utilized annual time series data spanning from 1980 to 2014. The results derived from a multiple regression model revealed that domestic exchange rates did not significantly influence private investment, whereas inflation had a positive effect. Similarly, Ayeni (2020) explored the determinants of domestic investment in Gambia, explicitly focusing on exchange rates and inflation. The exploration utilized an ARDL model to analyze time series data spanning from 1980 to 2019, and the findings emphasized that both exchange rates and inflation positively influenced domestic investment. In this context, a depreciation of the exchange rates of the domestic currency relative to foreign currencies and an increase in inflation were associated with increased domestic investment. Accordingly, Abate (2016) explored the effects of exchange rates and inflation on domestic investment in Ethiopia. The investigation included annual time series data from 1971 to 2014, which was analyzed using a VAR model. The obtained results demonstrated that the depreciation of the exchange rates of the domestic currency positively impacted investment. At the same time, an increase in inflation was associated with decreased investment.

3. Data and Methodology

3.1 Data

This study included analyzing time series data from 1990 to 2023. The data comprised four fundamental components, namely crude oil prices (measured in USD per barrel), IDR/USD exchange rates (a proxy for exchange rates, measured in IDR per USD), the consumer price index (acting as a proxy for inflation), and investment (proxied by total investment in sectors such as energy, transportation, communication, technology, water, and sanitation, measured in USD). The four time series data sets for crude oil prices, exchange rates, inflation, and investment are raw. The World Bank serves as the source for the IDR/USD exchange rate, consumer price index, and investment. The crude oil price data sources are the Energy Information Administration (EIA).

This study comprised four variables to accommodate the raw data, namely one dependent and three independent variables. The dependent variable is investment, while the independent variables include crude oil prices as the main variable, and exchange rates and inflation as control variables. The investment and exchange rate variables capture investment time series data and IDR/USD exchange rate data. The inflation and crude oil price variables record inflation data over time and the crude oil price time series, respectively. Therefore, the unit of measurement for the investment, exchange rate, and crude oil variables includes USD, IDR/USD, and USD per barrel, respectively. The unit of measurement for the inflation variable is a percentage when the index in the base year is 100%.

3.2 Data Transformation

Data transformation is a mathematical method for modifying data. This variable aims to (1) detect and eliminate outliers, (2) reduce value variation (Ramachandran & Sokos, 2021; Shintani, 2014), and (3) eliminate multicollinearity in the regression model (Gujarati & Porter, 2010). This section explains the transformation of raw data containing four variables, namely investment, crude oil prices, exchange rates, and inflation.

A mathematical method used to detect outliers is by calculating the z-score values. The lower and upper limits of the z-scores were set at -3 and +3, respectively (Ramachandran & Sokos, 2021; Yaro, et al., 2023). The results showed that only the investment data contained outliers. These outliers were removed using the winsorization method. Since the sample size, or number of observations, was only 34 in 2000 and 2020, there was no investment activity in the sectors of energy, transportation, information and communication technology, water, and sanitation. Therefore, the lower and upper limits of the Winsorization method were selected at the 10th and 90th percentiles, respectively (Reifman & Keyton, 2010).

To minimize variation, all time series data on crude oil prices, exchange rates, inflation, and investment were transformed using the natural logarithm. The next step was to check for multicollinearity using the Pearson correlation coefficient between the independent variables, namely crude oil prices, exchange rates, and inflation. Gujarati and Porter (2010) stated that two independent variables in a regression model did not have multicollinearity when the absolute value of the Pearson correlation coefficient was less than or equal to 0.8. The results showed that the correlation coefficient between the exchange rate and inflation was 0.9. This suggested multicollinearity because the correlation coefficient was greater than 0.8. The next step was to eliminate multicollinearity symptoms using the difference method as stated by Maddala (2001). The subsequent difference transformations were reported by OIL, EXC, INF, and INV for crude oil prices, exchange rates, inflation, and investment, respectively. Therefore, OIL, EXC, INV, and INV represent the change variables.

3.3 Methods

This study utilized the Autoregressive Distributed Lag (ARDL) model and the Error Correction Model for ARDL (ECM-ARDL). The ARDL model was selected primarily because of its distinct advantages over other time series models, such as the capability to offer the required flexibility to handle variables of order 0 or 1 integration and the ability to examine both short and long-term effects of independent variables on the dependent variable (Imane, et al., 2023). Accordingly, the ARDL model has been observed to address the limitations of traditional models, such as linear regression (Noman, et al., 2023). Based on this observation, several scholars, including Jaiswal (2023), prefer the ARDL model to test the' long-term and short-term effects of independent variables on dependent variables.

As defined in Subsection 3.2, the variables OIL, EXC, INF, and INV represent crude oil prices, exchange rates, inflation, and investment, respectively. These four variables were change variables. It is important to state that these four variable notations were used in formulating the ARDL model. According to Koop (2006), when there is multicollinearity between independent variables, the influence analysis can use the ARDL model involving variables in its differences. The ARDL model, denoted as ARDL (p, q, r, s), with time lag lengths specified as p, q, r, and s, is expressed using the equation proposed by Pesaran and Shin (1999) as follows:

$$INV_t = C_0 + \sum_{i=1}^{p} \theta_i INV_{t-i} + \sum_{j=0}^{q} \alpha_j OIL_{t-j} + \sum_{k=0}^{r} \beta_k \, EXC_{t-k} + \sum_{l=0}^{s} \gamma_l \, INF_{t-l} + \varepsilon_t \, , \qquad (1)$$

where C_0 , $\theta_i \; (i = 1, \; 2, \ldots, p)$, $\alpha_j \; (j = 0, \; 1, \ldots, q)$, $\beta_k \; (k = 0, \; 1, \ldots, r)$ and $\gamma_s \; (s = 0, \; 1, \ldots, s)$ represent the parameters of the ARDL equation, and ε_t denotes the residual. The residual of the ARDL model in Equation 1 was assumed to follow specific criteria, including normal distribution, no autocorrelation, and homoscedasticity. Furthermore, it was also assumed that all variables were stationary at the first difference and not stationary at the second. Precisely, the independent variables adhered to the assumption of strict exogeneity. In this regard, Equation 1 was utilized to test the long-term effects of crude oil prices, exchange rates, and inflation on investment. Equation 1 represents an ARDL model without a *t* trend, and within this context, the information criteria used to determine the length of the time lag p, q, r, and s is the Akaike Information Criterion (AIC), expressed as $= -\frac{2l}{T} + \frac{2k}{T}$, where k is the number of regression equation parameters, T is the number of observations, and l is the log likelihood (IHS Markit, 2022). Furthermore, the ARDL model specified by Equation 1 satisfies the linearity assumption (Mamun, 2025). The model explains the relationship between independent variables, namely crude oil prices, exchange rates, and inflation, with the dependent variable including investment (Naufal, et al., 2025; Shin, et al., 2014).

Define the L^i operator for the variables INV, OIL, EXC, and INV with $L^i INV_t = INV_{t-i} \; (i = 1, 2, \ldots, P)$, $L^j OIL_t = OIL_{t-j} \quad (j = 1, 2, \ldots, q)$, $\quad L^k EXC_t = EXC_{t-k} \; (k = 0, 1, \ldots, r)$, and $L^l INF_t = INF_{t-l} \; (l = 0, 1, \ldots, s)$, then Equation 1 can be written as Equation 2 as follows:

$$\theta(L)INV_t = C_0 + \alpha(L)OIL_t + \beta(L)EXC_t + \gamma(L)INF_t + \varepsilon_t, \quad (2)$$

where $\theta(L) = 1 - \sum_{i=1}^{p} \theta_i L^i$, $\alpha(L) = \sum_{j=0}^{q} \alpha_j L^j$, $\beta(L) = \sum_{k=0}^{r} \beta_k L^k$, and $\gamma(L) = \sum_{l=0}^{s} \gamma_l L^l$ are the polynomial functions of L. These polynomial functions are stationary, inferring that the changes in the price of crude oil, exchange rate, and inflation rate have long-term influences on the investment with coefficients of:

$$a = \frac{\alpha(1)}{\theta(1)} = \frac{\sum_{j=0}^{q} \alpha_j}{1 - \sum_{i=1}^{p} \theta_i}, \quad (3.1)$$

$$b = \frac{\beta(1)}{\theta(1)} = \frac{\sum_{k=0}^{r} \beta_k}{1 - \sum_{i=1}^{p} \theta_i}, \quad (3.2)$$

$$c = \frac{\gamma(1)}{\theta(1)} = \frac{\sum_{l=0}^{s} \gamma_l}{1 - \sum_{i=1}^{p} \theta_i}, \quad (3.3)$$

where the coefficients $a, b,$ and c are the long-term coefficients of crude oil price, exchange rate, and inflation rate, respectively. Therefore, for example, an increase of one unit (IDR/USD) in crude oil price will lead to change in the investment by a= $\frac{\alpha(1)}{\theta(1)}$ USD (Hassler & Wolters, 2006; Heij, et al., 2004; Pesaran, 2015).

The issue of spurious relationships between independent and dependent variables in regression models has long been a concern across various research. For instance, Granger and Newbold (1974) pioneered research on spurious regression models, which were subsequently explored by other scholars, including Ghouse, et al. (2018, 2021), Cheng, et al. (2021, 2022), Ghouse, et al. (2024), Wong, Cheng, and Yue (2024), Wong, Pham, and Yue (2024), Wong and Yue (2024), and Wong and Pham (2022a,b, 2023a,b, 2025a,b). According to the studies, spurious regression can arise in models that use either non-stationary time series data (Granger & Newbold, 1974) or stationary time series data under certain conditions (Wong, Cheng, & Yue, 2024). Dissimilar to these results, Cheng, et al. (2021) reported that non-stationary data did not usually lead to spurious regression.

The ARDL model is an econometric tool designed to address the issue of spurious regression (Ghouse, et al., 2018). This model typically comprises testing the stationarity of all variables and examining the integration between independent and dependent variables, as outlined in the econometric literature published by Ghouse, et al. (2021). According to previous research, spurious regression becomes insignificant when the independent variables are cointegrated with the dependent variables (Koop, 2006). In the ARDL model, regressors can be stationary either at the first difference I(1), level I(0) (Pesaran & Shin, 1999), or a combination of I(0) and I(1) (Pesaran, et al., 2001). Additionally, the dependent variable may be stationary either at the level I(0) or at the first difference I(1) (Sam, et al., 2019). In cases where all variables in Equations 1 and 2 are I(1) processes or stationary at the first difference, then the error $\varepsilon_t = INV_t - aOIL_t - bEXC_t - cINF_t$ should be I(0) or stationary at the level. Following this rule, the estimated coefficients in Equations 3.1, 3.2, and 3.3 did not show any spurious regression results (Bhatta, et al., 2020; Gujarati, 2004). Typically, assessing whether a model suffers from spurious regression includes testing the stationarity of its residuals. This stationarity check can be performed on the residuals from Equation 1 (Koop, 2006) or on the residuals from the long-term linear regression model in Equation 2 (Philips, 2022).

OIL, EXC, and INF have a long-term relationship (cointegration) with INV when the notations are all stationary at a level or integrated I(0). However, a cointegration test needs to be conducted when some variables are not stationary at the level or integrated I(0) (Koop, 2006). The long-term coefficients are expressed by Equations 3.1, 3.2, and 3.3, while the short-term coefficients are given by Equation 5 (Heij, et al., 2004). Following the determination of the influence of change, the long-run cointegration relationship between crude oil prices, exchange rates, and inflation with investment was tested using the ARDL Bound cointegration model with the following equation (Kripfganz & Schneider, 2023; Pesaran, et al., 2001):

$$\Delta INV_t = C_0 + \sum_{i=1}^{p-1} \theta_i \Delta INV_{t-i} + \sum_{j=0}^{q-1} \alpha_j \Delta OIL_{t-j} + \sum_{k=0}^{r-1} \beta_k \Delta EXC_{t-k} + \sum_{l=0}^{s-1} \gamma_s \Delta INF_{t-s} + \tau_1 OIL_{t-1} + \tau_2 EXC_{t-1} + \tau_3 INF_{t-1} + \tau_4 INV_{t-1} + \varepsilon_t, \quad (4)$$

where τ_i $(i = 1, 2, 3, 4)$ in Equation 4 represents the parameters. The symbol Δ preceding the variables indicated the differencing operation with $\Delta INV_t = INV_t - INV_{t-1} = INV - INV(t-1)$.

Furthermore, the hypotheses used to test cointegration are as follows: the null hypothesis H_0: $\tau_1 = \tau_2 = \tau_3 = \tau_4 = 0$ versus the alternative hypothesis H_1: $\tau_1 \neq \tau_2 \neq \tau_3 \neq \tau_4 \neq 0$. It is important to clarify that crude oil prices, exchange rates, and inflation would be considered cointegrated with investment if H_1 is accepted. In this regard, the criteria for accepting H_1 include when the F-statistic is greater than the upper bound critical value I(1) at a significance level of 1%, 5%, or 10%. Narayan (2005) stated that the F test had a non-standard F distribution where the critical values depended on (a) integrated I(0) or I(1), (b) the number of independent variables, (c) intercept or trend, and (c) sample size.

The short-term effects of crude oil prices, exchange rates, and inflation on investment were examined using the Error Correction Model for ARDL (ECM-ARDL(p-1, q-1, r-1, s-1)) as follows (Hassler & Wolters, 2006; Kripfganz & Schneider, 2023):

$$\Delta INV_t = C_0 + \sum_{i=1}^{p-1} \theta_i^* \Delta INV_{t-i} + \sum_{j=0}^{q-1} \alpha_j^* \Delta OIL_{t-j} + \sum_{k=0}^{r-1} \beta_k^* \Delta EXC_{t-k} + \sum_{l=0}^{s-1} \gamma_l^* \Delta INF_{t-s} + \alpha_0 \Delta OIL_t + \beta_0 \Delta EXC_t + \gamma_0 \Delta INF_t - \pi EC_{t-1+} \varepsilon_t, \quad (5)$$

where θ_i^*, α_j^*, β_k^*, and γ_l^* are parameters, and π is the error correction coefficient of the error correction variable EC_{t-1}. Variable EC_{t-1} satisfies the equation $EC_{t-1} = INV_{t-1} - aOIL_{t-1} - bEXC_{t-1} - cINF_{t-1}$, where the coefficients a, b, and c are expressed by Equations 3.1, 3.2, and 3.3, and the coefficient $\pi = \alpha(1) = \sum_{j=0}^{q} \alpha_j$. Furthermore, the coefficients θ_i^*, α_j^*, β_k^*, and γ_s^* in Equation 5 can be expressed by the coefficients in Equation 1, namely $\theta_i{}^* = -\sum_{i=1}^{p}\theta_i\,,\alpha_j{}^* = -\sum_{j=1}^{q}\alpha_j\,,\ \beta_k{}^* = -\sum_{k=1}^{r}\beta_k$ and $\gamma_l{}^* = -\sum_{l=1}^{s}\gamma_l$ (Kripfganz & Schneider, 2023; Pesaran, 2015). The coefficients a, b and c can also be referred to as long-term multiplier effects of crude oil prices, exchange rates, and inflation on investment (Heij, et al., 2004).

According to the ARDL model, the effect test comprised several sequential steps. First, it checked the stationarity of four variables: crude oil prices, exchange rates, inflation, and investment. This assessment used the Augmented Dickey-Fuller (ADF) test with the following equation (Fuller, 1976).

$$Y_t = \varphi + \varphi_1 t + \rho Y_{t-1} + \sum_{j=2}^{p}\vartheta_j\left(Y_{t-j+1} - Y_{t-j}\right) + e_t, \quad (6)$$

where $\varphi,\ \varphi_1, \vartheta_1,\ \theta_j\ (j = 2, 3, \ldots, p)$ are the parameters of the equation, and e_t is the residual at time t, which is usually distributed with mean 0 and standard deviation σ^2. The variable Y_t in Equation 6 represents the four observed study variables, namely INV, OIL, EXC, and INF in Equations 1, 2, 4, and 5. Accordingly, to determine whether Y_t is stationary, the significance of the coefficient ρ was tested. The ADF test hypothesis showed that $H_0: \rho = 0$ (Y_t is not stationary) while the alternative hypothesis indicated $H_1: \rho < 0$ (Y_t is stationary). Based on predefined standards, the criteria for the ADF test include, Y_t must be stationary (hypothesis H_1 is accepted), and this is only possible if the p-value of the ADF test is less than the selected significance level of 1%, 5%, or 10% (Asteriou & Hall, 2011). To test the stationarity of the residuals from Equations 1 and 2 and to assess potential spurious relationships between oil prices, exchange rates, inflation, and investment, the regression model specified in Equation 5 was utilized, followed by the application of the ADF test.

The second step includes testing the long-term and short-term effects of crude oil prices, exchange rates, and inflation on investment. The OIL, EXC, and INF variables' cointegration was first tested with INV using the cointegration model formulated in Equation 4 to determine long-term effects. As previously explained, OIL, EXC, and INF are considered to be cointegrated with INV if the coefficients τ_1, τ_2, τ_3 and τ_4 are significant at the significance level of 1%, 5%, or 10%. The statistical decision on this significance is that crude oil prices, exchange rates, and inflation have a long-term relationship with investment. To determine the significance of the relationship, it becomes necessary to test the significance of long-term coefficients *a*, *b*, and *c* in Equations 3.1, 3.2, and 3.3, after which, short-term coefficients are obtained by estimating the error correction coefficients of the ECM-ARDL model in Equation 4.

After parameter estimation, the assumptions of the residuals, specifically examining normality, autocorrelation, and homoscedasticity, were evaluated through the Jarque-Bera (JB), Breusch-Godfrey Serial Correlation LM (BGSCLM), and ARCH tests. The JB test statistic showed an asymptotic Chi-Square distribution with degrees of freedom 2. Based on this observation, the JB hypothesis was formulated as H_o, meaning that the residuals are normally distributed, dissimilar to the alternative hypothesis H_1. By the test criterion utilized in a previous study, the hypothesis H_o is accepted if the p-value of the test statistic is greater than the significance level (1%, 5%, or 10%) (Thadewald & Buning, 2007). Subsequently, the Breusch-Godfrey Serial Correlation LM (BGSCLM) test statistic was developed by regressing the e_t residuals on Equation 1 using AR(p) with p>1. The BGSCLM test statistic follows an asymptotic Chi-Square distribution with p-1 degrees of freedom. The test hypothesis for the BGSCLM is that H_o: Residuals do not have autocorrelation, while the alternative hypothesis H_1: considers residuals to have autocorrelation. The criterion for the BGSCLM test statistic includes the rule that the hypothesis H_o is only accepted if the p-value of this test statistic is greater than the significance level (1%, 5%, or 10%) (Heij, et al., 2004). Following the BGSCLM test, the Arch test statistic was developed using the ARCH(L) model, where L represents the length of the time lag. Based on predefined standards, if R^2 is the coefficient of determination of the ARCH(L) regression equation, and T is the sample size (number of observations), then the Arch test statistic is TR^2. The Arch test statistic has an asymptotic Chi-Square distribution with degrees of freedom L. The test hypothesis in this regard is $H_o,$ indicating that residuals are homoscedastic. The criterion for the test is that if the p-value of this test statistic is greater than the significance level (1%, 5%, or 10%), then the hypothesis H_o is accepted (Engle, 1982).

In the statistical or econometric literature, HWBZ (Hui, et al., 2017) and the Ramsey Reset tests have been developed to assess the linearity assumption in regression models. The linearity test uses the Ramsey Reset test with an F distribution. The hypothesis formulation for this test is H_0: The model is linear versus the alternative hypothesis H_1: The model is non-linear. Based on the F-statistic criteria, the model is linear or meets the linearity assumption when the p-value is greater than the significance level (1%, 5%, or 10%).

Subsequently, the exogeneity assumption of the independent variables was also examined using the Durbin-Wu-Hausman test (DWH). The DWH test uses the J-statistic, which follows a Chi-square distribution with degrees of freedom equal to the number of independent variables in the ARDL model (denoted as p). According to a previous study, the hypothesis test formulation of H_o: OIL, EXC, and INF were observed to be exogenous against the alternative hypothesis H_1: $\text{OIL, EXC, and INF,}$ which were endogenous (Davidson & Mackinnon, 1993). Lastly, the stability of the long-term parameters of the ARDL model using the CUSUM (Cumulative Sum) and CUSUM Square tests was assessed (Brown, et al., 1975).

Furthermore, the assumption of multicollinearity among independent variables in the ARDL model was checked using the Variance Inflation Factor (VIF) with an established criterion. This criterion includes that independent variables do not have multicollinearity if VIF ≤ 10 (Moore, et al., 2011). In addition, the assumption of multicollinearity between independent variables is checked using the Pearson correlation coefficient criterion. A total of two independent variables is said to have no multicollinearity when the absolute value of the correlation coefficient is less than or equal to 0.8 (Gujarati & Porter, 2010).

This study additionally presents an analysis of the individual contributions of each variable, namely crude oil price (OIL), exchange rate (EXC), and inflation (INF), to the investment variable (INV). The analytical methodology used is dominance analysis, as developed by Budescu (1993). Dominance analysis uses the R-square coefficients between combinations (i) without predictors (only constant C where R-square=0), (ii) OIL, (iii) EXC, (iv) INF, (v) OIL and EXC, (vi) OIL and INF, (vii) EXC and INF, and (viii) OIL, EXC, and INF. To calculate the average contribution of each variable, OIL, EXC, and INF, for example

$X_1 = \text{OIL}$, $X_2 = \text{EXC}$, $X_3 = \text{INF}$ and Y=INV, then the additional contribution of X_i $(i = 1, 2, 3)$ for k (k=0, 1, 2), additional variables from combinations (i) to (vii) are $C_{X_i}^{(k)}$ that satisfies Equation 7 (Budescu, 1993).

$$C_{X_i}^{(k)} = \sum \frac{\left(R_{Y.X_iX_h}^2 - R_{Y.X_h}^2\right)}{\binom{p-1}{k}}, \tag{7}$$

where X_h denotes one of the predictors replacing the predictor X_i, which was omitted from the combination of variables (i) to (vii), and p is the number of predictor variables. The contribution of each predictor variable X_i $(i = 1, 2, 3)$ is calculated by Equation 5 (Budescu, 1993).

$$C_{X_i} = \sum_{k=0}^{p-1} \frac{C_{X_i}^{(k)}}{p}, \tag{8}$$

where $C_{X_i}^{(k)}$ is expressed by Equation 7 with p=3. The total contribution of the three variables X_i $(i = 1, 2, 3)$ is equal to the coefficient of determination $R_{Y.X_1X_2X_3}^2$ from the combination of predictor variables in (vii), hence $R_{Y.X_1X_2X_3}^2 = \sum_{j=1}^{p} C_{X_j}$ is the total collective contribution of crude oil price, exchange rate, and inflation to investment from 1990 to 2023.

4. Results and Discussion

4.1 Results

Table 1 presents a comprehensive analysis of the four variables: crude oil price, exchange rate, inflation, and investment. The standard deviation of all four variables is small, indicating low volatility. The p-values for investment and crude oil price were greater than the 5% significance level, implying that these three variables followed a normal distribution. However, it was important to state that exchange rates and inflation did not follow a normal distribution.

Table 1. Descriptive statistics

Types of statistical measures	INV	OIL	EXC	INF
Mean	0.0818	0.0349	0.0640	0.0786
Median	0.0000	0.0409	0.0399	0.0619
Maximum	6.24318	0.5538	1.2360	0.4603
Minimum	-3.9867	-0.6496	-0.2428	0.0155
Std. Dev.	2.3288	0.2675	0.2279	0.0770
Jarque-Bera	0.7686	1.13940	630.74	466.3638
P-value	0.6809	0.5655	0.0000	0.0000
Observations	33	33	33	33

Note: INV=Investment, OIL=crude oil price, EXC=exchange rate, INF=Inflation

The initial data analysis phase included the Augmented Dickey-Fuller (ADF) test to assess the stationarity of the four key variables, namely crude oil prices, exchange rates, inflation, and investment, and the results are presented in Table 2. The Intercept column describes the statistical values of the ADF test using Equation 6 without a trend, while the intercept and trend column shows the estimated values of the test when a trend is included.

Table 2. ADF test

Variable	**Intercept**	**Intercept and trend**
OIL	-5.5228*	-5.4207*
ΔOIL	-7.8502*	-7.6753*
EXC	-2.8514**	-3.1087
ΔEXC	-7.3672*	-7.2364*
INF	-3.9714*	-4.5942*
ΔINF	-11.8862*	-4.9018*
INV	-8.9340*	-5.2687*
ΔINV	-6.9638*	-6.8323*

Note: *, ** significant at 1%, 5%. OIL=crude oil price, ΔOIL=crude oil price at first difference, EXC=exchange rate, ΔEXC=exchange rate at first difference, INF=inflation, ΔINF=inflation at first difference, INV=investment, ΔINV investment at first difference

All ρ coefficients for OIL, INF, and INV are significant at the 1% level of significance. Meanwhile, EXC is important at the 5% level of significance. Therefore, OIL, EXC, INF, and INV variables are stationary at the level or integrated of order 0.

Since crude oil prices, exchange rates, and inflation exhibit stationarity at the level, the variables have a long-term relationship (cointegration) with investment. The next step is determining the time lag length, p, q, r, and s of the ARDL (p, q, r, s) model using the AIC criterion. Based on the estimation results obtained p = 1, q = 1, r = 2, and s = 0, hence, the ARDL (1,1,2,0)

The estimation results for the long-term and short-term coefficients of ARDL(1,1,2,0) and ECM-ARDL(0,0,1) models are presented in Table 3.

Table 3. Estimation of Long and Short-term Coefficients ARDL3,2,2,3) and ECM-ARDL(2,1,1,2)

Constants and independent variables	**Coefficient**	**t-Statistics**	**P-value**
Panel A: Long-term coefficients, dependent variable: INV			
OIL	-1.4977	-1.1639	0.2564
EXC	-8.9651	-2.5518	0.0178
INF	9.7505	1.4871	0.1506
C	-0.0320	-0.0812	0.9360
Panel B: Short-term coefficients, dependent variable: ΔINV			
ΔOIL	2.2539	5.5678	0.0001
ΔEXC	-4.8037	3.1948	0.0060
$\Delta EXC(t-1)$	3.6629	0.0000	0.0000
$EC(t-1)$	-1.3968	0.0000	0.0000

Note: OIL=crude oil price, EXC=exchange rate, INF=inflation, C=constant, $\Delta OIL =$ crude oil price in first difference, ΔEXC=Exchange rate in first difference, ΔEXC(t-1)=exchange rate in first difference 1 year ago.

In Table 3, Panel A summarizes the results of the long-term coefficients estimation of the ARDl model. The coefficients of OIL and INF are all insignificant because the p-values are greater than 5%. The EXC coefficient is significant at the 5% level. Therefore, OIL and INF do not affect INV in the long term, while exchange rates affect investment. On the other hand, panel B summarizes the results of the short-term coefficients estimation of the ECM-ARDL (0,0,1) model. Following this, the short-term coefficients for the three variables: $\Delta OIL\ \Delta EXC,$ ΔINF and ΔEXC(t-1) were also significant at the 1% level. This shows that OIL, EXC, and INF affect INV in the short term. Only the exchange rate affects investment in the long term. Meanwhile, in the short term, crude oil prices and exchange rates affect investment.

To ensure the validity of long-term and short-term coefficients in Table 3, several assumptions were tested, including the residual assumptions, the exogeneity of the three independent variables, and multicollinearity. Additionally, the stability of the ARDL(1,1,2,0) model parameters was verified. The results of the estimated test statistics alongside corresponding p-values for the JB, BGSCLM, ARCH, and DWH tests are summarized in Table 4.

Table 4: Diagnostic tests of residuals, exogeneity of independent variables, and linearity assumptions

Test statistics	Probability distribution function	Test statistic value	P-value
JB	Chi-Square	2.8492	0.2406
BGCLM	Chi-Square	1.8839	0.3899
Arch	Chi-Square	2.9803	0.0843
DWH	Chi-Square	0.0000	
Ramsey Reset	F	0.0123	0.9128

Note: JB=Jarque Bera, BGCLM= Breusch-Godfrey Serial Correlation LM, DWH= Durbin-Wu-Hausman.

The data presented in Table 4 shows that the p-values associated with the Jarque Bera, Breusch-Godfrey Serial Correlation LM, and Arch tests were 0.2406, 0.3899, and 0.0483, respectively. These values surpassed the 5% significance level, indicating that the assumptions of normality, autocorrelation, and homoscedasticity for the ARDL (1.1.2.0) model hold.

Table 4 also presents the results of the DWH test, where the estimated Chi-Square statistic with 3 degrees of freedom is 0.0000. By the Chi-Square probability distribution standard, this value is significantly smaller than the critical value of 7.8150 at the 5% significance level. Based on the results, it was established that the variables OIL, EXC, and INF had exogeneity.

Table 4 presents the Ramsey Reset test statistic and the p-value, which is 0.9128, exceeding the 5% significance level. Therefore, the ARDL (1,1,2,0) model meets the linearity assumption since the relationships between oil prices, exchange rates, inflation, and investment are linear.

Table 5 presents the test for multicollinearity among independent variables using the VIF criterion. The obtained VIF values for all independent variables (OIL, EXC, and INF) were less than 10, showing the absence of multicollinearity among the independent variables.

Table 5. Multicollinearity Test

Variable	VIF
OIL	1.1891
EXC	2.8035
INF	2.5099

Note: OIL=crude oil price, EXC=exchange rate, INF=inflation

The VIF test is confirmed with the test criteria using the correlation coefficient between the independent variables (OIL, EXC, INF). These correlation coefficients are presented in Table 6.

Table 6. Pearson Correlation Coefficient Matrix

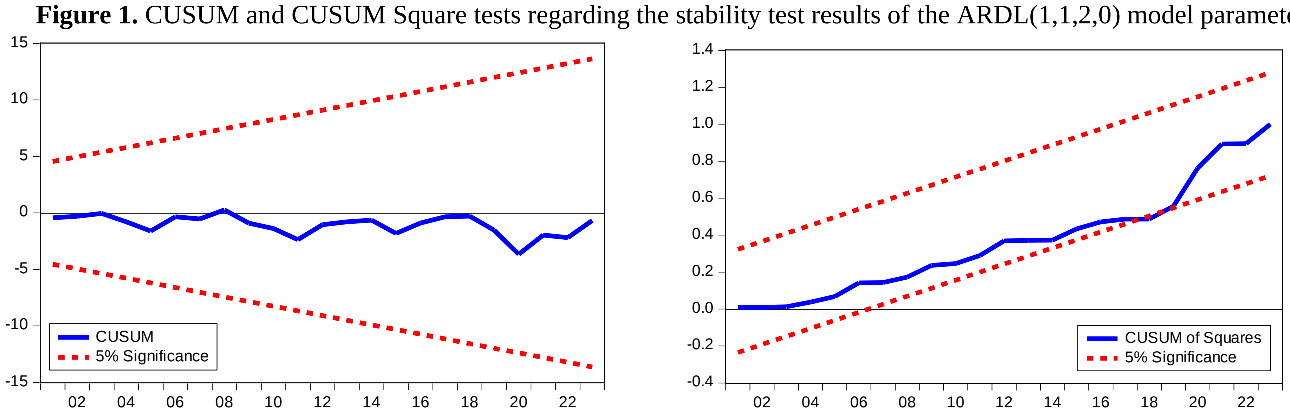
	OIL	EXC	INF
OIL	1		
EXC	-0.3708	1	
INF	-0.1914	0.7690	1

Note: OIL=crude oil price, EXC=exchange rate, INF=inflation

The results of the multicollinearity test using the VIF criterion are also consistent with the check using Pearson correlation coefficients between the independent variables (OIL, EXC, and INF). In this context, the absolute values of the correlation coefficients are less than 0.8.

The evaluation subsequently examined the stability assumption of the ARDL (1,1,2,0) model parameters, as shown in Figure 1. The image on the left shows the result of the parameter stability measurement using the CUSUM test. Meanwhile, the image on the right shows the result of the parameter stability measurement using the CUSUM Square test.

Figure 1. CUSUM and CUSUM Square tests regarding the stability test results of the ARDL(1,1,2,0) model parameters



In both figures above, the red dotted line reflects the 5% significance boundary line. Meanwhile, the blue curved line shows the movement trend of the parameters (coefficients) of the ARDL(1,1,2,0) model. The assessment of the stability assumptions of the long-term coefficients showed that the trends of these coefficients were significant at the 5% level of significance. This indicated that the stability assumptions for the long-term coefficients in the ARDL (1,1,2,0) model were met. Figure 1 is a visual representation of the trends of these coefficients.

The statistical decisions made based on the model assumption tests showed that the residuals of the ARDL (3,2,2,3) model were normally distributed, homoscedastic, and free from autocorrelation. Additionally, the three independent variables were not multicollinear and were exogenous. The parameters of the ARDL(1,1,1,0) model remained stable from 1990 to 2023. Based on these results, the analysis of long-term and short-term effects of crude oil prices, exchange rates, and inflation on investment using the ARDL (1,1,2,0) and ECM-ARDL (0,0,1) models is considered valid.

However, it is important to check the validity of the influence of crude oil prices, exchange rates, and inflation on investment by checking the residual stationarity of the ARDL (1,1,2,0) model. The results of the ADF residual ε_t test estimation, as presented in Table 6.

Table 6. Stationary test of residual ARDL(1,1,2,0) model

Variable	Intercept	Intercept and trend
ε_t	-5.3430*	-5.1939*

Note: * significant at 1%, e_t ARDL(1,1,2,0) model residual variables

Based on the ADF test using Equation 6, the coefficient ρ of the variable ε_t is significant at the 1% significance level. In other words, the residual ε_t of the ARDL (1,1,2,0) model was stationary at the level. Lastly, following the theoretical explanation presented in sub-chapter 3.2, the statistical decision was that the ARDL (1,1,2,0) model is not a spurious regression model.

From the series of assumption tests, it shows that (1) the residuals of the ARDL(1,1,2,0) model are normally distributed, homoscedastic, and have no autocorrelation, (2) the four independent variables are exogenous, (3) the model parameters are stable in the 1990-2023 time span, (4) Between independent variables (crude oil prices, exchange rates, and inflation) are free from multicollinearity, and (5) the ARDL(1,1,2,0) model is not a spurious regression model. Based on these assumption tests, the long-term and short-term coefficients are valid. This also shows that the test results regarding the long-term and short-term effects using the ARDL(1,1,2,0) model and the ECM-ARDL(0,0,1) model, namely, that there is a long-term and short-term effect of crude oil prices, exchange rates, and inflation on Indonesia's economic growth, are valid.

Table 7 outlines the influence of the three independent variables on investment, namely crude oil prices, exchange rates, and inflation, along with the ranking of each contribution made. The contribution ranking number of each variable is contained in the fourth column.

Table 7. Contribution of Each Independent Variable based on Dominance Analysis

Variable	Contribution	Contribution Percentage (%)	Rank
OIL	0.0309	33.9560	2
EXC	0.0439	48.2418	1
INF	0.0162	17.8022	3
Total ($R^2_{INV.(OIL)(EXC)(INF)}$)	0.0910		

Note: OIL=crude oil price, EXC=exchange rate, INF=inflation.

Accordingly, the cumulative impact of crude oil prices, exchange rate, and inflation on investment was observed to be 9.1000%, with the remaining 90.9000% attributed to other factors. This contribution was apportioned among the distinct influences of the three independent variables, as detailed in Table 7. In this study, the exchange rate made the most substantial contribution at 48.2418%, followed by the crude oil price at 33.9560% and inflation at 17.8022%.

4.2 Discussion

This study showed that crude oil prices significantly impacted short-term investments. During the short-term analysis, this impact was positive, implying that an increase in crude oil prices corresponded to an increase in investment. This increase could be due to crude oil exports by oil-exporting countries, which have enhanced global savings and led to lower interest rates and investment (Brown & Yucel, 2002; Dogrul & Soytas, 2010). This was also supported by Mallick, et al. (2017) and Wu and Wang (2021). Furthermore, the results were in line with the sentiment theory, as proposed by Wu and Wang (2021), which suggests that higher oil prices increase investment. The obtained results were not in line with prior empirical research conducted by Golberg (1993), Drakos and Konstantinous (2012), and Kandemir Kocaaslan (2021). This disparity may arise from the distinctive characteristics of these countries, where companies in Greece and China interpret rising oil prices as a positive signal to invest, which is in line with the sentiment theory proposed by Wu and Wang (2021).

Another significant finding from this study is that fluctuations in the exchange rates of the domestic currency negatively impacted investment. In essence, when the exchange rates of foreign currency (e.g., USD) appreciate, or the exchange rates of the domestic currency (IDR) depreciate, it reduces investment. This occurrence can be attributed to the heightened capital import costs associated with investment. Accordingly, these findings are closely in line with the theories proposed by Greene and Villanueva (1990) and Saidi, et al. (2019), and were consistent with the outcomes observed in the research conducted by Sadath and Acharya (2022). However, the study contradicted the findings of Harchaoui, et al. (2005) in Canada, where the depreciation of the exchange rate of the domestic currency was found to stimulate investment. This difference may be attributed to the country's unique characteristics under examination, which were also in line with the theories presented by Greene and Villanueva (1990).

The results obtained from this study showed several significant policy implications for the government as a decision-maker. Firstly, the observations suggested the importance of setting domestic crude oil prices with an orientation toward boosting investment. Secondly, the study emphasized the significance of implementing monetary policies by the Central Bank and fiscal policies by the government, such as initiatives aimed at stabilizing domestic currency exchange rates to appreciate against foreign currencies. Lastly, it underscored the importance of maintaining a stable inflation rate to ensure a continuous increase in investment. The present study suggests that inflation stabilization policy decisions should remain at an inflation level between the upper and lower thresholds set by the Central Bank. The strategic execution sequence for this policy should be in line with the hierarchical contribution order of crude oil price, exchange rate, and inflation. Consequently, efforts to stabilize inflation should be given primary attention, followed by initiatives to stabilize the exchange rate and crude oil price.

Regardless of the various associated benefits, this study possesses several limitations. First, the exchange rate variable was proxied by the IDR/US$ exchange rate, while conventional international trade comprises multiple foreign currencies in transactions across goods, capital, and foreign exchange markets. Second, the investigation is confined to Indonesia, an oil-importing country. Future studies could address these limitations by conducting a similar investigation in other countries, whether oil-importing or oil-exporting, and using an exchange rate index as a proxy. Expanding the study to include groups of countries could provide a broader perspective.

5. Conclusion

In conclusion, investment is a significant driver of economic growth and a key indicator of a country's economic health. This aspect has drawn significant attention from both academics and policymakers, as evidenced by the numerous studies that have explored the impact of macroeconomic variables on investment and other factors influencing investment decisions.

This study investigated the long-term and short-term impacts of crude oil prices, exchange rates, and inflation on investment in Indonesia. The ARDL and ECM-ARDL models were utilized to analyze annual time series data for the four variables above from 1990 to 2023 to assess these effects.

The analysis began by examining all variables' stationarity, including crude oil prices, exchange rates, inflation, and investment. The Augmented Dickey-Fuller (ADF) stationarity test results indicated that all four variables were stationary at the level. This shows that crude oil prices, exchange rates, and inflation exhibited cointegration or a long-term connection with investment. It is also crucial to establish that, based on the outcomes of the effect test, exchange rates were concluded to exhibit significant influences on investment in the long run. In the short term, crude oil prices affect investment, and investment does not depend on inflation.

This present study on the influence of crude oil prices, exchange rates, and inflation on investment using the ARDL model is a significant topic with important implications for policy and literature. The contributions include (1) determining long-term and short-term effects of crude oil prices, exchange rates, and inflation on investment, (2) utilizing the ARDL model to analyze these effects, and (3) providing a ranking of the contributions of each independent variable, namely crude oil prices, exchange rates, and inflation, to investment through dominant analysis methods. Accordingly, the exploration offers policy implications for government decision-making. It suggests that domestic crude oil prices should be set with consideration for the impact of the price on investment.

Following the impact of crude oil prices, domestic exchange rates and inflation should be managed to maintain stability, as this can foster increased investment. However, it is important to state that inflation should not fall below a critical threshold since meager inflation could lead to a higher unemployment rate.

Regardless of the associated benefits, the present study also has certain limitations. The study uses only the IDR/USD exchange rate as a proxy, while other foreign currencies are also used in international trade. Future investigations could address this limitation by adopting an exchange rate index as a proxy. Moreover, expanding the study to include other countries or variables could provide further insights.

References

Abate, Y. (2016). Determinants of domestic private investment in Ethiopia from 1971 to 2014: An empirical analysis. *The International Journal of Research Publication*, *5*(9), 86–95.

Adam, P., Rostin, R., & Saenong, Z. (2018a). The influence of fuel prices and unemployment rate towards the poverty level in Indonesia. *International Journal of Energy Economics and Policy*, *8*(3), 37-42.

Adam, P., Saidi, L. O., Tondi, L., & Sani, L. O. A. (2018b). The causal relationship between crude oil price, exchange rate and rice price. *International Journal of Energy Economics and Policy*, *8*(1), 90-94.

Aharon, D. J., Aziz, M. I. A., & Kalli, I. (2023). Oil price shocks and inflation: A cross-national examination in the ASEAN5+3 countries. *Resources Policy*, *82*, May 2023, 103573. https://doi.org/10.1016/j.resourpol.2023.103573.

Alekhina, V., & Yoshino, N. (2018). Impact of world oil prices on an energy exporting economy including monetary policy. ADBI Working Paper, No. 828. Tokyo: Asian Development Bank Institute. Extracted from https://www.adb.org/publications/impact-world-oil-prices-energy-exporting-economy-including-monetary-policy.

Archer, C., Junior, P. O., Adam, A. M., Asafo-Adjei, E., & Baffoe, S. (2022). Asymmetric dependence between exchange rate and commodity prices in Ghana. *Annals of Financial Economics*, *17*(02), 2250012. https://doi.org/10.1142/S2010495222500129.

Asteriou, D., & Hall, S. G. (2011). *Applied econometrics*. London : Palgrave Macmillan.

Ayeni, R. K. (2020). Determinants of private sector investment in a less developed country: a case of the Gambia. *Cogent Economics & Finance, 8*(1), 1794279. https://doi.org/10.1080/23322039.2020.1794279.

Bambe, B. W. W. (2023). Inflation targeting and private domestic investment in developing countries. *Economic Modelling*, *125*, 106353.

Banerjee, R., Hofmann, B., & Mehrotra, A. (2022). Corporate investment and the exchange rate: The financial channel. *International Finance*, 25(3), 296-312.

Bhatta, S. R., Adhikari, P., & Byanjankar, R. (2020). Choice of regression models in time series data. *Economic Journal of Development*, *29*, 1-2.

Binz, O., Ferracuti, E., & Joobs, P. (2023). Investment, inflation, and the role of internal information systems as a transmission channel. *Journal of Accounting and Economics*, 28 Juli 2023, 101632. https://doi.org/10.1016/j.jacceco.2023.101632.

Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society Series B: Statistical Methodology*, *37*(2), 149-163. https://doi.org/10.1111/j.2517-6161.1975.tb01532.x.

Brown, S., & Yucel, M. (2002). Energy prices and aggregate economic activity: an interpretative survey. *Quarterly Review of Economics and Finance, 42*(2), 193–208. https://doi.org/10.1016/S1062-9769(02)00138-2.

Budescu, D. V. (1993). Dominance analysis: A new approach to the problem of relative importance of predictors in multiple regression. *Psychological Bulletin*, 114(3), 542-551. https://doi.org/10.1037/0033-2909.114.3.542.

Chen, L., Yuan, Y., & Zhao, N. (2022). The effect of oil price uncertainty on corporate investment in the presence of growth options: Evidence from listed companies in China (1998–2019). *The North American Journal of Economics and Finance, 62*, 101779. https://doi.org/10.1016/j.najef.2022.101779.

Chen, X., Li, Y., Xiao, J., & Wen, Y. (2020). Oil shocks, competition, and corporate investment: Evidence from China. *Energy Economics*, *89*, June 2020, 104819. https://doi.org/10.1016/j.eneco.2020.104819.

Cheng, Y., Hui, Y., Liu, S., & Wong, W. K. (2022). Could significant regression be treated as insignificant: An anomaly in statistics. *Communications in statistics: Case Studies*, *Data Analysis and Applications*, *8*(1), 133-151. https://doi.org/10.1080/23737484.2021.1986171.

Cheng, Y., Hui, Y., McAleer, M., & Wong, W. K. (2021). Spurious relationships for nearly non-stationary series. *Journal of Risk and Financial Management*, *14*(8), 366. https://doi.org/10.3390/jrfm14080366.

Čipčić, M. L. (2021). The impact of oil prices on investment in croatia. *Dubrovnik International Economic Meeting*, *6*(1), 108-117. https://doi.org/10.17818/DIEM/2021/1.11.

DATAtab-Team. (2025). DATAtab: Online Statistics Calculator. DATAtab e.U. Graz, Austria. Extracted from https://datatab.net.

Davidson, R., & Mackinnon, J. G. (1993). *Estimation and inference in econometrics*. New York: Oxford University Press.

Diabate, N. (2016). An Analysis of Long Run Determinants on Domestic Private Investment in Côte d'Ivoire. *European Scientific Journal*, *12*(28), 240-251. http://dx.doi.org/10.19044/esj.2016.v12n28p240.

Dogrul, H. G., & Soytas, U. (2010). Relationship between oil prices, ınterest rate, and unemployment: Evidence from emerging market. *Energy Economic*, *32*(6), 1523-1528. https://doi.org/10.1016/j.eneco.2010.09.005.

Drakos, K., & Konstantinous, P. T. (2012). Investment decisions in manufacturing: Assessing th effect of real oil price and their uncertainty. *Journal of Applied Econometrics, 2012*. https://doi.org/10.1002/jae.2297.

Elneel, F. A., & Almulhim, A. F. (2022). The Effect of Oil Price shock on Saudi Arabia's economic growth in the light of vision 2030 "A combination of VECM and ARDL models". *Journal of the Knowledge Economy*, *13*, 3401-3423. https://doi.org/10.007/s13132-021-00841-7.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica.* 50, 987–1007. https://doi.org/10.2307/1912773.

Evans, O. (2023). The investment dynamics in renewable energy transition in Africa: the asymmetric role of oil prices, economic growth and ICT. *International Journal of Energy Sector Management*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/IJESM-03-2022-0002.

Farooq, U., Tabash, M. I., Hamouri, B., Daniel, L. N., & Safi, S. K. (2023). 2023. Nexus between Macroeconomic factors and Corporate Investment: Empirical Evidence from GCC Markets. *International Journal of Financial Studies*, *11*(35). https://doi.org/10.3390/ijfs11010035.

Fuller, W. A. (1976). *Introduction to statistical time series*. New York: John Wiley & Son Ltd.

Ghouse, G., Khan, S. A., & Rehman, A. U. (2018). ARDL model as a remedy for spurious regression: problems, performance and prospectus. MPRA Paper No. 83973, Pakistan Institute of Development Economics. Extracted from https://mpra.ub.uni-muenchen.de/83973/1/MPRA_paper_83973.pdf.

Ghouse, G., Khan, S. A., Rehman, A. U., & Bhatti, M. I. (2021). ARDL as an elixir approach to cure for spurious regression in nonstationary time series. *Mathematics*, *9*, 2839. https://doi.org/10.3390/math9222839.

Ghouse, G., Rehman, A. U., & Bhatti, M. I. (2024). Understanding of causes of spurious associations: Problems and Prospects. *Journal of Statistical Theory and Applications*, *23*(1), 44-66. https://doi.org/10.1007/s44199-024-00072-0.

Gohar, R., Bhatty, K., Osman, M., Wong, W. K., & Chang, B. H. (2022). Oil prices and sectorial stock indices of Pakistan: Empirical evidence using bootstrap ARDL model. *Advances in Decision Sciences*, (4), 1-27. https://doi.org/10.47654/v26y2022i4p50-77.

Golberg, L. S. (1993). Exchange Rates and Investment in United States Industry. *The Review of Economics and Statistics*, *75*(4), 575-588. https://doi.org/10.2307/2110011

Granger, C. W. J., & Newbold, P. (1974). Spurious regressions in econometrics. *Journal of Econometrics*, *2*(2), 111–20. https://doi.org/10.1016/0304-4076(74)90034-7

Greene, J., & Villanueva, D. (1990). Determinants of private investment in LDCs. *Finance & Development, International Monetary Fund*, December 1990, 40-42. Extracted from https://www.elibrary.imf.org/downloadpdf/journals/022/0027/004/article-A013-en.pdf

Gujarati, D. N. (2004). *Basic Econometrics*. New York: McGraw− Hill.

Gujarati, D. N., & Porter, D. C. (2010). *Essentials of Econometrics*, fourth edition. New York: McGraw-Hill Companies Inc.

Hamilton, J. D. (1983). Oil and the macroeconomy since World War II. *The Journal of Political Economy*, *91*(2), 228–248. https://doi.org/10.1086/261140.

Harchaoui, T., Tarkhani, F., & Yuen, T. (2005). The Effects of the Exchange Rate on Investment: Evidence from Canadian Manufacturing Industries. *Staff Working Papers* 05-22, Bank of Canada. https://www.bankofcanada.ca/2005/08/working-paper-2005-22/.

Hassler, U. W., & Wolters, J. (2006). Autoregressive distributed lag models Cointegration. *Allgemeines Statistisches Archiv*, *90*, 59-74. Https://doi.org/10.1007/s10182-006-0221-5.

He, Z., Zhou, F., Xia, X., Wen, F., & Huang, Y. (2019). Interaction between Oil Price and Investor Sentiment: Nonlinear Causality, Time- Varying Influence, and Asymmetric Effect. *Emerging Markets Finance and Trade*, *55*(12), 2756-2773. https://doi.org/10.1080/1540496X.2019.1635450.

Heij, C., De Boer, P., Franses, P. H., Kloek, T., & Van Dijk, H. K. (2004). *Econometric methods with applications in business and economics*. New York : Oxford University Prss.

Hui, Y., Wong, W. K., Bai, Z., & Zhu, Z. Z. (2017). A new nonlinearity test to circumvent the limitation of Volterra expansion with application. *Journal of the Korean Statistical Society*, *46*, 365-374.

IHS Markit. (2022). *EViews 13 user's guide II.* Englewood, USA: IHS Global Inc.

Imane, E., Chang, B. H., Elsherazy, T. A., Wong, W. K., & Uddin, M. A. (2023). The external exchange rate volatility influence on the trade flows: Evidence from nonlinear ARDL model. *Advances in Decision Sciences*, *27*(2), 75-98. https://doi.org/10.47654/v27y2023i2p75-98.

Jaiswal, R. (2023). From humble beginnings to a global economic powerhouse: A comprehensive study of India's economic development through the lens of selected macroeconomic indicators (1990–2020). *Annals of Financial Economics*, *18*(03), 2350003. https://doi.org/10.1142/S2010495223500033.

Kandemir Kocaaslan, O. (2021). Are the responses of output and investment to oil price shocks asymmetric?: The case of an oil-importing small open economy. *Empirical Economics*, *61*(5), 2501-2516. https://doi.org/10.1007/s00181-020-01983-4.

Kilian, L., & Vigfusson, R. J. (2011). Are the responses of the US economy asymmetric in energy price increases and decreases? *Quantitative Economics*, *2*(3), 419–453. https://doi.org/10.3982/QE99.

Koop, G. (2006). *Analysis of financial data*. Chichester : John Wiley & Son Ltd.

Kripfganz, S., & Schneider, D. C. (2023). Ardl: Estimating autoregressive distributed lag and equilibrium correction models. *The Stata Journal*, *23*(4), 983–1019. Https://doi.org/10.1177/1536867X231212434.

Lean, H. H., McAleer, M., & Wong, W. K. (2010). Market efficiency of oil spot and futures: A mean-variance and stochastic dominance approach. *Energy Economics*, *32*(5), 979-986. https://doi.org/10.1016/j.eneco.2010.05.001.

Lean, H. H., McAleer, M., & Wong, W. K. (2015). Preferences of risk-averse and risk-seeking investors for oil spot and futures before, during and after the Global Financial Crisis. *International Review of Economics & Finance*, *40*, 204-216. https://doi.org/10.1016/j.iref.2015.02.019

Maddala, G. S. (2001). *Introduction to econometrics, third edition*. Chichester : Wiley & Son Inc.

Mallick, H., Mahalik, M. K., & Sahoo, M. (2017). Is Crude Oil Price Detrimental to Domestic Private Investment for an Emerging Economy? The Role of Public Sector Investment and Financial Sector Development in an Era of Globalization. *Energy Economic, 69*(C), 307-324. https://doi.org/10.1016/j.eneco.2017.12.008.

Mamun, T. G. M. A. (2025). Replacing ARDL? Introducing the NSB-ARDL Model for Structural and Asymmetric Forecasting. Working Paper. Cornell University. Extracted from https://doi.org/10.48550/arXiv.2504.09646

Maydybura, A., Gohar, R., Salman, A., Wong, W. K., & Chang, B. H. (2023). The asymmetric effect of the extreme changes in the economic policy uncertainty on the exchange rates: evidence from emerging seven countries. *Annals of Financial Economics*, *18*(02), 2250031. https://doi.org/10.1142/S2010495222500312.

Mizutani, F., & Tanaka, T. (2010). Productivity effects and determinants of public infrastructure investment. *The Annals of Regional Science, 44*, 493-521. https://doi.org/10.1007/s00168-008-0279-y

Moore, D. S., McCabe, G. P., Alwan, L. C., Craig, B. A., & Duckworth, W. M. (2011). *The practice of statistics for business and economics (third edition)*. New York: W. H. Freeman and Company.

Mukhamediyev, B., Zhamanbayev, S., & Mukhamediyeva, A. (2024). Central bank independence and oil prices impact on macroeconomic indicators. *International Journal of Energy Economics and Policy*, *14*(3), 9–17. https://doi.org/10.32479/ijeep.15621.

Muthalib, D. A., Adam, P., Azis, M. I., Nur, M., Makkulau, A. R., Tambunan, R., ... & Putera, A. (2026). The effect of crude oil prices and inflation on the profitability of government banks in Indonesia. *Multidisciplinary Science Journal*, *8*(1), 2026047-2026047. https://doi.org/10.31893/multiscience.2026047

Narayan, P. K. (2005). The saving and investment nexus for China: evidence from cointegration tests. *Applied Economics, 37*, 1979–1990. http://dx.doi.org/10.1080/00036840500278103.

Naufal, M. J., Ompusunggu, D. P., Sinaga, R. K., Sitohang, M. D. A., Gunawan, T. N., Simatupang, M., Salsabila, N. S., Simanullang, T., & Hutasoit, B. T. (2025). A Theoretical Study of Multicollinearity and Linearity in Econometric Models for Economic Research. *Balance Jurnal Ekonomi, 21*(1), 43-52.

Noman, M., Maydybura, A., Channa, K. A., Wong, W. K., & Chang, B. H. (2023). Impact of cashless bank payments on economic growth: Evidence from G7 countries. *Advances in Decision Sciences*, *27*(1), 1-20. https://doi.org/10.47654/v27y2023i1p1-22.

Pesaran, M. H. (2015). *Time series and panel data econometrics*. New York: Oxford University Press.

Pesaran, M. H., & Shin, Y. (1999). *An autoregressive distributed lag modelling approach to cointegration analysis* (Vol. 9514, pp. 371-413). Cambridge, UK: Department of Applied Economics, University of Cambridge. https://doi.org/10.1017/CCOL521633230.011

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Economics, 1*6, 289–326. https://doi.org/10.1002/jae.616

Philips, A. Q. (2022). How to avoid incorrect inferences (while gaining correct ones) in dynamic models. *Political Science Research and Methods*, *10*(4), 879-889. https://doi.org/10.1017/psrm.2021.31

Pilbeam, K. (2023). *International finance* (Fifth Edition). London : Bloomsbury Academic.

Ramachandran, K. M., & Sokos, C. P. (2021). *Mathematical statistics with applications in R, third edition*. London: Elsevier Inc.

Reifman, A., & Keyton, K. (2010). Winsorize. In N. J. Salkind (Ed.), *Encyclopedia of Research Design* (pp. 1636-1638). Thousand Oaks, CA: Sage

Rosnawintang, R., Tajuddin, T., Adam, P., Pasrun, Y. P., & Saidi, L. O. (2021). Effects of crude oil prices volatility, the internet and inflation on economic growth in ASEAN-5 countries: A panel autoregressive distributed lag approach. *International Journal of Energy Economics and Policy*, *11*(1), 15-21. https://doi.org/10.32479/ijeep.10395

Rumbia, W. A., Jabani, A., Adam, P., Abbas, B., Nur, M., & Pasrun, Y. P. (2023). Effect of exchange rates and information and communication technology on Indonesia's economic growth: A nonlinear autoregressive distributed lag approach. *Journal of Telecommunications and the Digital Economy, 11*(4), 1-20. https://doi.org/10.18080/jtde.v11n4.743

Sadath, A. C., & Acharya, R. H. (2022). Effects of exchange rate fluctuation on investment: Firm level evidence from India. In: Yoshino, N; Paramik, R. N., Kumar, A. S. (eds), Studies on international economics and finance. *India Studies in Business and Economics*. Springer, Singapore. https://doi.org/10.1007/978-981-16-7062-6_26

Saidi, L. O., Adam, P., Rahim, P., & Rosnawintang, R. (2019). The effect of crude oil prices on economic growth in South East Sulawesi, Indonesia: An application of autoregressive distributed lag model. *International Journal of Energy Economics and Policy*, *9*(2), 194-198. https://doi.org/10.32479/ijeep.7322

Sam, C. Y., McNown, R., & Goh, S. K. (2019). An augmented autoregressive distributed lag bounds test for cointegration. *Economic Modelling*, *80*, 130–141. https://doi.org/10.1016/j.econmod.2018.11.001

Sethi, D., Wong, W. K., & Acharya, D. (2018). Can a disinflationary policy have a differential impact on sectoral output. A look at sacrifice ratios in OECD and non-OECD countries. *Margin: The Journal of Applied Economic Research*, *12*(2), 138-170.

Shin, Y., Yu, B. C., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In: Sickels, R., Horrace, W., editors. Festschrift in Honor of Peter Schmidt: *Econometric Methods and Applications* (281-314). New York: Springer.

Shintani, A. (2014). Primer of statistics in dental research: Part I. *Journal of Prosthodontic Research, 58*(1), 11-16. https://doi.org/10.1016/j.jpor.2013.12.006

Swift, R. (2006). Measring the effects of exchange rate changes on investment in Australia manufacturing industry. *Economics Record, 82*(S1), S19-S25.

Tang, J., Sriboonchitta, S., Ramos, V., & Wong, W. K. (2016). Modelling dependence between tourism demand and exchange rate using the copula-based GARCH model. *Current Issues in Tourism*, *19*(9), 876-894.

Thadewald, T., & Buning, H. (2007). Jarque-Bera test and its competitors for testing normality- A power comparison. *Journal of Applied Statistics*, *34*(1), 87-105. https://doi.org/10.1080/02664760600994539.

Wale, Y. (2015). *Determinants of Private Investment in Ethiopia: Time Series Analysis*. Proceedings of the 9th Annual National Student Research Forum. London: St. Mary's University. http://repository.smuc.edu.et/bitstream/123456789/2494/1/Yechale%20Wale.pdf

Wang, K. H., Liu, L., Li, X., & Oana-Ramona, L. (2022). Do oil price shocks drive unemployment? Evidence from Russia and Canada. *Energy*, *253*, 124107. https://doi.org/10.1016/j.energy.2022.124107

Wang, L., & Wissel, J. (2013). Mean-variance hedging with oil futures. *Finance & Stochastics*, *17*(4), 1-43. Https://doi.org/10.1007/s00780-013-0203-x.

Wang, Y., Wu, C., & Yang, L. (2013a). Oil price shocks and stock market activities: evidence from oil-importing and oil-exporting countries. *Journal of Comparative Economics*, *41*, 1220-1238. https://doi.org/10.1016/j.jce.2012.12.004

Wong, W. K., Cheng, Y., & Yue, M. (2024). Could regression of stationary series be spurious?. *Asia-Pacific Journal of Operational Research*, 2440017. https://doi.org/10.1142/S0217595924400177

Wong, W.-K., & Pham, M. T. (2022a). Could the test from the standard regression model could make significant regression with autoregressive noise become insignificant?. *The International Journal of Finance*, 34, 1–18.

Wong, W.-K., & Pham, M. T. (2022b). Could the test from the standard regression model could make significant regression with autoregressive noise become insignificant – a note. *The International Journal of Finance*, 34, 19-39.

Wong, W.-K., & Pham, M. T. (2023a). Could the test from the standard regression model could make significant regression with autoregressive Yt and Xt become insignificant?. *The International Journal of Finance*, 35, 1–19.

Wong, W.-K., & Pham, M. T. (2023b). Could the test from the standard regression model could make significant regression with autoregressive Yt and Xt become insignificant – a note. *The International Journal of Finance*, 35, 20-41.

Wong, W. K., & Pham, M. T. (2025a). Could the correlation of a stationary series with a non-stationary series obtain meaningful outcomes?. *Annals of Financial Economics*, forthcoming.

Wong, W.-K., & Pham, M. T. (2025b). How to model a simple stationary series with a non-stationary series?. *The International Journal of Finance*, 37, 1–19.

Wong, W.-K., Pham, M. T., & Yue, M. (2024). Could regressing a stationary series on a non-stationary series obtain meaningful outcomes – a remedy. The International Journal of Finance, 36, 1–20.

Wong, W. K., & Yue, M. (2024). Could regressing a stationary series on a non-stationary series obtain meaningful outcomes?. *Annals of Financial Economics*, *19*(03), 2450011.

Wu, X., & Wang, Y. (2021). How does corporate investment react to oil prices changes? Evidence from China. *Energy Economics, 97*, May 2021, 105215. https://doi.org/10.1016/j.eneco.2021.105215.

Wuhan, L. S., & Adnan, K. (2015). The effect of interest rate on investment: Empirical evidence of Jiangsu Province, China. *Journal of International Studies*, *8*(1), 81-90. https:/doi.org/10.14254/2071-8330.2015/8-1/7

Yaro, A. S., Maly, F., & Prazak, P. (2023). Outlier detection in time-series receive signal strength observation using Z-Score method with S_n scale estimator for indoor localization. *Applied Sciences*, 2023, 13, 3900. https://doi.org/10.3390/app13063900

Yıldız, B. F., Hesami, S., Rjoub, H., & Wong, W. K. (2021). Interpretation of oil price shocks on macroeconomic aggregates of South Africa: Evidence from SVAR. *The journal of contemporary issues in business and government*, *27*(1), 279-287.

Yin, L., & Yang, S. (2023). Oil price returns and firm's fixed investment: A production pattern. Energy *Economics*, *125*, 106896. https://doi.org/10.1016/j.eneco.2023.106896