EXAMINING THE FACTORS AFFECTING THE CRUDE OIL PRICES IN THE UNITED STATES

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DECLARATION

I hereby declare that:

1. This undergraduate research project is the end result of my own work, and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

2. No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

3. The word count of this research report is .

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ABSTRACT

This study thoroughly investigates the macroeconomic determinants of crude oil prices in the United States. The aim of this study is to understand the influence of independent variables (IV), including GDP, Inflation, Exchange Rate, Oil Supply and Oil Demand have towards the dependent variable, crude oil price. Data of these varaibles were collected and analyzed using econometric methods. The relationship of the independent variables and dependent variables were analyzed using the time series data method and Vector Error Correction Model (VECM). The findings found that DEMAND, SUPPLY, and EXC have an insignificant relationship towards crude oil price whereas INF and GDP have a significant relationship towards crude oil price. The results provide policymakers with insights into U.S. oil volatili

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

There will be eight sections in Chapter One. The research overview will give audiences a general understanding of crude oil pricing. Researchers can comprehend the price volatility of crude oil in the United States through this study. Chapter 1 can provide information related to any factors that will bring the fluctuations of oil prices in the United States.

1.1 Research Background

Crude oil is a crucial source of energy and can even be used as a financial tool for modern business and economic growth. A petroleum product known as crude oil is composed of hydrocarbon and other organic matter deposits that are found in nature. Petrochemicals, diesel, and other valuable goods are made from refined crude oil. It is a finite resource since it is non-renewable and cannot be naturally replaced quickly enough for human usage (Encyclopaedia Britannica, n.d.). Crude oil prices are the most often utilised indicator of commodity prices globally. The global economy is significantly impacted by changes in oil prices. After the crisis, there have been more frequent price changes for oil. Due to the financialization of crude oil, the volatility of the oil price gradually increased. (Razek & Michieka, 2019). Crude oil futures prices could be higher, lower, or equal to spot prices. Price discrepancies between the futures and spot markets provide information about the overall health of the market and its expectations. When the futures price is higher than the spot price, it typically means that investors are betting on an upward market trend and are prepared to pay more for oil that will be delivered later. Investors expect a downward trend in the market if the futures price is less than the spot price. (Chen, 2022).

Being one of the world's largest consumers of oil, the performance of the U.S. economy will largely affect oil price movements. The United State may also experience significant economic effects from changes in oil prices. Oil prices have fluctuated significantly multiple times in the US during the last few decades. The oil price shocks of the 1970s caused a dramatic spike in oil prices, which had a huge influence on the US economy and resulted in high inflation and a recession. Oil prices spiked substantially once more in the early 2000s, this time due to supply interruptions in oil-producing nations and rising demand from emerging economies. The cost and price of petroleum goods rise when oil prices rise, which in turn lowers productivity and results in slow economic growth. The oil price declines of 2014-2016 were another significant period of volatility, with prices dropping sharply due to oversupply and slowing demand growth. This period had a notable impact on the US energy industry, causing substantial job losses and bankruptcies in the shale oil sector (Hamilton, 2009).

One major driver of job creation in the United States has been the exploration and development of shale formations. Since hydraulically fractured wells often have a shorter production life, additional drilling is constantly being done to locate the next deposit. These are all labor-intensive tasks.

Cheaper oil means less drilling and exploratory activity because most of the new oil-driving economic activity is unconventional and costs more per barrel than a conventional source of oil. Layoffs brought on by a decline in activity may be detrimental to the companies that employ these people.

The banking and investment industries often bear the brunt of declines in U.S. oil prices. Numerous businesses operate on shale deposits, drilling and maintaining wells, and many of them rely on debt and capital raising to fund their activities. This implies that if the price of oil declines to the point that drilling and servicing firms become unprofitable and investors and banks lose money, then both will suffer financial losses (Beattie, 2015).

Moreover, macroeconomic indicators in the United States will affect changes in oil prices. Oil consumption will increase quickly as a result of the economy's rapid growth and significant size expansion, and it may eventually far surpass oil supplies, which can lead to higher crude oil prices. However, when the US economy is in a recession or experiencing slow growth, oil demand may decrease, leading to lower crude oil prices (U.S. Energy Information Administration, n.d.).

<u>Figure 1.1: Crude Oil WTI</u>

(Source: https://tradingeconomics.com/commodity/crude-oil)

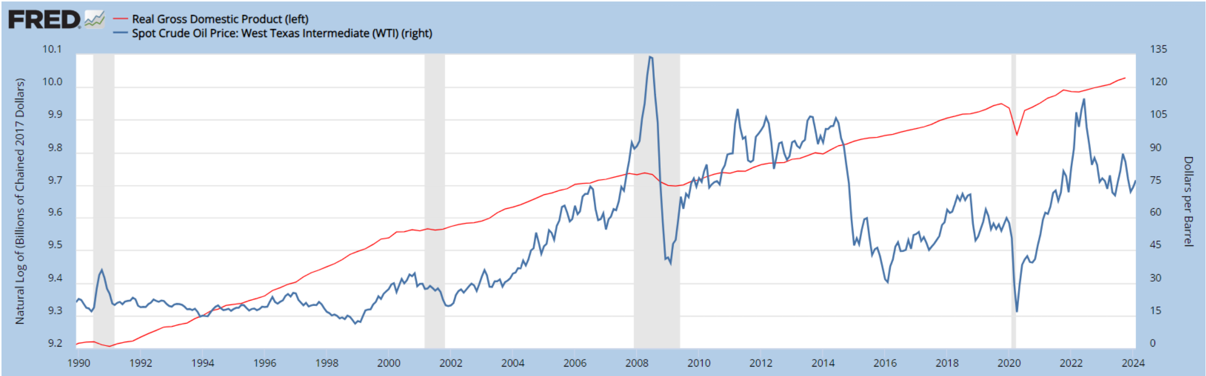
From the graph, we can see that the movement of crude oil price from the year 2000 to 2022. In 2020, the pandemic caused a notable slowdown in the US economy, with GDP contracting by around 3.5%. As the economy slowed down, so did energy demand, which caused crude oil prices to plummet once again. In 2020, crude oil prices briefly fell dramatically, which was a historic low. This resulted from a number of causes, including as a decline in the world's oil consumption, an abundance, and insufficient storage space.

Crude oil prices started to climb again in 2021 and 2022 as the US economy started to recover from the pandemic. A number of causes, including a rebound in energy demand as economies reopen, supply interruptions brought on by extreme weather events like hurricanes and cold snaps, and persistent geopolitical tensions in oil-producing countries like the Middle East, have contributed to this price spike (The White House, n.d.).

1.2 Problem Statement

Crude oil has been an important commodity in the world economy for the last century. US dollars are used to express the price of crude oil. We can say that dollars are mainly used as the unit of exchange for crude oil prices. This implies that the price of oil on global markets can be significantly influenced by the US economic activities' performance. On the demand side, a primary measure of economic expansion is the swiftly rising demand for or consumption of oil. A good economic performance in the US may increase demand for crude oil and the price. Conversely, it reduces oil demand and oil prices if the US has a weak economic performance. This can lead to increased demand for crude oil and higher prices (González & Nabiyev, 2009). However, higher GDP growth can incentivize increased domestic oil production in the US as companies seek to capitalize on a growing market and potentially reduce reliance on imports. This will lead to a decrease in oil prices as supply increases (Ghalayini, 2021). As a result, the impact of GDP growth on crude oil prices is ambiguous and the diagram also shows the fluctuation situation of the relationship between GDP growth and oil prices. Then, more investigation is needed to look at the connection between US crude oil prices and GDP growth.

Figure 1.2: Relationship between GDP and Crude Oil Price



(Sources: FRED Economic Data. https://fred.stlouisfed.org/graph/?g=c5zh#0)

Furthermore, WTI and Brent crude oil are the two varieties traded on the market. As dollars are mainly used as the unit of exchange for crude oil prices. This suggests that the US dollar's value in respect to other currencies has a major impact on the price of oil. Therefore, the price that those buyers will pay for a barrel of oil in their own currencies depends on the exchange rate between the US dollar and other currencies. a stronger US dollar can decrease the demand for oil as imports become more expensive in local currencies for countries besides the US. Then the oil price will decrease as the demand has reduced. Conversely, when the US dollar is weak, it makes oil less expensive for buyers in other countries. This may raise the price. This is because buyers in other countries can purchase more barrels of oil for the same amount of their own currency when the US dollar is weaker. In addition, a depreciation of the US dollar can lead to limitations in oil supply by producers, causing them to raise oil prices to stabilize their export revenues (Beckmann et al, 2020). Therefore, we must determine how exchange rates affect the price of crude oil in the US.

In addition, the price of oil is linked to both social and economic events. The price of oil fluctuates frequently when events take place on a big enough scale. For instance, the pricing war between Saudi Arabia and Russia, which resulted in an excess of oil on the market, had an impact on the drop in crude oil prices at that time. This led to a sharp dip in oil prices, which was further compounded by the pandemic's economic devastation and decreased demand. Severe variations in oil prices will affect the world economy. An increase in oil prices will result in higher inflation and slower economic growth. The cost of goods manufactured using petroleum products is directly impacted by oil prices. As was already established, the price of oil has an indirect impact on expenses related to manufacturing, transportation, and heating. Producers may pass production costs on to customers, which could have an impact on the prices of a range of goods and services. The degree to which rising oil prices affect consumer prices varies according to how essential oil is to the creation of a particular kind of commodity or service. Because high oil prices diminish wealth and create uncertainty about the future, they can also lower demand for other items (Federal Reserve Bank of San Francisco, 2007). In summary, the fluctuations of oil prices can reverberate throughout the global economy, impacting businesses, consumers, financial markets, and governments.

Numerous factors influence the link between the supply and demand of crude oil and its price. For example, on the supply side, factors such as geopolitical events, the U.S. dollar against foreign currencies, the world economy, production volume, and OPEC will all affect oil supply. On the demand side, oil consumption levels, global exchange rates, and oil speculation in the financial market will all affect oil demand. But we generally know that according to the law of supply and demand, the price of any product, including crude oil will increase as demand increases or supply decreases. Conversely, if demand decreases or supply increases, prices will fall. However, when demand and supply increase or decrease at the same time, oil prices can move unpredictably, depending on the extent of their movements.

1.3 Research Question

1.3.1 General Research Question

What is the relationship between macroeconomic variables and crude oil prices in the United States?

1.3.2 Specific Research Question

1. What is the effect of GDP growth on crude oil prices in the United States?

2. How does inflation impact crude oil prices in the United States?

3. What is the relationship between exchange rate and crude oil prices in the United States?

4. How do oil supply and demand influence crude oil prices in the United States?

1.4 Research Objectives

1.4.1 General Research Objectives

To investigate the factors that affecting crude oil price in the United States.

1.4.2 Specific Research Objectives

1. To examine the influence between GDP growth, inflation, exchange rates, supply and demand with crude oil prices in the United States.

1.5 Hypotheses of the Study

H0: There is no positive relationship between GDP growth (GDP) and crude oil price (COP) in United States.

H1: There is a positive relationship between GDP growth (GDP) and crude oil price (COP) in United States.

H0: There is no positive relationship between Inflation (INF) and crude oil price (COP) in United States.

H1: There is a positive relationship between Inflation (INF) and crude oil price (COP) in United States.

H0: There is no positive relationship between Exchange Rate (EXC) and crude oil price (COP) in United States.

H1: There is a positive relationship between Exchange Rate (EXC) and crude oil price (COP) in United States.

H0: There is no positive relationship between Supply (SUPPLY) and crude oil price (COP) in United States.

H1: There is a positive relationship between Supply (SUPPLY) and crude oil price (COP) in United States.

H0: There is no positive relationship between Demand (DEMAND) and crude oil price (COP) in United States.

H1: There is a positive relationship between Demand (DEMAND) and crude oil price (COP) in United States.

1.6 Significance of Study

First, in order for stakeholders and policymakers to make educated choices about supply, demand, and pricing, they must have a thorough grasp of the dynamics of the oil market. A few of the variables that affect the supply and demand of crude oil are inflation, GDP growth, and exchange rates. Policymakers can decide on oil prices, production, and imports with knowledge of the relationship between these variables and crude oil prices. They can also improve their grasp of the dynamics of the oil market, which will help them prepare for shocks to the price of oil that might have a big effect on the economy.

Research on the impact of macroeconomic factors and supply and demand on crude oil prices in the United States can improve investment decision-making.

Investors can use the findings of such research to make informed investment decisions, manage risks, and potentially increase returns. For instance, if research indicates that inflation significantly affects crude oil prices, investors can modify their investment strategies to reduce the impact of inflation on their portfolios.

Policymaking is a critical application of research on the variables influencing crude oil prices in the US. It is critical to develop policies that can control the price of crude oil and lessen the negative economic effects of oil price shocks. Governments can implement policies that promote economic development and stability in order to avert oil price shocks, for instance, if research indicates that GDP growth significantly affects crude oil prices. Research findings can also be used by policymakers to create programmes that encourage the use of alternative energy sources, lessening reliance on crude oil and lessening the negative effects of oil price shocks on the economy.

1.7 Chapter Layout

1.7.1 Chapter 1

The five chapters that make up this study are organised. The background of this study serves as the chapter's primary topic. The study paper primarily discusses the fundamental factors and the volatility of oil prices in the US. However, the problem definition, significance, and study hypotheses will also be provided. This chapter will also feature additional subtopics like research questions and objectives to help readers better comprehend the problem of crude petroleum oil price.

1.7.2 Chapter 2

This chapter helped to make this study on the pricing of crude petroleum oil better. The independent factors influencing the study of crude petroleum oil pricing will be determined by the literature review. A conceptual framework, the creation of hypotheses, and a discussion of pertinent theoretical models will all be covered in this chapter. To help the reviewer grasp the correlation between the independent and dependent variables, the chart framework for each relevant variable will also be covered.

1.7.3 Chapter 3

Chapter 3 will also address the study methods used for this research report. This chapter also covers data collection, sample size, time frame, sampling design, and research instrument. The model and analysis test used in this study includes a data analysis component when looking at the relationship between dependent and independent variables.

1.7.4 Chapter 4

Following that, this chapter will present the outcomes of the empirical research. Descriptive statistics and analysis, for instance, are used for interpretation. Result Inferential analyses and scale measurement were also covered in Chapter 4. The relationship between the independent variables will be ascertained by implementing the hypotheses presented in Chapter 2 in some tests.

1.7.5 Chapter 5

The findings, limitations, and recommendations for additional research will be discussed. Lastly, there will be a detailed discussion of the synopsis of the results from Chapter 4 in this part. This is to make whether the study is correct and consistent when compared to other studies conducted by other researchers, based on the discussions of the research paper's primary findings.

1.8 Conclusion

One of the most important aspects of chapter one was the factors affecting the oil prices in the US. The second chapter will address previous studies on the topic and contribute to our comprehension of the variables affecting the price of crude oil in the US. It provides a comprehensive summary of the current status of the area, making it easy to identify relevant theories, methods, and gaps in the literature to make connections between the study.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter will further discuss the literature study on this subject. This section will also include the theoretical and conceptual framework, the construction of the crude oil price assumptions, and independent variables. Knowing the correlation between dependent and independent variables will help us understand this chapter's topic better. It gives a clear framework chart to understand the chapter's summary.

2.1 Literature Review

2.1.1 Crude Oil Price (COP)

The objective of this review of the literature is to fully explore and elucidate the relationships that exist between fluctuations in the price of crude oil and the consequences that these fluctuations have for a range of economic variables, including GDP growth, inflation, exchange rates, supply and demand for oil.

Crude oil is a key worldwide commodity, and changes in price can have a direct effect on the stability of international trade as well as the trade benefits of nations that import and export crude oil. The relationship between crude oil, stock markets, and foreign exchange markets has grown in prominence since the 1970s, when the crude oil pricing system denominated in US dollars was established (Basher et al., 2016).

During an economic and financial crisis, the degree of risk spillover from shocks to oil prices was greatly increased, and the United States, being the source of the problem, exacerbated the risk spillover across the entire system. Since then, the global overcapacity of crude oil and significant supply and demand mismatches brought about by the U.S. shale oil revolution have caused more severe shocks to the global crude oil and financial markets than those experienced during the financial crisis (Chen & Zhang, 2023).

The interaction between GDP and crude oil prices emerges as a key topic of discussion among scholars. Research supports the idea that changes in real exchange rates brought on by shocks to the price of oil can have a variety of effects on the trajectories of economic growth (Alekhina, 2020; Ahmad, 2022; Baek & Yoon, 2022; Zulfigarov & Neuenkirch, 2020; Sheng et al., 2020). However, the complexity of this impact is mediated by the intrinsic flexibility of nominal exchange rate regimes, leading to complex responses within the dynamics of real GDP.

The correlation between oil prices and inflation is another important topic. Inflation has historically been associated with increases in the consumer price index, which is a function of rising crude oil prices. According to the report, rising oil prices cause transportation costs to rise, which in turn raises the cost of manufacturing as a whole. An inflationary trend is brought about by the overall amount of this manufacturing price increase over time (Belloumi, 2023).

Exchange rates and oil prices have a complicated relationship. Changes in the price of oil have a big impact on exchange rates; they affect changes in nominal exchange rates as well as the stability of the macroeconomic environment. The study claims that because Bangladesh depends on global markets for its crude oil purchases, there is a greater need for foreign currencies—especially the US dollar—which could lead to currency devaluation. As a result of this ongoing currency depreciation, there are other economic difficulties that arise, such as fluctuations in prices and a reduction in gross international reserves (Nandi et al, 2024).

2.1.2 GDP growth (GDP)

The article "Does Gross Domestic Product, inflation, Total Investment, and Exchanges Rate Matter in Natural Resources Commodity Prices Volatility" touches upon various aspects of the relationship between oil prices and GDP growth, emphasizing the importance of understanding this dynamic for economic policymakers and researchers. A number of research that are discussed in the text add to the conversation about how oil prices affect macroeconomic factors, especially GDP growth. The authors construct a four-variable VAR model in order to investigate the dynamic link between these variables and the volatility of natural resource commodity prices across time. The study's conclusions demonstrated a positive correlation between the amount of investment, GDP growth, inflation, and exchange rate with the volatility of oil prices. The need for energy sources to power manufacturing facilities, machinery, and other supporting logistics increases as the GDP growth rate rises. Consequently, the usage of coal and oil drives up their prices (Huawei, 2022).

Yang et al. (2021) used data from the Russian economy from 1988 to 2019 to perform theoretical research on the connection between oil prices and GDP growth. The application of the nonlinear autoregressive distributed lag model (NARDL) revealed that increases in GDP were associated with rises in oil prices, indicating a positive correlation between the two factors.

Umar et al. (2020) introduced the concept that natural resource utilization, including oil, contributes to economic growth. The authors argued that as economic growth rates rise, there is an increased preference for investing in natural resources, resulting in higher commodity prices. The article also notes that 40 million barrels of oil are consumed daily by the US, China, Japan, India, and Russia combined. This suggests that as China and India's economies grow and threaten the dominance of global trade, there may be a rise in the need for energy.

Scholars such as Kilian (2009) and Hamilton (2009) have explored the causal relationship between GDP and oil prices, with findings suggesting that economic activities can negatively influence oil prices. As economic activities grow, the investment activities in oil production tend to increase in the market. The increase in investment will cause producers to increase supply and oil prices reduced. Higher oil prices often contribute to increased production costs, reduced consumer spending, and reduced overall economic growth, while lower prices may stimulate economic expansion. This indicate there are a negative relationship. Not only that, but the increase in oil prices will also cause a decline in the GDP growth rates of import countries, especially those that heavily rely on oil demand. A rise in oil prices increases production costs for firms. Lower output and increase in factor prices will affect consumption and investment negatively (Nyangarika et al, 2018). According to the study "Role of macroeconomic determinants on the natural resource commodity prices: Indonesia futures volatility", it implies that GDP growth has a positive association with crude oil price. When a nation achieves a high GDP rate, the stimulation of its economy through improved infrastructure, more tourism, transportation, and production leads to a high demand for natural resources and price volatility. These results are in line with previous research by Ben-Salha et al. (2018), which discovered that higher GDP growth raises people's income levels, employment opportunities, and standards of life. When a nation's population is able to buy natural resources in proportion to their requirements, and as a result, demand for natural resources surpasses supply and the price will rise (Ekananda, 2022).

2.1.3 Inflation (INF)

According to several studies, there is a positive association between inflation and crude oil prices, which has a variety of consequences for economic activity, output, buying power dynamics, business activity, and consumer price index. Notably, the increase in oil prices frequently acts as a catalyst for increased economic activity and production levels. In response to rising prices for scarce natural resources, firms expand output, boosting economic development and raising prices within economies (Chien, 2022) (Tian, 2022) (Sekati et al, 2020).

When the economy grows rapidly, demand for products and services rises, which also drives up demand for energy, particularly crude oil (Chien, 2022). The relationship between the CPI and crude oil prices also affects purchasing power dynamics and inflation. Businesses, particularly those in the oil industry, are driven to pass on their rising production costs to customers to offset their declining buying power due to rising crude oil costs (Tian, 2022; Chien, 2022; Sekati et al, 2020).

Comprehensive statistical and investigations have shown that the method by which general price increases are transmitted to the pricing of natural resource commodities is complex. Insights into controlling inflation and its effects on crude oil prices have been provided through studies using cutting-edge statistical techniques that have revealed the relationship between macroeconomic factors and the pricing of natural resources (Mao, 2021). Balcilar (2016) Mensi et al. (2023) show a clear connection between inflation and market resource value, which raises resource prices.

However, from the article "Study of the impact of crude oil prices on economic output and inflation in Saudi Arabia", the results of the inflation ARDL model show that oil prices have a major impact on inflation in Saudi Arabia over the short and long terms. In the medium and long terms, rising crude oil prices could result in lower inflation, while falling prices could have the opposite effect. This is because when oil prices increase, the costs of producing and transporting these goods and services also increase, which may lead to lower economic growth and lower inflation. Furthermore, Sarmah & Bal (2021) discover that as inflation increases, central banks may react by raising interest rates to reduce inflationary pressures. The increase in interest rates can lead to a slowdown in economic activity and a decrease in demand for goods and services, including oil. As demand weakens, oil prices may decrease as a result.

2.1.4 Exchange Rates (EXC)

There are many studies states that exchange rate and crude oil prices have a positive relationship. Academics like Yousefi and Wirjanto (2003, 2005) stress how important it is for OPEC nations to modify their oil prices in accordance with the US dollar's value in order to preserve their market share and protect the purchasing power of their oil money. The price of oil income in U.S. dollars and the collusive nature of OPEC are the reasons for the incomplete exchange rate pass-through in OPEC countries. Feinberg (1989) and others emphasize how market dominance by foreign manufacturers, who can readily pass on exchange rate shocks to consumers through frequent price adjustments, plays a role in local price destabilization. The correlation between them is also explored in the literature, with differing results. Studies by Huang and Tseng (2010), Tiwari et al. (2013), and Ding and Vo (2012) indicate a bi-directional relationship, while others like Basher et al. (2012) and Narayan et al. (2008) suggest short-term oil price shocks depressing U.S. dollar exchange rates. By using variance decomposition, impulse response function analysis, and Granger causality testing, the research advances our knowledge of this intricate link. They find that fluctuations in exchange rates immediately affect the price of oil and that, over time, having a causal correlation between the price of oil and the US dollar. Crude oil prices are significantly impacted negatively by exchange rate shocks, but the exchange rate variable's impulse reaction to such shocks was statistically negligible. It seems that currency rates and the price of crude oil could play a significant effect. For instance, if a commodity is valued in US dollars and price shocks to supply or demand cause the commodity to rise, the only option to restore the global economy's general equilibrium is by adjusting the exchange rate.

On the other hand, the positive link between the exchange rate and the price of oil extends to inflation, where the exchange rate pass-through effect plays a key role in converting the high oil prices experienced globally into local inflation (Zhao, 2022). When exchange rates and oil prices move together, inflationary tendencies are likely to follow, which might impact real GDP and lead to short-term economic overheating from real exchange rate changes. The excessive demand for oil imports would impact the cost of production, local inflation, economic growth, consumption patterns, and investment choices (Jalal & Gopinathan, 2022). The extensive consequences of the exchange rate-oil price synergy for monetary policy and tactical risk management are highlighted by this research review. As evidenced by the fact that U.S. crude oil imports are getting more expensive as a result of the sinking dollar (Brahmasrene et al, 2014), it is clear that this complicated interdependency requires careful considerations in risk mitigation techniques.

2.1.5 Oil Supply (SUPPLY)

Scholars, including Bentzen (2007) emphasize the impact of OPEC decisions, such as quotas and production restrictions, on oil prices, highlighting the asymmetric nature of this relationship, where OPEC decisions influence prices but changes in prices do not necessarily affect OPEC's decisions. The global nature of the oil market is underscored by Bentzen's findings, supporting the contention of a cohesive global oil market. Other studies, such as those by Lanza et al. (2005), delve into the structural relationships between heavy oil prices and final products, revealing strong connections between them. Furthermore, the literature explores the broader implications of oil prices on economic indicators, inflation, and economic growth, providing a comprehensive understanding of the multifaceted dynamics between oil supply, prices, and economic performance. The research also highlights the importance of considering the supply side in explaining recent oil price fluctuations, indicating that production variables may have a more direct impact on oil prices compared to consumption factors. The article employs unrestricted vector autoregressive model (VAR) models to conduct causality tests between oil prices and consumption in order to determine the relationship between these variables. According to the research, supply factors have a far greater impact on oil prices than consumption does, and there is no clear correlation between the two. Therefore, they assert that the supply side of the market appears to be the source of both rising and dropping oil prices (Gallo, Mason, Shapiro & Fabritius, 2010).

Wars or political tensions in oil-rich regions have a significant negative direct effect on oil supply, primarily through disruptions to production. The severity of these disruptions depends on the scale and duration of conflicts, indicating an indirect influence on oil prices (L. Kilian, 2010). A reduction in oil supply can increase the crude oil price. Additionally, while economic activity remains the primary factor influencing oil price dynamics, oil supply ranks as the second most influential factor. Context-based evaluations of oil supply changes are crucial, distinguishing between disruptions caused by wars and those attributable to non-war-related events. Such distinctions are necessary as supply changes induced by conflicts tend to exert more pronounced effects on oil prices compared to other supply changes. Historical events such as wars, financial crises, and geopolitical tensions underscore the importance of economic activity and political stability in explaining oil price changes. Overall, the literature suggests a negative relationship between oil supply and oil prices, heavily influenced by geopolitical factors, economic activity, and speculative trading behaviours (Wang & Sun, 2017).

2.1.6 Oil Demand (DEMAND)

Historical oil price shocks were initially attributed to supply disruptions and geopolitical disturbances, as discussed by Baumeister and Lutz (2016). However, the 2007–2008 oil price increase marked a departure from the traditional supply-driven shocks, with demand playing a central role. This shift was characterized by a surge in demand from rapidly growing emerging economies, particularly in Asia, as noted by According to Behr (2009), the rise in oil demand has had a disproportionate impact on the price of oil globally. The literature also highlights the changing distribution of oil consumption, with rising demand in developing countries, especially in China and non-OECD Asian nations (BP, 2013). The analysis emphasizes the importance of understanding the elasticities of income and price in differentiating consumption patterns between developed and developing economies. Studies by Gately and Huntington (2002) and Hamilton (1983) underscore the asymmetry in price effects, with price increases having a more substantial impact on demand than decreases, particularly in OECD countries. The recent literature has also explored the role of income growth in developing countries, infrastructure development, and energy efficiency as key factors influencing oil demand patterns (Barclays, 2012; Merrill Lynch, 2012). Then from the result, they found that the key factors with the oil demand and oil price are positive relationships (Jobling & Jamasb, 2017).

A thorough examination of the variables impacting oil demand, particularly during the 2014–2016 oil price collapse, can be found in the research "Explanations for the 2014 Oil Price Decline: Supply or Demand?" While acknowledging the scarcity of academic studies addressing the impact of the shale revolution on oil prices, the research emphasizes the significance of demand-side explanations in understanding the dynamics of oil demand. Using a vector autoregressive (VAR) model, Baumeister and Kilian (2016c) provide insightful analysis by showing that, based on data available as of June 2014, almost half of the decrease in Brent oil prices during the second half of 2014 was predictable. Importantly, their findings suggest that supply shocks, whether originating from the U.S. or globally, accounted for no more than 30% of the price decline, with all supply-side impacts occurring before June 2014. The paper also highlights Kilian's (2017) use of a structural VAR model to construct a counter-factual scenario without the U.S. oil boom, concluding that the shale revolution had a negligible impact on oil prices. The evidence consistently points towards weakening economic conditions and a decline in global economic activity, suggesting that demand decline played a more pivotal role in driving the observed decline in oil prices (Prest, 2018).

2.2 Review of Relevant Theoretical Models

A commodity's supply on the market is determined by some variables, such as supply interruptions, geopolitical tensions, rising demand, and OPEC production choices, in addition to the price that can be obtained for the commodity (Oil Prices and Outlook - U.S. Energy Information Administration (EIA), n.d.). The measure will raise the price of crude oil. Buyers will often bid the price higher if they desire to buy more of a commodity than the market offers. Higher crude oil prices can increase production costs for companies in various economic sectors.

Numerous sectors depend on oil as a crucial component for production, transportation, and energy production. The market is supposed to balance supply and demand through the pricing mechanism. Energy consumption rises as economies expand, particularly for transporting commodities and resources from producers to consumers (Trang et al, 2017). Due to manufacturers' potential to pass along production costs to consumers, the rise in these expenses may impact the prices of various goods and services. Oil price hikes can also hinder the economy's expansion through their impact on the supply and demand for items other than oil (Ahmad, 2022).

Businesses might boost production levels to produce larger profits to balance the increased expenses brought on by higher oil prices. Taylor's rule is used in monetary policy; as oil prices rise, general price levels increase (inflation), and interest rates decrease (Mishkin, 2011). That is because increasing oil prices make it more expensive for businesses to produce products and services, which can increase inflation.

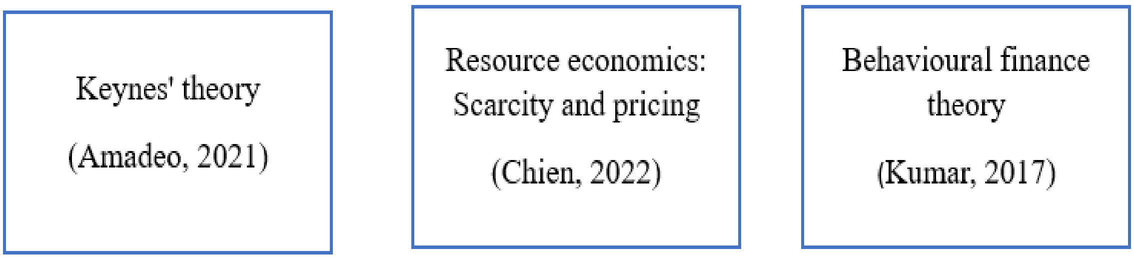
According to Keynes' theory, aggregate demand defined as the total of consumer, company, and government spending, is the main engine of an economy (Amadeo, 2021). In addition, Keynes said that free markets lack the self-balancing processes that provide full employment and stable prices. Keynesianism is a "demand-side" theory concentrating on short-run economic fluctuations because they think a lack of demand for products and services causes unemployment (What Is Keynesian Economics, 2014). The reasoning behind this is that when businesses perceive a lack of demand, they reduce production and consequently lay off workers. This cyclical effect can exacerbate economic downturns Keynes stated that the dynamic force controlling economic activity is an investment which reacts to changes in interest rates and expectations for the future. According to Keynesian economists, the government may directly affect demand for products and services by changing tax laws and spending priorities. Keynesian ideas hold that changes in aggregate demand considerably affect total economic activity. Keynesian ideas advise raising public expenditure and decreasing taxes to boost demand during economic downturns and recessions (Amadeo, 2021). Increasing output and economic growth may result from this rise in demand for products and services. That is because oil is necessary for many economic sectors, such as transportation, manufacturing, and energy generation. Keynesian policies have increased economic activity, which is anticipated to raise oil demand. Higher levels of item and service production and consumption frequently result in greater demands for transportation and energy, which raise oil prices. When demand for oil rises due to increased economic activity brought on by Keynesian policies, and if supply does not grow to keep up with this greater demand, oil prices may increase (Grant,2013).

A fundamental tenet of resource economics is scarcity and its effect on pricing (Chien, 2022). Prices for scarce commodities like crude oil frequently change in response to supply and demand. Prices typically increase when demand exceeds supply, as shown in the case of crude oil. As a result, oil prices increase, which may have a domino impact on many economic sectors. The impact of this price rise on oil prices and the whole economy may be seen, as well as the exploration of new sources (Oxford Business Group, 2022). Exploration and the development of new oil sources are encouraged by rising oil prices. Exploration of new oil reserves, especially in harsh areas, and the developing of cutting-edge extraction technology to speed up the process are necessary as prices rise. High oil prices can stimulate investments in alternative energy sources. Developing and implementing renewable energy technologies, such as solar, wind, and electric cars, becomes more financially advantageous when oil prices rise (How Oil and Gas Companies Can Be Successful in Renewable Power, 2023). This diversification can lessen reliance on oil and the effects of price changes. Increasing manufacturing costs for various goods and services will reduce consumers' buying power (Butt et al, 2022). This decline in purchasing power might result in changed spending patterns, lowered consumer confidence, and potential economic instability.

Behavioural finance theory is exploring how human emotions and cognitive biases affect financial decisions and market results behavioral finance theory, which blends parts of psychology and economics (Kumar, 2017). Changes in market sentiment brought on by behavioral variables might affect investor expectations for the direction of oil prices.

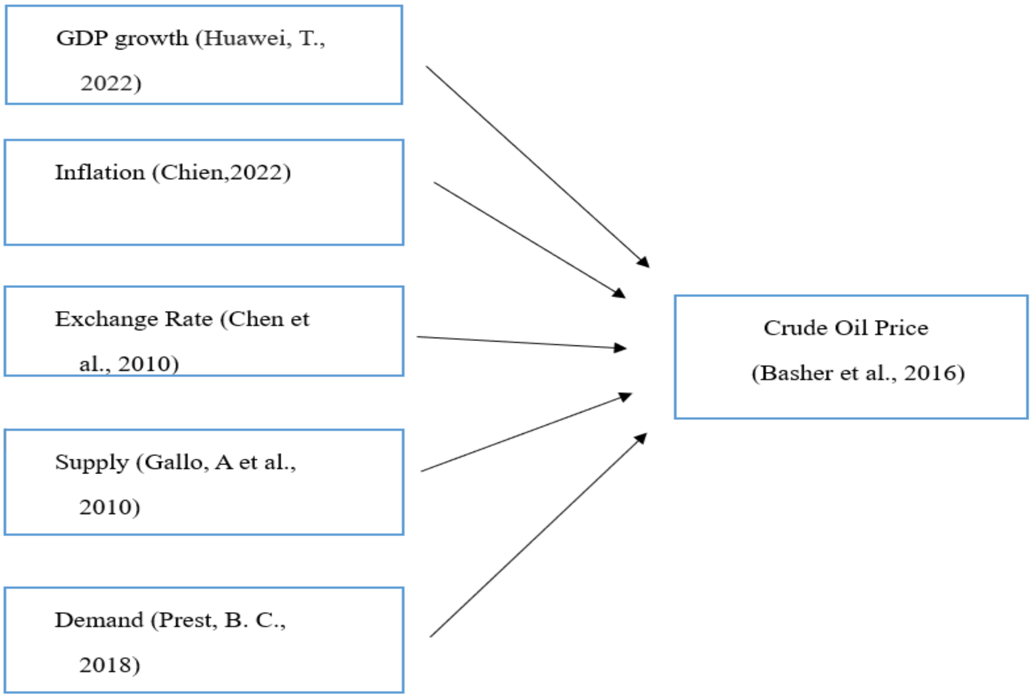
The hypothesis contends that such organizations and many investors have the same overconfidence, overreaction, and overrepresentation traits (Vipond, 2023). That is so because investors frequently imitate what others do instead of making their judgments. It can lead to inflated price swings not always supported by supply and demand fundamentals if many investors start buying or selling oil futures based on herd behavior (ThemeGrill, 2023).

Figure 2.1: Theoretical Framework



2.3 Proposed Conceptual Framework

Figure 2.2: Proposed Conceptual Framework



2.4 Hypothesis Development

H1: There is a positive relationship between GDP growth (GDP) and Crude Oil Price (COP) in United States.

H2: There is a positive relationship between Inflation (INF) and Crude Oil Price (COP) in United States.

H3: There is a positive relationship between Exchange Rate (EXC) and Crude Oil Price (COP) in United States.

H4: There is a positive relationship between Oil Supply (SUPPLY) and Crude Oil Price (COP) in United States.

H5: There is a positive relationship between Oil Demand (DEMAND) and Crude Oil Price (COP) in United States.

2.5 Conclusion

The chapter includes many prior studies to explore the link between these variables. The study framework and hypotheses were created based on the reviewed past works. Chapter 3 will explain this research paper's methodology research and analysis in chapter 2.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter will provide an overview of the study's research design, data collection, sample plan, research instrument, and data analysis methods.

3.1 Research Design

3.1.1 Quantitative Research

Quantitative research gathers and analyses numerical data to characterize, forecast, or study dependent variables. An organized, measured, and numerical method of acquiring information is known as quantitative research (Sreekumar, 2023). This kind of study aids in determining the causal links between variables, developing hypotheses, and extrapolating findings to larger populations. Quantitative research aims to examine a predetermined theory or hypothesis and either accept or reject it considering the findings. This kind of research is applied in psychology, economics, sociology, and marketing. Quantitative research aims to find patterns, connections, and trends in the data so researchers can conclude things and generalize about a more significant population. This collection reflects the intended population or market, and reliability is ensured. Commonly used quantitative methods include closed-ended survey questions, numerical observations, and experiments (Streefkerk, 2023).

3.2 Data Collection Method

The exact methods and procedures utilized to acquire information and data for research objectives are data collection methods. These techniques specify the means for gathering data, the categories of data that will be gathered, and the steps to ensure the data's accuracy and dependability. Depending on the research topics and goals, different data collection techniques might be needed.

3.2.1 Secondary Data

Secondary data are the kind of data used in this investigation. Scholars can readily employ secondary data, which has already been collected from primary sources, for their own research projects. Books, journals, articles, and websites are some of the sources of secondary data.

3.2.2 Data Collection

Secondary data are data available from publications where the data that will be collected for the variables of this research will be from the World Bank Data, OECD, Federal Reserve Bank of St. Louis, and U.S. Energy Information Administration. The data collected will be from the year 1990 to the year 2022 and it will be an annually data collection. The developed country that will be used in this research is the United States.

Table 3.1 Data Collection

Variable	Description	Source of Data
Crude Oil Price	This crude oil price refers to the import prices that come from the IEA's Crude Oil Import Register. This indicator is measured in USD per barrel of oil.	OECD Database
GDP growth	GDP growth (annual %) which is the percentage of the GDP growth rate	World Bank

	annually at market prices based on a fixed currency	
Inflation	The Consumer Price Index, which calculates the annual percentage change in the average consumer's cost of a fixed basket of goods and services, is the basis for measuring inflation.	World Bank
Exchange Rate	The exchange rate is U.S. Dollars to U.K. Pound Sterling spot rate.	Federal Reserve Bank of St. Louis
Oil Supply	The oil supply is the total production of crude oil in the United States. This indicator is measured in USD per million barrels of oil.	U.S. EIA
Oil Demand	The oil demand is the total consumption of crude oil in the United States. This indicator is measured in USD per million barrels of oil.	U.S. EIA

3.3 Model Specification

$$\boldsymbol{COP_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 INF_{t-1} + \beta_3 EXC_{t-1} + \beta_4 SUPPLY_{t-1} + \beta_5 DEMAND_{t-1} + \varepsilon_t}$$

$$\boldsymbol{\Delta LNCOP_t = \beta_0 + \beta_1 \Delta GDP_{t-1} + \beta_2 \Delta INF_{t-1} + \beta_3 \Delta EXC_{t-1} + \beta_4 \Delta SUPPLY_{t-1} + \beta_5 \Delta DEMAND_{t-1} + \varepsilon_t}$$

Where:

COP = Crude Oil Price (USD/barrel)

GDP = GDP growth (%)

INF = Inflation (%)

EXC = Exchange Rate (USD/GBP)

SUPPLY = Oil Supply (USD)

DEMAND = Oil Demand (USD/million barrel)

$\boldsymbol{\beta_0}$ = Intercept

$\boldsymbol{\beta_1}, \boldsymbol{\beta_2}, \boldsymbol{\beta_3}, \boldsymbol{\beta_4}, \boldsymbol{\beta_5}$ = Coefficient

LN = Log

$\boldsymbol{\varepsilon}$ = Error

T =Time period (year 1990 to year 2022)

3.3.1 Time Series Data

The technique of projecting or anticipating future values of a variable based on past data points in a time series is known as a time series data estimate (What Is Time Series Analysis? n.d.). Trend analysis and time series data are the subjects of the statistical technique known as time series analysis. Data from time series are periodic time periods that have been measured at regular intervals or gathered at certain times (Pandian, 2023). Studying the features of the response variable with regard to time as the independent variable is done through time series analysis. This form of data is frequently employed in various disciplines, including economics, finance, environmental science, and engineering because it offers insights into how a variable evolves over time.

3.4 Research Instrument

A statistical software created specifically for econometric analysis is called EViews 12. It offers resources for forecasting, regression, time series, and data analysis. It is extensively utilized in government organizations, businesses, and academic research. It can carry out sophisticated econometric approaches and handle enormous datasets. EViews furthermore offers sophisticated forecasting capabilities that enable users to predict future values and trends with a high degree of accuracy (EViews.com, n.d.). Overall, EViews is a strong and adaptable tool for econometric research that offers users a variety of statistical techniques, data management tools, and forecasting.

3.5 Data Processing

There are 5 independent factors in this analysis that will impact the price of crude oil in the US. The secondary data, which cover the period from the year 1990 to 2022, are then retrieved online. The variables are crude oil price, GDP, inflation, exchange rate, oil supply, and oil demand.

Step 1: Selection of Variables

- Determine the variables based on the literature or earlier investigations.

Step 2: Data Collection

- Collect the data from secondary sources such as World Bank, Federal Reserve Economic Data (FRED) database and others.

Step 3: Data Rearrangement

- Combine and reorder the data that corresponds to our independent variable, such as by arranging them in log, first difference, and second difference modes.

Step 4: Data Analysis

- Apply the EViews 12 applications to analyze each portion of data and model.

Step 5: Interpretation of Results

- Interpret the result that get from EViews 12.

3.6 Descriptive Analysis

A sort of data analysis called descriptive analysis helps to precisely describe, show, or summarize data items so that patterns might appear that completely satisfy the data needs (Rawat, n.d.). Examples of characteristics of a dataset that must be analyzed include measures of the form (skewness, kurtosis), measurements of dispersion (standard deviation, variance, range), and measures of central tendency (mean, median, mode) (Frost, 2022). The main objectives of descriptive analysis are to provide the reader with a comprehensive picture of the data and identify any trends or patterns. Descriptive analysis helps understand the data and spot possible issues such as outliers or missing values. It helps convey information to others clearly and succinctly.

3.7 Unit Root Test

A time series' stationary character is determined using the unit root test. According to Gujarati (2009), a time series is considered stationary if a change in time does not result in a change in the distribution structure; non-stationarity can have several causes, including unit roots. The ADF test is often used based on the time series regression on its own lagged values. If the null hypothesis is not accepted, the series can be stationary. It is possible to examine the residual for random walk components. Before performing the PP test, researchers must compute an autoregressive (AR) time series model. Then, it is necessary to determine whether the coefficient on the lag-dependent variable significantly deviates from one. The number of periods of serial correlation to include, or the truncation lag for the Newey-West correction, must be specified for the PP test (Studenmund, 2017).

Ho: The time series data is unit root (nonstationary).

HA: The time series data is no unit root (stationary).

Statistical significance is denoted by *** at a level of p-value < 0.01, ** at a level of p-value < 0.05, * at a level of p-value <0.1, and "ns" (not significant) at a level of p-value > 0.1. If the p-value of the variable is less than 0.1, the null hypothesis will be rejected, and we can say the series is stationary and without a unit root.

3.8 Correlation Analysis

The method of statistical correlation analysis assesses the relationship between two variables. The correlation coefficient, sometimes known as Pearson's, is the most popular correlation metric (Statistics Solutions, 2021). The correlation coefficient measures the linear relationship between two variables, which reveals their strength and direction. The variable is significant if the study shows that the correlation coefficient deviates noticeably from zero. It is not significant if the correlation coefficient varies but is not significantly different from zero. Correlation analysis is frequently used in various areas, including psychology, the social sciences, and economics, to determine how closely two variables are related. Calculating a correlation coefficient, a quantitative value between -1 and +1, is the basis for correlation analysis (Studenmund, 2017).

3.9 Granger Causality Test

The Granger causality test is a statistical hypothesis test for detecting if one time series helps forecast another (Studenmund, 2017). If you want to know if two-time series or two variables are co-integrated, you can apply the Granger tests.

The stationary and linear combination is the name given to it. The link between the variables is the co-integrated and long-term equilibrium relationship. The Granger causality test ascertains if the previous values of one variable provide crucial information beyond what can be anticipated from those previous values alone for projecting the future values of another variable (Eric, 2021). "Granger cause" is the first variable, and the second is whether one variable's past values significantly aid in predicting the future values of another variable. Granger causality just highlights the potential for forecasting; it does not explain the causal relationship between two variables.

3.10 Vector Error Correction Model (VECM)

The vector error correction model is the cointegrated VAR model. An error-correction term derived from that relationship and a VAR model of order p - 1 on the discrepancies between the variables make up this notion of the Vector Error Correction Model (VECM), which is based on a known approximated cointegrating relationship (Maitra, 2021). A cointegration equation and VECM equations were added to the VECM model. The cointegration equation is incorporated into the specification to prevent the endogenous variables' long-term behavior from converging to a cointegrating connection. The VECM equations incorporate all endogenous variables while permitting short-term adjustment dynamics. Since partial short-term adjustments are used to gradually correct deviations from long-term equilibrium, the cointegration equation is also known as the error correction technique (ECM model). The VECM model includes an error correction factor for deviations from long-run equilibrium connections between variables (Silvestrini & Burke, 2018).

3.11 Scale Measurement

3.11.1 Normality Test

Ho: Residuals are normally distributed.

HA: Residuals are not normally distributed

Decision:

- Reject Ho: (There is not normally distributed); P-value ≤ Critical α 0.05 Value.

- Do not reject Ho: (There is normally distributed; P-value > Critical α 0.05 Value

The test is used to check if the residuals from a regression model have a normal distribution. All methods for testing hypotheses will be useless if it is found that the error terms are not regularly distributed. However, if the sample size for the study is large than 100, the probability distributions for the t and F statistics are quite similar. Consequently, the hypothesis testing techniques are still applicable despite error dispersion among the error terms. The validity of the model's normalcy assumption is further assessed using a P-value analysis with a significance threshold of 1%.

Many statistical tests and confidence intervals in regression analysis depend on the assumption of normality for the residuals. A statistical test called the Jarque-Bera test assesses if the standardized residual distribution of a regression model deviates significantly from normality. The Jarque-Bera test uses the skewness and kurtosis of the standardized residuals. Kurtosis measures the flatness or peakiness of the distribution. The skewness and kurtosis should be very low if the standardized residual distribution is nearly normal.

3.11.2 Multicollinearity Test

Ho: Residuals are not multicollinearity

HA: Residuals are multicollinearity

Reject Ho: (There is multicollinearity); P-value ≤ Critical α 0.05 Value.

Do not reject Ho: (There is no multicollinearity); P-value > Critical α 0.05 Value.

When more than two variables in the model have a strong correlation with one another, this is statistically referred to as multicollinearity. Substant multicollinearity may be observed if the correlation coefficient is more than 0.8. EViews 12 may calculate the correlation coefficients between two independent variables in absolute value. Finally, multicollinearity is likely if the tolerance (TOL) is close to zero and the variance inflation factor (VIF) is around 10. It can be more difficult to understand the data and derive significant inferences from the model when multicollinearity leads to unstable and unreliable coefficient estimations (Bhandari, 2023).

3.11.3 Serial Autocorrelation Test

Ho: Residuals are not serial autocorrelation

HA: Residuals are serial autocorrelation

Decision:

Reject Ho: (There is Serial Autocorrelation); P-value $\leq$ Critical α 0.05 Value.

Do not reject Ho: (There is no Serial Autocorrelation); P-value > Critical α 0.05 Value.

The statistical term autocorrelation, commonly referred to as serial correlation, shows how closely a time series or sequence of data points is linked with itself at various time delays. In plainer terms, it assesses how one observation in a time-ordered collection relates to earlier observations.

The ability to identify patterns and connections in data across time makes autocorrelation an essential topic in time series analysis. First-order serial correlation, in which the error term's present value depends on its past value (lag value), is the type of serial correlation that is most frequently assumed. It will be more challenging for Ordinary Least Square (OLS) to provide precise estimates of the standard errors of the coefficients if there is a systematic correlation between one observation of the error component and another.

3.11.4 Heteroscedasticity Test

Ho: Residuals are not heteroskedasticity

HA: Residuals are heteroskedasticity

Decision:

- Reject Ho: (There is heteroscedasticity); P-value $\leqslant$ Critical α 0.05 Value.

- Do not reject Ho: (There is no heteroscedasticity); P-value > Critical α 0.05 Value.

A regression analysis scenario known as heteroskedasticity occurs when the variability of the errors (also known as residuals) is not constant across all levels of the independent variables. Furthermore, a heteroskedasticity problem might be brought on by the existence of outliers in the result. Additionally, if important variables are excluded from the model, regression residuals may suggest that the model variances are not evenly distributed. One of the fundamental presumptions of linear regression is that the residuals have a constant variance. That means that regardless of the observation or range of observations, the error term's variance cannot vary. Homoskedasticity is the name for this presumption. Heteroskedasticity results when this presumption is broken, and the variance of the residuals is not constant. The Breusch-Pagan-Godfrey Test (BPG), and the White Test may all be used to identify heteroskedasticity.

3.12 Inferential Analysis

3.12.1 R-square

A statistical metric that demonstrates how well a regression model fits the observed data is the coefficient of determination, known as the R-squared

(Studenmund, 2017). R-squared assesses the contribution of the independent variables to the variance of the dependent variable. If the independent variables strongly influence the independent variable, R2 is the simplest, non-calculative measure of the variables. There is no meaningful correlation with the dependent variable when it is 0 with an R2 of 1. ($0 \leqslant R2 \leqslant 1$), the ideal significant link (Studenmund, 2017). Make it clear that R2 has limitations as a measure of significance, including the propensity for researchers to ignore considering the impact on the error term to increase R2 merely. Therefore, corrected R2 is a more trustworthy measure.

3.12.2 Adjusted R-square

For conventional R-squared, the adjusted R-squared value typically ranges from 0 to 1. When model complexity is taken into account, a higher adjusted R-squared implies that the independent variables account for a greater percentage of the variance in the dependent variable. A modified form of the standard R-squared (R2) statistic used in regression analysis is called adjusted R-squared (Team, 2023). A more trustworthy indicator of the model's goodness of fit is adjusted R-squared, which takes into consideration the quantity of independent variables included. According to Studenmund (2017), R2 quantifies the percentage of the variation in the dependent variable that can be explained by the independent variables in a model. The basic adjusted R-squared will increase when more independent variables are included, even if they do not improve the model's ability to predict the future. A more accurate picture of how well the model fits the data may be obtained by comparing models with different amounts of predictors.

3.13 Conclusion

This chapter has discussed the technique for gathering data, model specification, and all the analyses and tests. Chapter 4 is going to adopt EViews 12 to run the analysis and test in Chapter 3 and interpret the result.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

This chapter presents the time series analysis for the period spanning from the year 1990 to 2022. Prior to determining the optimal model, a series of diagnostic tests were conducted, which encompassed the Unit Root test, Serial Correlation test, and normality test. In order to conduct a comprehensive assessment of the objectives stated in Chapter 1, additional statistical measures such as Granger Causality Test, Vector Error Correction Model are employed to establish the relationship between the various independent variables and the price of Crude Oil.

4.1 Descriptive Analysis

Table 4.1 Descriptive Analysis

	D_LNCOP	D_SUPPLY	D_INF	D_GDP	D_EXC	D_DEMAND
Mean	0.0453	0.3247	0.0814	0.005488	-0.0176	0.1029
Median	0.0847	0.0210	0.0243	-0.167556	-0.01370	0.1930
Maximum	0.5664	2.2890	3.4643	8.713287	0.1853	1.7040
Minimum	-0.6690	-0.8420	-4.1946	-5.062242	-0.2716	-2.3570
Std. Dev.	0.2878	0.7268	1.4280	2.526365	0.1074	0.6577
Skewness	-0.5399	0.9725	-0.0658	1.225043	-0.4993	-1.4936
Kurtosis	2.8898	3.1761	4.9106	6.373627	3.0712	8.3379
Jarque-Bera	1.5705	5.0850	4.8902	23.1790	1.3363	49.8893
Probability	0.4560	0.0787	0.0867	0.0000	0.5127	0.0000
Sum	1.4487	10.391	2.6048	0.1756	-0.5617	3.2920
Sum Sq. Dev.	2.5685	16.377	63.2146	197.8581	0.3576	13.4095
Observations	32	32	32	32	32	32

D_LNCOP:

Crude oil price has a relatively low mean (0.0453) and a moderate standard deviation (0.287846), indicating moderate variability around the mean. The minimum value is -0.6690, and the maximum value is 0.5664. The negative skewness (-0.5399) suggests a longer left tail, and the positive kurtosis (2.8898) indicates heavy tails. The crude oil price has a wide range of values with some extreme values towards both ends of the distribution.

D_SUPPLY:

The oil supply has a higher mean (0.3247) and a larger standard deviation (0.7268), indicating substantial variability around the mean. The minimum value is -0.842, and the maximum value is 2.289. The positive skewness (0.9725) suggests a longer right tail, and the positive kurtosis (3.1761) indicates heavy tails. The supply exhibits a wide range of values with a notable number of higher values contributing to the positive skewness.

D_INF:

Inflation has a moderate mean (0.0814) and a large standard deviation (1.4280), indicating considerable variability around the mean. The minimum value is -4.1946, and the maximum value is 3.4643. The skewness is close to zero (-0.0658), suggesting a relatively symmetric distribution, while the kurtosis (4.9106) indicates heavy tails. The inflation shows moderate variability with some extreme values towards both ends of the distribution.

D_GDP:

GDP growth has a small mean (0.0055) and a large standard deviation (2.5264), indicating substantial variability around the mean. The minimum value is -5.062242, and the maximum value is 8.7133. The positive skewness (1.2250) suggests a longer right tail, and the high kurtosis (6.3736) indicates heavy tails. The GDP growth exhibits significant variability with a few extreme positive values contributing to the right skewness.

D_EXC:

Exchange rate has a slightly negative mean (-0.0176) and a moderate standard deviation (0.1074), indicating moderate variability around the mean. The minimum value is -0.2716, and the maximum value is 0.1853. The negative skewness (-0.4993) suggests a longer left tail, and the positive kurtosis (3.0712) indicates moderately heavy tails. The exchange rate shows a relatively small range of values, with a tendency towards lower values.

D_DEMAND:

Oil demand has a moderate mean (0.1029) and a substantial standard deviation (0.6577), indicating considerable variability around the mean. The minimum value is -2.357, and the maximum value is 1.704. The negative skewness (-1.4936) suggests a longer left tail, and the high kurtosis (8.3389) indicates heavy tails. Oil demand exhibits significant variability with a number of extreme values towards the lower end of the distribution.

4.2 Unit Root Test

Table 4.2 Unit Root Test

Variables	ADF Statistics			PP Statistics		
	Level	1st Diff	2nd Diff	Level	1st Diff	2nd Diff
COP	-1.0132	-4.8987***	-7.2608***	-0.8952	-5.1670***	-15.9374***
GDP	-5.0626***	-9.7411***	-7.0521***	-5.0569***	-13.5867***	-34.7890***
INF	-2.6124**	-4.3273***	-6.9307***	-2.3574	-4.8729***	-12.7344***
EXC	-1.6667	-4.5752***	-7.5038***	-1.3056	-4.2829**	-11.1090***
SUPPLY	1.0355*	-3.1700**	-8.4747***	2.1791*	-3.2636**	-9.1583***
DEMAND	-2.0770	-6.3326***	-7.2405***	-2.0770	6.3412***	-18.2328***

The two statistics test the null hypothesis that the time series has a unit root, indicating non-stationarity. In the level stage, some variables are not statistically significant in the PP and ADF statistics, suggesting that these series may have a unit root.

The asterisks next to the statistics (e.g., *, **, ***) indicate the level of significance. For example, p-value less than 0.1 is 1 star, less than 0.05 is 2 stars and less than 0.01 is 3 stars. More asterisks generally signify higher confidence in rejecting the null hypothesis.

The statistical significance of both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) t statistics for the variables "COP," "GDP," "INF," "EXC," and "DEMAND" are highly significant ($p < 0.01$) at the first difference level. This suggests that the first difference data is stationary and does not possess a unit root. However, it is worth noting that the SUPPLY of the ADF and PP t statistics exhibit significance ($p < 0.05$) when considering the 1st difference level.

Due to the application of first differencing, the data exhibits stationarity, as evidenced by the presence of highly significant statistical results at the 1% significance level. Consequently, there is no need to do second differencing for any of the variables.

4.3 Correlation Analysis

Table 4.3 Correlation Analysis

	D_LNCOP	D_SUPPLY	D_INF	D_GDP	D_EXC	D_DEMAND
D_LNCOP	1	-0.0289	0.7441	0.3764	0.2931	0.3786
D_SUPPLY	-0.0289	1	-0.0560	0.0647	-0.1032	0.2069
D_INF	0.74406	-0.0560	1	0.3217	0.1699	0.3797
D_GDP	0.3764	0.0647	0.3217	1	0.3690	0.7080
D_EXC	0.2931	-0.1032	0.1699	0.3690	1	0.2450
D_DEMAND	0.3786	0.2069	0.3797	0.7080	0.2450	1

The correlation analysis shows that there is a negative correlation of about -0.0560 between D_INF (Inflation) and D_SUPPLY (Supply), indicating they are an inverse relationship. Moreover, there also shows a negative correlation of about -0.1032 between D_SUPPLY (Supply) and D_EXC (Exchange rate). This suggests that an increase in exchange rate will lead to a slight decrease in supply. Overall, the correlation result for all variables shows that all the values do not exceed 0.8, we can conclude that there is no collinearity problem between variables in the result.

4.4 Granger Causality Test

Table 4.4 Granger Causality Test

Pairwise Granger Causality Tests
Date: 03/08/24 Time: 01:42
Sample: 1990 2022
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
D_SUPPLY does not Granger Cause D_LNCOP	31	7.54539	0.0104**
D_LNCOP does not Granger Cause D_SUPPLY		2.95186	0.0968*
D_INF does not Granger Cause D_LNCOP	31	0.33674	0.5664
D_LNCOP does not Granger Cause D_INF		2.39391	0.1330
D_GDP does not Granger Cause D_LNCOP	31	0.03623	0.8504
D_LNCOP does not Granger Cause D_GDP		4.68886	0.0390**
D_EXC does not Granger Cause D_LNCOP	31	0.82886	0.3704
D_LNCOP does not Granger Cause D_EXC		0.33126	0.5695
D_DEMAND does not Granger Cause D_LNCOP	31	0.02133	0.8849
D_LNCOP does not Granger Cause D_DEMAND		1.49199	0.2321
D_INF does not Granger Cause D_SUPPLY	31	5.93304	0.0215**
D_SUPPLY does not Granger Cause D_INF		0.64636	0.4282
D_GDP does not Granger Cause D_SUPPLY	31	0.09100	0.7651
D_SUPPLY does not Granger Cause D_GDP		0.74687	0.3948
D_EXC does not Granger Cause D_SUPPLY	31	0.16326	0.6892
D_SUPPLY does not Granger Cause D_EXC		0.60185	0.4444
D_DEMAND does not Granger Cause D_SUPPLY	31	0.44673	0.5094
D_SUPPLY does not Granger Cause D_DEMAND		2.27233	0.1429
D_GDP does not Granger Cause D_INF	31	2.96916	0.0959*
D_INF does not Granger Cause D_GDP		2.00541	0.1678
D_EXC does not Granger Cause D_INF	31	0.47899	0.4946
D_INF does not Granger Cause D_EXC		0.44459	0.5104
D_DEMAND does not Granger Cause D_INF	31	0.45973	0.5033
D_INF does not Granger Cause D_DEMAND		0.02322	0.8800
D_EXC does not Granger Cause D_GDP	31	0.05410	0.8178
D_GDP does not Granger Cause D_EXC		2.09650	0.1587

D_DEMAND does not Granger Cause D_GDP	31	4.02876	0.0545*
D_GDP does not Granger Cause D_DEMAND		0.23171	0.6340
D_DEMAND does not Granger Cause D_EXC	31	0.45215	0.5068
D_EXC does not Granger Cause D_DEMAND		0.06325	0.8033

From the Granger Causality Test, the findings suggest the presence of statistically significant bi-directional causal associations between D_SUPPLY and D_LNCOP. F statistics of the two variables of D_SUPPLY → D_LNCOP is significance at ∝ 0.05 level, but D_LNCOP → D_SUPPLY is significance at ∝ 0.10 level. There is a variable D_SUPPLY "G-causes" a variable D_LNCOP. The variables have both an equilibrium connection over the long term and a cointegrated relationship.

There were four unidirectional causal linkages, namely: (1) D_GDP and D_LNCOP, (2) D_INF and D_SUPPLY, (3) D_GDP and D_INF, (4) D_DEMAND and D_GDP. For the first group, F-statistics of the two variables of D_GDP → D_LNCOP is not significance at ∝ 0.01 level and D_LNCOP → D_GDP is significance at ∝ 0.05 level. Second, F-statistics of the two variables of D_INF → D_SUPPLY is significance at ∝ 0.05 level and D_SUPPLY → D_INF is not significance at ∝ 0.01 level. Third, F-statistics of the two variables of D_GDP → D_INF is significance at ∝ 0.10 level and D_INF → D_GDP is not significance at ∝ 0.01 level. Forth, F-statistics of the two variables of D_DEMAND → D_GDP is significance at ∝ 0.10 level and D_GDP → D_DEMAND is not significance at ∝ 0.01 level. Then, there are cointegrated and also long-term equilibrium relationships between these variables.

The variables of D_INF and D_LNCOP, D_EXC and D_LNCOP, D_DEMAND and D_LNCOP, D_GDP and D_SUPPLY, D_EXC and D_SUPPLY, D_DEMAND and D_SUPPLY, D_EXC and D_INF, D_DEMAND and D_INF, D_EXC and D_GDP, D_DEMAND and D_EXC are not significance at ∝ 0.01 level. Then, there are not cointegrated and also not a long-term equilibrium relationship between these variables.

4.5 Vector Error Correction Model (VECM)

Table 4.5 Vector Error Correction Model (VECM)

Vector Error Correction Estimates
Date: 12/11/23 Time: 16:23
Sample (adjusted): 1993 2022
Included observations: 30 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
D_LNCOP(-1)	1.000000
D_SUPPLY(-1)	0.172114 (0.03401) [5.06091]
D_INF(-1)	-0.083462 (0.03291) [-2.53580]
D_GDP(-1)	0.033017 (0.02929) [1.12715]
D_EXC(-1)	-0.843329 (0.26730) [-3.15502]
D_DEMAND(-1)	0.347333 (0.06391) [5.43464]
C	-0.146633

Error Correction:	D(D_LNCOP)	D(D_SUPPLY)	D(D_INF)	D(D_GDP)	D(D_EXC)	D(D_DEMAND)
CointEq1	-1.063578 (0.24596) [-4.32411]	-2.520389 (0.49135) [-5.12949]	-2.952516 (1.30429) [-2.26370]	-9.437876 (1.90618) [-4.95119]	-0.003250 (0.14278) [-0.02276]	-3.347969 (0.55624) [-6.01896]
D(D_LNCOP(-1))	0.281523 (0.25607) [1.09940]	2.085983 (0.51154) [4.07785]	0.872823 (1.35787) [0.64279]	2.463957 (1.98450) [1.24160]	-0.064289 (0.14865) [-0.43249]	0.772968 (0.57909) [1.33480]
D(D_SUPPLY(-1))	-0.100199 (0.12129) [-0.82614]	0.785000 (0.24229) [3.23996]	-0.941907 (0.64315) [-1.46453]	1.909882 (0.93994) [2.03192]	-0.014186 (0.07041) [-0.20149]	0.923431 (0.27428) [3.36673]
D(D_INF(-1))	-0.085539 (0.05168) [-1.65529]	0.038323 (0.10323) [0.37123]	-0.819776 (0.27403) [-2.99161]	-0.360454 (0.40048) [-0.90005]	0.006212 (0.03000) [0.20706]	0.049994 (0.11686) [0.42780]
D(D_GDP(-1))	-0.035265 (0.02473) [-1.42618]	-0.041286 (0.04940) [-0.83582]	0.022153 (0.13112) [0.16895]	-0.486483 (0.19163) [-2.53865]	-0.013232 (0.01435) [-0.92184]	0.069844 (0.05592) [1.24901]
D(D_EXC(-1))	0.373710 (0.39932) [0.93587]	-1.020098 (0.79770) [-1.27880]	2.082728 (2.11749) [0.98359]	0.854881 (3.09465) [0.27624]	-0.088200 (0.23181) [-0.38049]	-0.975775 (0.90304) [-1.08054]

D(D_DEMAND(-1))	0.447684	0.218218	1.719732	0.430639	0.025095	-0.199351
	(0.10612)	(0.21198)	(0.56271)	(0.82238)	(0.06160)	(0.23998)
	[4.21879]	[1.02940]	[3.05617]	[0.52365]	[0.40738]	[-0.83071]
C	0.000597	-0.009364	0.131456	-0.121075	-0.000459	-0.036314
	(0.04780)	(0.09549)	(0.25349)	(0.37046)	(0.02775)	(0.10810)
	[0.01248]	[-0.09806]	[0.51859]	[-0.32682]	[-0.01653]	[-0.33592]
R-squared	0.696416	0.662694	0.637363	0.838363	0.144240	0.752607
Adj. R-squared	0.599822	0.555369	0.521979	0.786933	-0.128048	0.673892
Sum sq. resids	1.473935	5.881928	41.44565	88.52419	0.496696	7.537935
S.E. equation	0.258838	0.517069	1.372550	2.005948	0.150257	0.585349
F-statistic	7.209671	6.174659	5.523823	16.30110	0.529733	9.561069
Log likelihood	2.630769	-18.12846	-47.41594	-58.79933	18.94647	-21.84942
Akaike AIC	0.357949	1.741898	3.694396	4.453289	-0.729765	1.989961
Schwarz SC	0.731601	2.115550	4.068049	4.826942	-0.356112	2.363614
Mean dependent	0.011960	0.045633	0.150370	-0.250487	-0.004510	0.002367
S.D. dependent	0.409167	0.775441	1.985201	4.345723	0.141472	1.025024

Determinant resid covariance (dof adj.)	5.42E-05
Determinant resid covariance	8.43E-06
Log likelihood	-80.15059
Akaike information criterion	8.943373
Schwarz criterion	11.46553
Number of coefficients	54

The cointegrating equation for COP is:

$-1.0636\Delta LNCOP_{t-1}$ - $2.5204\Delta SUPPLY_{-1}$ – $2.9525\Delta INF_{t-1}$ – $9.4379\Delta GDP_{t-1}$ –

[-4.3241**] [-5.1295***] [-2.2637** [-4.9512**]

- $0.0033\Delta EXC_{t}$-1 - $3.3480\Delta DEMAND_{t-1} = 0$

[-0.0228] [-6.0190***]

In the LNCOP cointegration equation, the variables of LNCOP, SUPPLY, INF, DEMAND and GDP are cointegrated between the variables.

There is also a long-term relationship between LNCOP, INF, GDP, SUPPLY and DEMAND variables statistically significant at α 0.05 level and α 0.01 level respectively.

VECM Model Equation:

$\Delta LNCOP_{t-1} = 0.0006 – 0.1002\Delta SUPPLY_{t-1} – 0.0855\Delta INF_{t-1} – 0.0353\Delta GDP_{t-1}$ +

[-0.8261] [-1.6553*] [-1.4262**]

$0.3737\Delta EXC_{t}$-1 + $0.4477\Delta DEMAND_{t-1}$ + 0.0478et

[0.9359] [4.2188]

R2 = 0.70 ; Adj R2 = 0.60

Based on the LNCOP VECM model's results, the explanatory variables accounted for about 70 percent of the variation in the Crude Oil Price (COP) equation.

Estimations reveal that the explanatory variables, namely inflation (INF) and demand (DEMAND), were the important explanatory variables with statistically significance at the α 0.10 level and at the 0.05 level, respectively. However, demand was the most important variable in the model.

Therefore, assuming all other variables remain constant, an average 1 unit increase in INF has a negative influence on a 0.0855 unit decrease in the COP, with statistical significance at the 0.10 level.

Thus, assuming no change in other variables, an average 1 unit rise in GDP has a negative impact on the COP, reducing it by 0.0353 units with statistical significance at the 0.05 level.

4.6 Scale Measurement

4.6.1 Normality Test

Table 4.6.1 Normality Test

Diagnosis Test	Result	Decision
H0: Residuals are normally distributed. HA: Residuals are not normally distribute	Jaguar Bera: 2.4787 p-value: 0.2896	Since p-value (0.2896) > α 0.05, do not reject $H0$.Thus, residuals are normal distributed.

Since the p-value (0.2896) > α 0.05, we should do not reject the $H0$.Thus, it can be inferred that the error term for this model is normally distributed at the 5% level of significance.

4.6.2 Multicollinearity

Table 4.6.2 Multicollinearity

Diagnosis Test	Result	Decision
H0: Residuals are not multicollinearity HA: Residuals are multicollinearity	VIF: 3.33 R-square: 0.70	Since VIF (3.33) < VIF (10), do not reject $H0$.Thus, residuals are not multicollinearity.

From the multicollinearity test, the variable inflation factor (VIF) is record at 3.33. Based on the observation that the variance inflation factor (VIF) values are below 10, we fail to reject the null hypothesis (Ho) that the result does not exhibit multicollinearity.

4.6.3 Serial Autocorrelation

Table 4.6.3 Serial Autocorrelation

Diagnosis Test	Result	Decision
H0: Residuals are not serial autocorrelation	F-statistic: 1.0108	Since p-value (0.4790) > α 0.05, do not reject

HA: Residuals are serial autocorrelation	P-value (36, 51.1): 0.4790	$H0$.Thus, residuals are not multicollinearity.

From the test, since p-value (0.4790) >α 0.05, so we do not reject $H0$.Thus, The residuals do not display a substantial issue of serial autocorrelation since its p-value is above the predetermined significance level.

4.6.4 Heteroskedasticity

Table 4.6.4 Heteroskedasticity

Diagnosis Test	Result	Decision
H0: Residuals are not heteroskedasticity HA: Residuals are heteroskedasticity	P-value: 0.4338	Since p-value (0.4338) > α 0.05, do not reject $H0$.Thus, residuals are not multicollinearity.

Since the p-value (0.4338) is above α 0.05, so we do not reject the null hypothesis. Thus, the residuals are not heteroskedasticity.

4.7 Inferential Analysis

Table 4.7 Inferential Analysis

R-square	0.6964
Adjusted R-square	0.5998

The coefficient of determination, denoted as R2 quantifies the degree to which the regression model accurately represents the underlying data. The range of R2 is bounded by 0 and 1, indicating that its values fall within the interval [0, 1].

A higher R^2 value signifies that a substantial proportion of the independent variables used in the model can elucidate the variations observed in the dependent variables. Nevertheless, the results of regression analysis (R^2) indicate that in cases where the dependent variable has a value of zero, neither of the independent variables can well explain its variation.

From the table, it shown that the value of R-squared is accounted at 0.6964. Hence, we can conclude that 69.64 % of the Crude Oil Price can be accounted for the variables in the US.

For linear models, adjusted R^2 is a corrected goodness-of-fit (or model accuracy) metric. It indicates the proportion of the target field's variance that the input or inputs account for. The fit of the linear regression is typically estimated optimistically by adjusted R^2. As more effects are incorporated into the model, it always rises.

This overestimation is attempted to be corrected for in adjusted R^2. In the event that a particular influence does not enhance the model, adjusted R^2 may fall. R^2 is always greater than or equal to adjusted R^2. A model that precisely predicts values in the target field has a value of 1.

From the table, it shown that the value of Adjusted R-squared is accounted at 0.5998. Hence, we can conclude that 59.98 % of the Crude Oil Price can be accounted for the variables in the United States.

4.8 Conclusions

This chapter encompasses descriptive analysis, unit root test and scale measurement as its primary components. The EViews 12 software is utilized to execute all of the obtained outcomes. The subsequent chapter (Chapter 5) will include a comprehensive discussion of the study's findings, conclusions, limits, suggestions, and other pertinent material.

CHAPTER 5: DISCUSSION, CONCLUSION, AND IMPLICATIONS

5.0 Introduction

This chapter aims to provide a comprehensive overview of the main results and previous discussions after the completion of data analysis in Chapter 4. Furthermore, this research will emphasize the findings, constraints, and suggestions of this investigation.

5.1 Discussions of Major Findings

5.1.1 Gross Domestic Product

The regression findings indicate that the Gross Domestic Product Growth (GDP) in the United States had a significant negative correlation with crude oil prices. But this is not similar to the results of most studies. Other studies show a positive correlation between GDP and crude oil prices. According to Huawei (2022), higher GDP growth rates result in higher energy consumption for manufacturing facilities, equipment, and other supporting logistics. Consequently, the price of coal and oil rises as a result of consumption. According to Umar et al. (2020), when economic growth rates rise, so does people's inclination to invest in natural resources, which drives up the price of commodities. However, some studies have also demonstrated a negative correlation between them. Nyangarika et al. (2018) discovered that businesses' production expenses went up as oil prices rose. Investment and consumption will suffer from declining output and increasing factor costs. In addition, as GDP grows, the market's consumption and investment in oil increase at the same time. The increase in investment and demand will cause producers to increase supply. When supply exceeds demand in the market, oil prices will fall.

5.1.2 Inflation

The regression findings indicate a negative and statistically significant correlation between inflation (INF) and crude oil prices. Multiple studies have shown that there is a positive correlation between inflation and crude oil prices (Chien, 2022) (Tian, 2022) (Sekati et al, 2020). When the economy grows rapidly, the demand for products and services rises in the market, which also drives the demand for energy, especially crude oil, thereby increasing the price of the products. However, Sarmah & Bal (2021) demonstrate that when inflation rises, central banks may curb inflationary pressures by raising interest rates. Rising interest rates could lead to a slowdown in economic activity and reduced demand for goods and services, including oil. Oil prices could fall as demand weakens.

5.1.3 Exchange Rate

The statistical analysis reveals an insignificant positive correlation between exchange rates and crude oil prices in the United States. Despite Zhao (2022) raised the point of positive correlation. When exchange rates and oil prices fluctuate simultaneously, inflationary trends may follow, which may affect real GDP and cause short-term economic overheating due to changes in real exchange rates. Excessive demand for oil imports will increase oil prices. However, the opposite view is taken by Brahmasrene et al (2014) who explain that US crude oil imports have become more expensive due to the depreciation of the US dollar. Narayan et al (2008) also show that short-term oil price shocks will depress the US dollar exchange rate. Additionally, as the main reserve currency of the world, the U.S. dollar is influenced by a number of factors outside of domestic economic circumstances, including investor mood around the world and monetary policy decisions made by other major central banks. There are situations when these outside variables have a greater effect on crude oil prices than changes in the domestic currency rate.

5.1.4 Oil Supply

The oil supply exhibits insignificant negative coefficients concerning crude oil prices. L. Kilian (2010) shows that wars or political tensions in oil-rich regions have a significant negative direct impact on oil supply, mainly through production disruptions. Reduced oil supply will cause crude oil prices to rise. And the findings reveal that conflict-induced supply changes tend to have a more pronounced impact on oil prices than other supply changes. Gallo, Mason, Shapiro & Fabritius (2010) believe that production variables may have a more direct impact on oil prices than consumption factors. So they assert that the supply side of the market seems to be the source of rising and falling oil prices. However, the oil market operates within a complex network of geopolitical, economic, and technological factors. Studies indicate that supply shocks, such as those caused by geopolitical tensions or disruptions in major oil-producing regions, often lead to market uncertainty and price volatility rather than straightforward price decreases.

5.1.5 Oil Demand

The oil demand exhibits insignificant positive coefficients concerning crude oil prices. Because according to the law of supply and demand, the price of any product, including crude oil, will rise as demand increases or supply decreases. Conversely, if demand decreases or supply increases, prices will fall. Behr (2009) pointed out that the increase in oil demand has had a disproportionate upward impact on global oil prices, benefiting from the surge in demand from fast-growing emerging economies, especially Asia. Additionally, Barclays (2012) and Merrill Lynch (2012) explore the role of income growth, infrastructure development and energy efficiency in developing countries as key factors influencing oil demand patterns. Then from the results, they found that the key factors are positively correlated with oil demand and oil prices. However, the demand responsiveness to price changes might be muted due to various factors like long-term contracts, habit persistence, and structural shifts in energy consumption patterns. Research by Kilian (2009) and Hamilton (2009) emphasizes the importance of considering both supply and demand shocks in understanding oil price movements. These studies highlight that demand for oil can be influenced by factors such as changes in consumer behavior, economic growth, and government policies, which may not always respond immediately or proportionally to price changes.

5.2 Implications of the Study

The intricate link between economic factors and oil prices is crucial for many economic research and decision-making aspects. Consider GDP, inflation, and exchange rates, for instance. These variables are entangled with oil prices, impacting economic patterns and indicating interdependencies. Strong evidence of a relationship between GDP growth and oil prices suggests that stable prices are necessary for economic expansion. This information serves as a basis for planning and modifying tactics in reaction to these trends and providing insights about expected economic movements.

For governments to create plans that work, precise data is essential. It becomes essential to comprehend how supply and demand volatility affect oil prices. Governments may mitigate possible negative economic impacts from policy changes by anticipating risks and making educated decisions based on accurate evaluations of how supply and demand will affect oil prices. Additionally, this analytical method substantially contributes to improved risk management techniques.

The study's analysis of the stronger relationship between several variables and American crude oil prices suggests complicated market dynamics at various places. This finding might light the various ways that local economic conditions, governmental policies, and supply and demand affect the fluctuations in the price of a commodity sold globally, like crude oil. By recognising these differences, stakeholders may better tailor energy investment, procurement, and risk management strategies to specific regional conditions, reducing related risks that impact the oil markets.

Furthermore, businesses directly impacted by oil prices, such as manufacturing, transportation, and energy, can gain a great deal by knowing how oil prices relate to other economic variables. In recent years, significant disruptions to international trade, demand trends, and economic activity in the United States were caused by the COVID-19 pandemic, which may have altered the long-standing correlations between oil prices and economic indicators.

Lastly, studies that shed light on these changes may be able to improve economic forecasting models. Accurate predictions of oil price movements can help businesses and investors make informed decisions, thereby minimizing risks and maximizing returns.

5.3 Limitations of the Study

The selected research time frame of this study may place limitations on the comprehensiveness of the research insights. We are unable to take into account major events that occurred before 1990 that may have affected changes in the original price. For example, war, geopolitical or technological events.

Consequently, this limitation has the potential to impact the overall correctness and validity of the study. This is because factors such as the emergence of renewable energy sources, significant geopolitical events, or advancements in extraction techniques might have potentially impacted crude oil prices in a manner.

Furthermore, implications for other regions or countries are also limitations. The study's scope is limited to the United States only, so its applicability and generalizability to other countries or areas may be limited despite the potential for valuable insights into the factors influencing crude oil prices in these particular countries. Therefore, the dynamics that impact crude oil prices can vary substantially globally.

Next, the variables omitted are also the limitation. The selected independent variables unquestionably significantly impact crude oil price fluctuations—Gross Domestic Product, Inflation, Exchange Rates, Oil Supply and Oil Demand. However, the energy market is intricate and influenced by a multitude of factors. Other potential determinants of oil prices that are not accounted for in the analysis include geopolitical tension, policy uncertainty, and consumer behaviour.

Regional variation can be a concern when attempting to accurately represent the entire global oil market, despite the fact that the United States is substantial participants in the industry. Major oil-producing nations, trade alliances, and a variety of geopolitical interests are a few of the numerous participants in the global oil market. Particularly in the United States, the impact of these external influences on the relationship between the selected independent variables and crude oil prices might differ from that which is observed globally.

5.4 Recommendations for Future Research

Firstly, the recommendation pertains to the use of extended data analysis. Follow-up research should include contemporaneous or updated data after 2022 and before 1990 to try to fully assess the ongoing impact of all relevant events on crude oil prices. It is important to engage in consistent monitoring of economic policies, geopolitical events, outbreaks of crises, and alterations in energy consumption patterns to comprehend their direct impacts on oil prices comprehensively. The use of a larger historical study facilitates the attainment of a more thorough comprehension of enduring patterns and the progression of variables influencing the fluctuations in oil prices.

Secondly, it is recommended that future research include a broader range of factors that may influence crude oil prices. The technological breakthroughs in extraction methods, progress in renewable energy sources, geopolitical events, and changing consumer preferences towards electric cars have the potential to have a substantial impact on oil prices. Consequently, it is important to include these factors while conducting an analysis. To enhance the generalizability of findings, it is advisable to use a more diverse array of nations or areas in research projects, extending beyond the scope of the United States.

Taking a wider perspective will provide a more thorough comprehension of the ways in which diverse geopolitical, economic, and policy issues influence oil prices in different international markets. This is because doing comparative analysis across nations with distinct economic policies, energy dependence, and geopolitical locations helps elucidate the differential impact of many variables on oil prices across different areas.

5.5 Conclusion

The chapter's conclusion highlights the relationships between economic conditions and crude oil prices in the United States by combining study findings with prior literature. Examining variables such as inflation, GDP, exchange rates, oil supply, and oil demand, reveals complex crude oil market dynamics. The elevated inflation variable significance shows a higher impact on oil prices.

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Appendixes

Appendix 1: Descriptive Analysis

	D_LNCOP	D_SUPPLY	D_INF	D_GDP	D_EXC	D_DEMAND
Mean	0.0453	0.3247	0.0814	0.005488	-0.0176	0.1029
Median	0.0847	0.0210	0.0243	-0.167556	-0.01370	0.1930
Maximum	0.5664	2.2890	3.4643	8.713287	0.1853	1.7040
Minimum	-0.6690	-0.8420	-4.1946	-5.062242	-0.2716	-2.3570
Std. Dev.	0.2878	0.7268	1.4280	2.526365	0.1074	0.6577
Skewness	-0.5399	0.9725	-0.0658	1.225043	-0.4993	-1.4936
Kurtosis	2.8898	3.1761	4.9106	6.373627	3.0712	8.3379
Jarque-Bera	1.5705	5.0850	4.8902	23.1790	1.3363	49.8893
Probability	0.4560	0.0787	0.0867	0.0000	0.5127	0.0000
Sum	1.4487	10.391	2.6048	0.1756	-0.5617	3.2920
Sum Sq. Dev.	2.5685	16.377	63.2146	197.8581	0.3576	13.4095
Observations	32	32	32	32	32	32

Appendix 2: Unit Root Test Result

Variables	ADF Statistics			PP Statistics		
	Level	1st Diff	2nd Diff	Level	1st Diff	2nd Diff
COP	-1.0132	-4.8987***	-7.2608***	-0.8952	-5.1670***	-15.9374***
GDP	-5.0626***	-9.7411***	-7.0521***	-5.0569***	-13.5867***	-34.7890***
INF	-2.6124**	-4.3273***	-6.9307***	-2.3574	-4.8729***	-12.7344***
EXC	-1.6667	-4.5752***	-7.5038***	-1.3056	-4.2829**	-11.1090***
SUPPLY	1.0355*	-3.1700**	-8.4747***	2.1791*	-3.2636**	-9.1583***
DEMAND	-2.0770	-6.3326***	-7.2405***	-2.0770	6.3412***	-18.2328***

Appendix 3: Correlation Analysis

	D_LNCOP	D_SUPPLY	D_INF	D_GDP	D_EXC	D_DEMAND
D_LNCOP	1	-0.0289	0.7441	0.3764	0.2931	0.3786
D_SUPPLY	-0.0289	1	-0.0560	0.0647	-0.1032	0.2069

D_INF	0.74406	-0.0560	1	0.3217	0.1699	0.3797
D_GDP	0.3764	0.0647	0.3217	1	0.3690	0.7080
D_EXC	0.2931	-0.1032	0.1699	0.3690	1	0.2450
D_DEMAND	0.3786	0.2069	0.3797	0.7080	0.2450	1

Appendix 4: Granger Causality Test

Pairwise Granger Causality Tests
Date: 03/08/24 Time: 01:42
Sample: 1990 2022
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
D_SUPPLY does not Granger Cause D_LNCOP	31	7.54539	0.0104**
D_LNCOP does not Granger Cause D_SUPPLY		2.95186	0.0968*
D_INF does not Granger Cause D_LNCOP	31	0.33674	0.5664
D_LNCOP does not Granger Cause D_INF		2.39391	0.1330
D_GDP does not Granger Cause D_LNCOP	31	0.03623	0.8504
D_LNCOP does not Granger Cause D_GDP		4.68886	0.0390**
D_EXC does not Granger Cause D_LNCOP	31	0.82886	0.3704
D_LNCOP does not Granger Cause D_EXC		0.33126	0.5695
D_DEMAND does not Granger Cause D_LNCOP	31	0.02133	0.8849
D_LNCOP does not Granger Cause D_DEMAND		1.49199	0.2321
D_INF does not Granger Cause D_SUPPLY	31	5.93304	0.0215**
D_SUPPLY does not Granger Cause D_INF		0.64636	0.4282
D_GDP does not Granger Cause D_SUPPLY	31	0.09100	0.7651
D_SUPPLY does not Granger Cause D_GDP		0.74687	0.3948
D_EXC does not Granger Cause D_SUPPLY	31	0.16326	0.6892
D_SUPPLY does not Granger Cause D_EXC		0.60185	0.4444
D_DEMAND does not Granger Cause D_SUPPLY	31	0.44673	0.5094
D_SUPPLY does not Granger Cause D_DEMAND		2.27233	0.1429
D_GDP does not Granger Cause D_INF	31	2.96916	0.0959*
D_INF does not Granger Cause D_GDP		2.00541	0.1678
D_EXC does not Granger Cause D_INF	31	0.47899	0.4946
D_INF does not Granger Cause D_EXC		0.44459	0.5104
D_DEMAND does not Granger Cause D_INF	31	0.45973	0.5033
D_INF does not Granger Cause D_DEMAND		0.02322	0.8800
D_EXC does not Granger Cause D_GDP	31	0.05410	0.8178
D_GDP does not Granger Cause D_EXC		2.09650	0.1587
D_DEMAND does not Granger Cause D_GDP	31	4.02876	0.0545*
D_GDP does not Granger Cause D_DEMAND		0.23171	0.6340
D_DEMAND does not Granger Cause D_EXC	31	0.45215	0.5068
D_EXC does not Granger Cause D_DEMAND		0.06325	0.8033

Appendix 5: Vector Error Correction Model (VECM)

Vector Error Correction Estimates
Date: 12/11/23 Time: 16:23
Sample (adjusted): 1993 2022
Included observations: 30 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
D_LNCOP(-1)	1.000000
D_SUPPLY(-1)	0.172114 (0.03401) [5.06091]
D_INF(-1)	-0.083462 (0.03291) [-2.53580]
D_GDP(-1)	0.033017 (0.02929) [1.12715]
D_EXC(-1)	-0.843329 (0.26730) [-3.15502]
D_DEMAND(-1)	0.347333 (0.06391) [5.43464]
C	-0.146633

Error Correction:	D(D_LNCOP)	D(D_SUPPLY)	D(D_INF)	D(D_GDP)	D(D_EXC)	D(D_DEMAND)
CointEq1	-1.063578 (0.24596) [-4.32411]	-2.520389 (0.49135) [-5.12949]	-2.952516 (1.30429) [-2.26370]	-9.437876 (1.90618) [-4.95119]	-0.003250 (0.14278) [-0.02276]	-3.347969 (0.55624) [-6.01896]
D(D_LNCOP(-1))	0.281523 (0.25607) [1.09940]	2.085983 (0.51154) [4.07785]	0.872823 (1.35787) [0.64279]	2.463957 (1.98450) [1.24160]	-0.064289 (0.14865) [-0.43249]	0.772968 (0.57909) [1.33480]
D(D_SUPPLY(-1))	-0.100199 (0.12129) [-0.82614]	0.785000 (0.24229) [3.23996]	-0.941907 (0.64315) [-1.46453]	1.909882 (0.93994) [2.03192]	-0.014186 (0.07041) [-0.20149]	0.923431 (0.27428) [3.36673]
D(D_INF(-1))	-0.085539 (0.05168) [-1.65529]	0.038323 (0.10323) [0.37123]	-0.819776 (0.27403) [-2.99161]	-0.360454 (0.40048) [-0.90005]	0.006212 (0.03000) [0.20706]	0.049994 (0.11686) [0.42780]
D(D_GDP(-1))	-0.035265 (0.02473) [-1.42618]	-0.041286 (0.04940) [-0.83582]	0.022153 (0.13112) [0.16895]	-0.486483 (0.19163) [-2.53865]	-0.013232 (0.01435) [-0.92184]	0.069844 (0.05592) [1.24901]
D(D_EXC(-1))	0.373710 (0.39932) [0.93587]	-1.020098 (0.79770) [-1.27880]	2.082728 (2.11749) [0.98359]	0.854881 (3.09465) [0.27624]	-0.088200 (0.23181) [-0.38049]	-0.975775 (0.90304) [-1.08054]

D(D_DEMAND(-1))	0.447684	0.218218	1.719732	0.430639	0.025095	-0.199351
	(0.10612)	(0.21198)	(0.56271)	(0.82238)	(0.06160)	(0.23998)
	[4.21879]	[1.02940]	[3.05617]	[0.52365]	[0.40738]	[-0.83071]
C	0.000597	-0.009364	0.131456	-0.121075	-0.000459	-0.036314
	(0.04780)	(0.09549)	(0.25349)	(0.37046)	(0.02775)	(0.10810)
	[0.01248]	[-0.09806]	[0.51859]	[-0.32682]	[-0.01653]	[-0.33592]
R-squared	0.696416	0.662694	0.637363	0.838363	0.144240	0.752607
Adj. R-squared	0.599822	0.555369	0.521979	0.786933	-0.128048	0.673892
Sum sq. resids	1.473935	5.881928	41.44565	88.52419	0.496696	7.537935
S.E. equation	0.258838	0.517069	1.372550	2.005948	0.150257	0.585349
F-statistic	7.209671	6.174659	5.523823	16.30110	0.529733	9.561069
Log likelihood	2.630769	-18.12846	-47.41594	-58.79933	18.94647	-21.84942
Akaike AIC	0.357949	1.741898	3.694396	4.453289	-0.729765	1.989961
Schwarz SC	0.731601	2.115550	4.068049	4.826942	-0.356112	2.363614
Mean dependent	0.011960	0.045633	0.150370	-0.250487	-0.004510	0.002367
S.D. dependent	0.409167	0.775441	1.985201	4.345723	0.141472	1.025024

Determinant resid covariance (dof adj.)	5.42E-05
Determinant resid covariance	8.43E-06
Log likelihood	-80.15059
Akaike information criterion	8.943373
Schwarz criterion	11.46553
Number of coefficients	54

Appendix 6: Normality Test

Diagnosis Test	Result	Decision
H0: Residuals are normally distributed. HA: Residuals are not normally distribute	Jaguar Bera: 2.4787 p-value: 0.2896	Since p-value (0.2896) > α 0.05, do not reject $H0$.Thus, residuals are normal distributed.

Appendix 7: Multicollinearity Test

Diagnosis Test	Result	Decision
H0: Residuals are not multicollinearity HA: Residuals are multicollinearity	VIF: 3.33 R-square: 0.70	Since VIF (3.33) < VIF (10), do not reject $H0$.Thus, residuals are not multicollinearity.

Appendix 8: Serial Autocorrelation Test

Diagnosis Test	Result	Decision

H0: Residuals are not serial autocorrelation HA: Residuals are serial autocorrelation	F-statistic: 1.0108 P-value (36, 51.1): 0.4790	Since p-value (0.4790) > α 0.05, do not reject $H0$.Thus, residuals are not multicollinearity.

Appendix 9: Heteroskedasticity

Diagnosis Test	Result	Decision
H0: Residuals are not heteroskedasticity HA: Residuals are heteroskedasticity	P-value: 0.4338	Since p-value (0.4338) > α 0.05, do not reject $H0$.Thus, residuals are not multicollinearity.

Appendix 10: Inferential Analysis

R-square	0.6964
Adjusted R-square	0.5998