



**Faculty of Economics and Business**

**The Asymmetric Response of Macroeconomic Indicators to Shocks of Oil  
Price in Yemen**

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# The Asymmetric Response of Macroeconomic Indicators to Shocks of Oil Price in Yemen

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## DECLARATION

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



.....

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## **DEDICATION**

Father and uncle, I dedicate this thesis to both of you, who have left a deep and indelible mark on my life. Your always support, love, and guidance have been vital in shaping me into the one I am today. Although you are no longer with us, your memory and spirit continue to inspire me every day.

Father, though you passed away long ago, but you were my strength pillar, always there to encourage me and push me to reach for the stars. Your love and devotion were never in doubt, and I will always cherish the memories we shared together. Uncle, though you left this life just a few months ago, but in your lifelong, you have become my father since my father died and become my biggest support in life, you worked hard to ensure I achieved the dream of my father to finish my study, and you were always there for me. You were my mentor and guide, showing me the value of hard work, perseverance, and determination. Your wisdom and insights have stayed with me and continue to shape my worldview.

This thesis is a testament to the values that you instilled in me, and I hope that I have made you both proud. Thank you for everything you have done for me, and for the love that you have given me. I miss you both dearly, and I dedicate this work to your memory.

With love and gratitude,

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## ABSTRACT

Yemen's economy, which heavily relies on oil revenues, is exposed to the effects, whether negative or positive of oil shocks in the global market. For this reason, this study targeted YEMEN, aiming mainly to examine the asymmetric responses of key macroeconomic indicators, namely "gross domestic product, inflation, exchange rate, and the unemployment rate" to shocks of oil prices from 1991 to 2023. Additional aims include the examination of both short and long-run associations among these variables and the shocks of oil prices, and the diagnosis of the "Dutch disease" symptoms in these indicators alongside some key economic sectors. To realize this, the nonlinear autoregressive distributed lag (NARDL) and its associated bootstrap NARDL for an augmented analysis of cointegration were adopted. In addition, an OLS regression was used as well for further analysis. According to findings, variables were found to be cointegrated in all models. More specifically, GDP has significant positive short-run association with only negative shocks of oil prices and significant positive long-run association with both negative and positive shocks. Thus, GDP was found to respond asymmetrically to both shocks in both long and short runs. Regarding the inflation rate, Short-term negative shocks were found to be significantly associated with inflation, while positive but negligible associations were found in the long run. Therefore, the asymmetric impact of both shocks was spotted in the short run only. Much like GDP, the exchange rate responded asymmetrically to both shocks in both long and short runs. The association, however, was found to be significantly positive with the positive shocks in the long run, and significantly positive in response to negative shocks in the short run. As for the unemployment rate, it was noticeable that in the long run, the unemployment rate spiked due to negative shocks more than its rise due to positive ones. Thus, its response to oil shocks was asymmetric only in the long run. Additionally, the magnitude of negative oil price

shocks generally exceeded that of positive ones for all variables. Moreover, the research indicates there is a one-way causal relationship from oil price shocks to the exchange rate, with no evidence of re-verse causation. Lastly, signs of Dutch disease in the Yemeni economy were observed, particularly affecting key indicators like unemployment and the exchange rate. However, the impact was less obvious compared to that in the key non-oil tradable sectors such as agriculture, services, and manufacturing. To address these issues, this study recommends that Yemeni policymakers focus on diversifying revenue sources to reduce dependence on oil. Implementing both short and long-term strategies will be essential to mitigate current and future economic shocks related to oil price fluctuations.

**Keywords:** Asymmetry, NARDL, Augmented ARDL, Oil price shocks, Yemen

## ***Tindak balas Asimetri Indikator Makroekonomi terhadap Kejutan Harga Minyak di Yaman***

### ***ABSTRAK***

*Ekonomi Yaman yang sangat bergantung pada hasil minyak, terdedah kepada kesan, sama ada negatif atau positif, daripada kejutan minyak di pasaran global. Oleh itu, kajian ini memfokuskan pada Yaman dengan tujuan utama untuk menganalisis tindak balas asimetri penunjuk makroekonomi utamanya—iaitu Keluaran Dalam Negara Kasar (KDNK), inflasi, kadar pertukaran, dan kadar pengangguran terhadap kejutan harga minyak dari tahun 1991 hingga 2023. Selain itu, termasuk pemeriksaan hubungan jangka pendek dan jangka panjang di antara pembolehubah ini serta kejutan harga minyak, dan diagnosis simptom "penyakit Belanda" dalam petunjuk ini bersama beberapa sektor ekonomi utama. Bagi mencapai objektif kajian, kaedah ARDL Tak linear (NARDL) dan pendekatan bootstrap NARDL berkaitan telah digunakan bagi analisis kointegrasi di-perkukuh. Selain itu, analisis tambahan turut dijalankan menggunakan regresi Kuasa Dua Terkecil Biasa (OLS) . Berdasarkan dapatan kajian, semua pembolehubah menunjukkan ciri kointegrasi yang signifikan dalam kesemua model yang dianggarkan. Secara lebih spesifik, KDNK menunjukkan hubungan positif yang signifikan dalam jangka pendek hanya dengan kejutan negatif harga minyak, manakala dalam jangka panjang, KDNK mempunyai hubungan positif yang signifikan dengan kedua-dua kejutan negatif dan positif harga minyak. Oleh itu, didapati bahawa KDNK memberikan tindak balas tidak simetri terhadap kedua-dua kejutan harga minyak, baik dalam jangka pendek mahupun jangka panjang. Bagi kadar inflasi, kejutan negatif jangka pendek didapati mempunyai hubungan yang signifikan, manakala hubungan positif yang tidak ketara diperhatikan dalam jangka panjang. Oleh itu, kesan tidak simetri bagi kedua-dua kejutan hanya dapat dikesan dalam jangka pendek.*

*Sebagaimana KDNK, kadar pertukaran juga menunjukkan tindak balas tidak simetri terhadap kedua-dua kejutan dalam kedua-dua jangka pendek dan jangka panjang. Namun begitu, hubungan tersebut didapati signifikan positif dengan kejutan positif dalam jangka panjang, dan signifikan positif sebagai tindak balas kepada kejutan negatif dalam jangka pendek. Bagi kadar pengangguran, dapat diperhatikan bahawa dalam jangka panjang, kadar pengangguran meningkat lebih ketara akibat kejutan negatif berbanding peningkatan yang disebabkan oleh kejutan positif. Oleh itu, tindak balas kadar pengangguran terhadap kejutan harga minyak adalah tidak simetri hanya dalam jangka panjang. Selain itu, magnitud kejutan negatif harga minyak secara umumnya melebihi magnitud kejutan positif bagi kesemua pembolehubah. Tambahan pula, kajian menunjukkan wujudnya hubungan kausal sehala daripada kejutan harga minyak kepada kadar pertukaran, tanpa bukti kausal songsang. Akhirnya, tanda-tanda “penyakit Belanda” telah diperhatikan dalam ekonomi Yaman, terutamanya memberi kesan kepada penunjuk utama seperti kadar pengangguran dan kadar pertukaran. Walau bagaimanapun, kesannya kurang ketara berbanding kesan terhadap sektor boleh niaga bukan minyak utama seperti pertanian, perkhidmatan, dan pembuatan. Bagi menangani isu-isu ini, kajian mencadangkan agar pembuat dasar Yaman memberi tumpuan kepada kepelbagaian sumber pendapatan untuk mengurangkan kebergantungan terhadap minyak. Pelaksanaan strategi jangka pendek dan jangka panjang adalah penting untuk mengurangkan kesan kejutan ekonomi semasa dan masa hadapan yang berkaitan dengan turun naik harga minyak.*

**Kata Kunci:** *Asimetri, NARDL, ARDL Terpertingkat, Kejutan Harga Minyak, Yaman*

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## LIST OF ACRONYMS

|           |                                                           |
|-----------|-----------------------------------------------------------|
| ACAPS     | Assessment Capacities Project                             |
| ARDL-ECM  | The autoregressive distributed lag-error correction model |
| AMF       | Arab monetary fund                                        |
| bbl       | Barrel                                                    |
| Bm2       | Broad money                                               |
| BNARDL    | Bootstrap NARDL                                           |
| BP        | Bai- Perron                                               |
| CBY       | Central bank of Yemen                                     |
| CMD       | Cumulative dynamic multiplier                             |
| CMB       | Controlling monetary policies                             |
| CMWG      | Cash and Market Working Group                             |
| CUSUM     | Cumulative sum                                            |
| CUSUMQ    | Cumulative sum of squares                                 |
| CSO       | Yemen central statistic organization                      |
| DD        | Dutch disease                                             |
| DDT       | Dutch disease theory                                      |
| DDTagriy  | DDT symptom in Yemen's agriculture sector                 |
| DDTmany   | DDT symptom in Yemen's manufacturing sector               |
| DDTservy  | DDT symptom in Yemen's service sector                     |
| DFID      | U.K. Department for International development             |
| DF-GLS    | Dickey-Fuller GLS detrended test                          |
| DVs & IVs | Dependent variables & independent variables               |
| ECB       | European Central Bank                                     |

|           |                                                                                         |
|-----------|-----------------------------------------------------------------------------------------|
| ECM       | Error correction model                                                                  |
| ECOWAS    | economic community of West African states                                               |
| EGARCH    | Exponential Generalized autoregressive conditional heteroskedasticity                   |
| EIA       | U.S energy information administration                                                   |
| EXCHRY    | Exchange rate of Yemen                                                                  |
| G7        | Group of seven                                                                          |
| GARCH     | Generalized autoregressive conditional heteroskedasticity                               |
| GARCH-M   | Generalized autoregressive conditional heteroskedasticity-in-Mean                       |
| GCC       | Gulf cooperation countries                                                              |
| GDP       | Gross domestic product                                                                  |
| GDPY      | Gross domestic product of Yemen                                                         |
| GDPcY     | Gross domestic product per capita of Yemen                                              |
| GJR-GARCH | Glosten, Jagannathan & Runkle-Generalized autoregressive conditional heteroskedasticity |
| ILO       | International labor organization                                                        |
| IMF       | International Monetary Fund                                                             |
| INFLRY    | Inflation rate of Yemen                                                                 |
| IPS       | Im-Pesaran-Shin (2003) test                                                             |
| IRF       | Impulse response function                                                               |
| KPSS      | Kwiatkowski–Phillips–Schmidt–Shin test                                                  |
| KSS       | Kapetanios-Shin-Snell test                                                              |
| LDCs      | Least developed countries                                                               |
| LLC       | Levin, Lin and Chu (2002) test                                                          |
| LR        | Long-run                                                                                |

|           |                                                                 |
|-----------|-----------------------------------------------------------------|
| MENA      | Middle East and North Africa                                    |
| MOM       | Yemen Ministry of oil & mineral resource                        |
| MoPIC     | Yemen Ministry of Planning & International Cooperation          |
| NARDL-ECM | Nonlinear autoregressive distributed lag-error correction model |
| NP        | Ng-perron's test                                                |
| OECD      | Organization for Economic Co-operation and Development          |
| OP        | Oil prices                                                      |
| OPEC      | Organization of the Petroleum Exporting Countries.              |
| PP        | Phillips- Perron                                                |
| PEPA      | The Petroleum Exploration and Production Authority              |
| PPP       | Purchasing power parity                                         |
| QQR       | Quantile-on-Quantile regression approach                        |
| SLT       | Symmetric long-term                                             |
| SoOP      | Shocks of oil price                                             |
| SR        | Short run                                                       |
| SST       | Symmetric short-term                                            |
| STAR      | Smooth transition regression model.                             |
| SVAR      | Structural vector autoregressive                                |
| TVAR      | Threshold vector autoregressive                                 |
| TWB       | The World bank                                                  |
| UN        | United nations                                                  |
| UNEMPRY   | Unemployment rate of Yemen                                      |
| UVAR      | Unrestricted vector autoregressive                              |
| VAR       | Vector autoregression                                           |

|            |                               |
|------------|-------------------------------|
| VECM       | Vector error correction model |
| WEcouncil. | World energy council          |
| YLF        | Yemen labor force             |
| YOC        | Yemen oil company             |
| YOGC       | Yemen oil and gas corporation |

# CHAPTER 1

## INTRODUCTION

### 1.1 Background of the Study

This chapter in general provides an introduction and background to the topic under investigation by the study. It includes, in addition to this section, a statement to the problem from which the objectives of the study are derived and highlights the study's significance, scope and organization.

The importance of oil as a commodity of high global demand has been reflected on its prices and thereby on all economies that are reliant on it. In this regard, Park (2007) stated that oil price (OP, hereafter) is the greater influencing factor on the economy of countries around the globe since 1973. His claim considered the global recession which occurred in response to the oil ban to the USA imposed by Arabic members in OPEC between 1973 and 1974 (i.e., the period of Arab-Israel war) with similar cases go on since then. In the viewpoint of Ahmed (2016) and Humbatova and Hajiyevev (2019) exporters as well as importers of oil, whether developed or developing economies are of exposure to the impact of oil prices. World Economic Council (2016) pointed out in its annual energy source report the calculation carried out by economists of Oxford where they calculated 0.4 % global economic growth over the subsequent 2 /3 years (i.e., 2018 -2019) for a drop of \$20 in oil prices which are more or less similar to an estimation carried out by the International Monetary Fund. On the contrary, 30 % increase in global oil prices would reduce economic growth by 0.5 % and boost inflation by about 1.2 % (IMF, 2023). Regardless of how accurate these calculations or estimations, but it does indicate a strong association between

the decrease and increase of oil prices and the growth of the global economy and certainly on each individual economy.

The impact of oil prices on the economy of world countries can be explained by the percentage of change in it from time to another. The change in oil price can be small or substantial and the substantial volatility in the prices of oil or the gap between the expected prices and eventually realized prices is what is taken as “price shock” as claimed by (Baumeister and Kilian, 2016). In this regard, several oil prices shocks have been identified and that have affected the global crude oil price significantly as depicted in Figure 1.1 below (Appendix 1.1 for details).

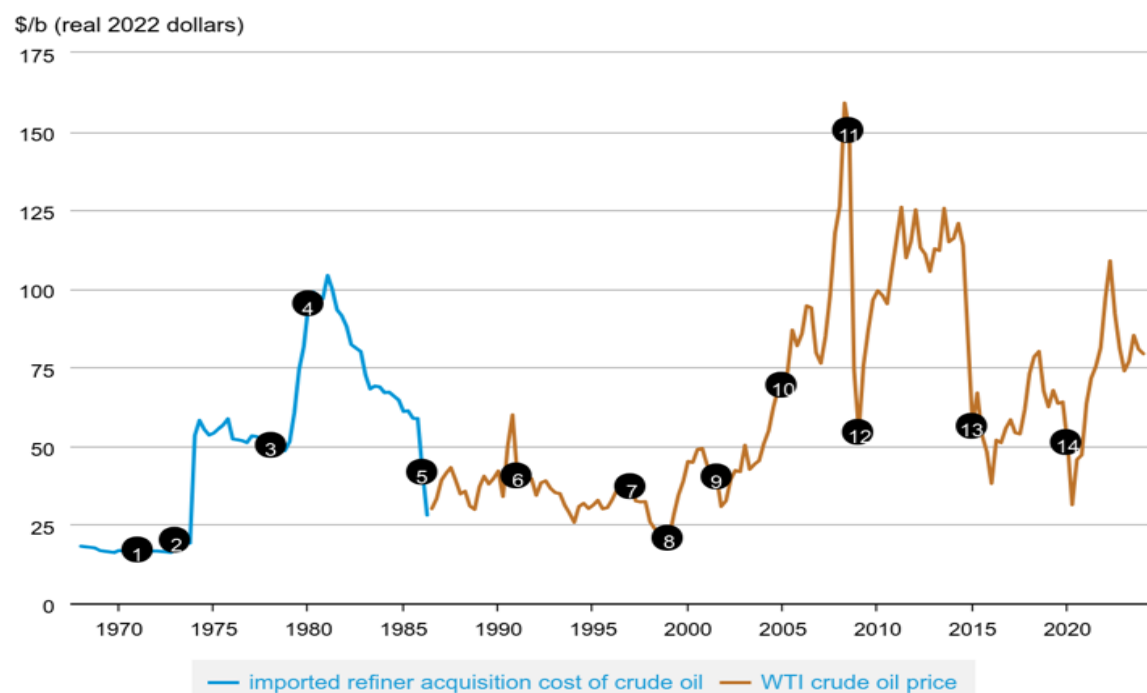


**Figure 1.1: Oil Price Shocks Since the 70s and their Causing Factors**

Source: EIA (2024)

As shown in the figure above, the history of oil price shocks dates back to the early 1970s, precisely with the Arab embargo shock following the Arab-Israel war in 1973 when

oil increased by about 18 % reaching approximately (\$20/ bbl) and continuing through different shocks such as Iran-Iraq war in the 1980s.

In the recent past, some of the shocks include but are not limited to the Gulf War in the 1990s, which resulted in a supply shock reflected in a sharp increase in oil prices by 53 % until it witnessed the highest drop in recent years in 1998 with less than (\$20/ bbl) due to the Asian financial crisis in mid-97. In the early 2000s up to 2008, the 9-11 attacks and the great surge of commodities led to a significant increase in the prices of oil before it was hit by the global financial crises between 2008 and 2009 dropping to around (\$76/ bbl) from (\$150/ bbl) at the start of the crises.

Most recently, the Arab Spring revolution in 2011 led to a supply shock causing the prices to rise by 35 % before prices witnessed another shock between June 2014 and January 2015, where the prices fell from (\$112/ bbl) to about (\$56/ bbl) due to the imbalance in the global oil market as the OPEC kept its quota of production unchanged. In addition, the COVID-19 global pandemic as prescribed by the World Health Organization (WHO) in March 2020 which has stormed the globe caused a huge drop in the demand for Oil leading to a further drop in oil prices. The history of shocks of oil prices clearly indicates that the shocks can be either positive or negative and with a substantial change and can be caused by different factors.

Causes of these shocks in oil prices have drawn the attention of researchers since the 80s, which is the period following the second major shock that took place in the late 1970s. For instance, Baumeister and Peersman (2012, 2013) and Fueki et al. (2018) argued that both supply as well as demand shocks, explain the historical shocks of oil prices while Hamilton (1983) and Ioungani (1986) blamed the disturbance in supply due to some external

factors such as wars for the large fluctuations in oil prices. Moreover, another attention has been put into the exploration and investigation of the relationship between these shocks and macroeconomic activities of the countries. Earlier studies until the mid-1980s, according to Kose and Baimaganbetov (2015) utilized some estimation models of linearity to examine the linearity of the relationship between economic activities and shocks of oil price which indicates symmetric-alike behavior. However, because such models predicted great positive impact for the oil price drop that occurred in the late 1980s, the impact, in reality, was found to be positively small and here the asymmetric impact of oil prices on economic activities started to take place in econometric studies. Similarly, Farhani (2012) mentioned that empirical studies since 1896 which is the period after the oil price drop indicated that relationship between oil price and economic growth is no longer the same as it is before.

The studies and research that investigated the nonlinearity or asymmetric relationship between oil price and macroeconomic activities have mostly focused on Developed and major exporting countries in comparison to developing and under developing countries (also known as least developing nations). Most of these studies and others have documented the existence of asymmetry in the relationship between macroeconomic indicators and shocks of oil prices with some similarities in the impact among some cases and differences in some others.

Such consequences linked to oil and its prices or to the excess dependency on any other natural resources is what is so-called "Dutch disease" (DD, hereafter) as named by the "economist" magazine in the late of the year 1977 describing Netherlands's economic crisis following the discovery of a gas field in the late 1950s. DD generally refers to the negative "impact" on countries' economies that can be caused following a natural resources discovery

such as oil, gas, mineral, etc. due to the great flow of foreign income which might in return affect the country's dependency on other sources of income (Hiroyuki, 2016). DD is easy to have but hard to treat as stated by world bank economists Ianchovichina and Onder (2017) as its effects can be beyond those observed in some key economic indicators such as exchange rate movements to negatively impact other key economic sectors (manufacturing, service, etc.) due to the inequality in the use of such natural resources' rents. However, the exposure to DD in the case of exporting-oil countries is even greater as the high dependence on oil may lead to an adverse effect on other key economic indicators which might be tremendously linked to oil price movements in the global market.

In relation to what has been stated, Yemen's economy, therefore, is no exception of this great influencing factor (i.e., oil prices) as it is among the many economies which have been relied primarily on the revenues from oil and gas sector since the reunion of its south and north part in 1990 and the discovery of oil started to attract the attention of the united government. According to OPEC (2019), 64.5 % of the global oil reserves are in the underground of the Middle East region. Yemen as a middle eastern country though not OPEC member has a 3 billion barrels of proven oil reserves with a big chance for the figure to increase in the future. Therefore, Yemen as a non-net oil exporter though not a major one but the oil revenue still consider the backbone of the county's budget which makes it stand in a vulnerable position to oil price volatility and as stated by Al-Mawali (2016) though there are comprehensive studies concerning the impact of "oil price" fluctuations on macroeconomic conditions but the concentration of most were on the developed nations and importing countries rather than on developing and exporting countries such as Yemen. Hence, this study came into existence in order to investigate the impact of oil price in terms of its asymmetric behavior on the macroeconomic of Yemen. More details regarding Yemen's

macroeconomic activities trends and development are to be further discussed in the subsequent section. In general, this study is to be among the very limited literature that have been targeted under developing economies or what is so called “least developed countries” (hereafter, LDCs).

## 1.2 Yemen’s Economy: An Overview

This section extends the background in the previous section to include more details regarding the economy of the country concerning its key macroeconomic indicators.

### 1.2.1 Global Stand of the Yemen's Economy

According to the United Nation (UN, hereafter) (2023, 2024) classification, the world countries are divided into four categories based on their economic advancement and development namely developed, in transition to be developed, developing and least developed countries (LDCs, hereafter). In general, the annual economic growth rate is lower in the case of developed nations in comparison to other economies under the remaining categories as shown in Table 1.1.

**Table 1.1:** Average Economic Growth Rate of the World Main Economic Groups

| Category               | 1997-2011(avg) | 2012-2019(avg) | 2020-2022(avg) | 2023(f) |
|------------------------|----------------|----------------|----------------|---------|
| <b>Developed</b>       | 2              | 1.81           | 1              | 1.6     |
| <b>In transition</b>   | 4.5            | 1.58           | 0.2            | 3.3     |
| <b>Developing</b>      | 5.3            | 4.32           | 3              | 4.1     |
| <b>Least developed</b> | 5.8            | 4.7            | 2.2            | 4.4     |

Source: UN (2020, 2023, 2024)

LDCs economic growth rate between 2012 to 2019 averaged at 4.7 % which was higher than the growth rate of developing nations that averaged at 4.3 % which in turn was

higher than the in-transition economies growth rate that averaged at 1.58 %. This higher growth rate for LDCs and developing economies is expected to continue in 2023 compared to the growth rate of in-transition and developed nations but with the price of higher inflation in comparison to developed and in-transition economies (Appendix 2.1).

The weak position of LDCs and developing countries' economies, their effort in the process of transforming into more developed ones and being in the earlier stages of development explain their high average annual growth rate and inflation rate in comparison to developed nations. On the contrary, the lower growth rate of developed nations reflects the fact these countries are already having large scale economy and are in the lead of almost every aspect which means these economies depend on no further development to grow, yet just innovation.

In regard to Yemen, it is a western Asia country that is classified under the category of LDCs (Appendix 2.2 for a full list of LDCs) as the only exception among Western Asia countries that are classified as developing countries (UN, 2020). The western Asia countries (Appendix 2.3 for a full list of western Asia) in turn are divided into oil exporters among which is Yemen and oil importers countries. In the subsequent lines, detailed review is provided regarding the country's macroeconomy.

### **1.2.2 Yemen's Demography**

With an area of about 555,000 km<sup>2</sup>, Yemen is considered the second largest country right after Saudi Arabia in the Arabic peninsula taking its southwestern part and bordering with Oman, Saudi Arabia, Red Sea, and the Arabian Sea. With a yearly average growth rate of around 3 % which is among the highest rate of population growth in the world, the

population of Yemen has spiked from 6 million in 1975 to 23 million in 2010 and to around 33 million in 2022 and expected to hit 40 million by 2025 based on the official statistics of The World Bank (WB) and International Monetary Funds (IMF). Figure 1.2 below depicted the increase in population of Yemen.

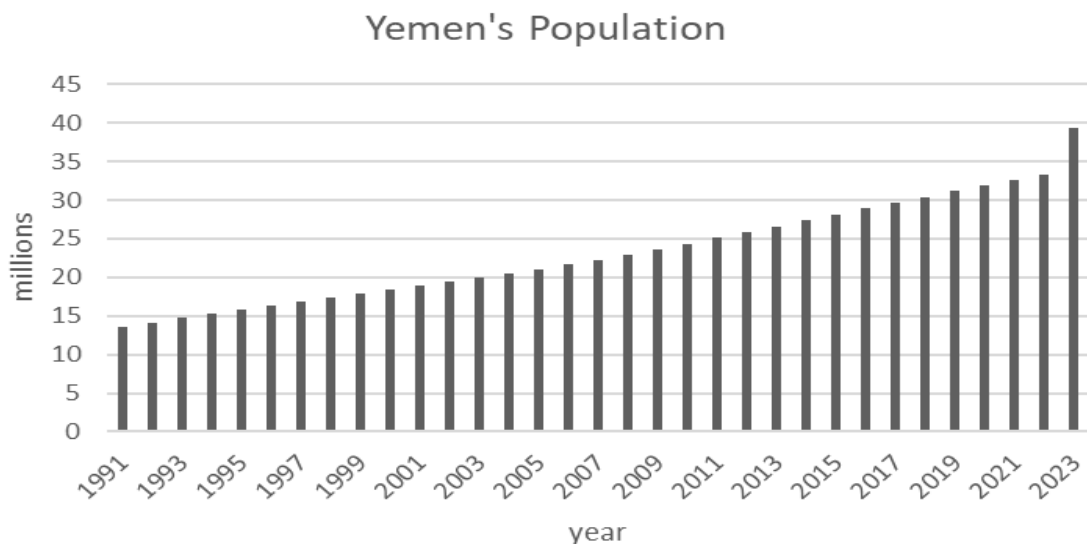


**Figure 1.2:** Yemen's Population, 1991-2023

Source: Adopted from IMF (2023a)

According to Yemen's Central Statistical Organization (CSO) (2023), the urban population makes up a total of more than 10 million (32.23 %) of the total population of the country while the rural areas take over the remaining residents of 67.77 %. There is no big difference in the ratio of males to females with males taking around 50.88 % of the total population as compared to 49.12 % of females. Table 1.2 summarizes these statistics.

**Table 1.2:** Demography of Yemen

| Total population as of 2023: |           |         |         | 32,618,000           |                       |                      |
|------------------------------|-----------|---------|---------|----------------------|-----------------------|----------------------|
| Males %                      | Females % | Urban % | Rural % | Under 15 years old % | Between 15 & 65 old % | Above 65 years old % |
| 50.88 %                      | 49.12 %   | 32.23 % | 67.77 % | 44.30 %              | 53.26 %               | 2.44 %               |

Source: Adopted from CSO (2023)

Furthermore, the continuing growth in the country's population is one of the highest in the world since 1990 to the present as stated earlier and shown in Figure 1.2 above has contributed to the regular increase in the labor force in the country particularly among people aged 15 and above which makes up the main group of Yemen's Labor Force (YLF, hereafter) as they make up the biggest percentage of the overall population as seen in Table 1.2 above.

The first YLF survey by ILO and CSO reported that 13.5 million of the population is of the working-age (i.e., 15+ old) with a slight difference in the ratio of males to females. However, with a 36.3 % labor force participation rate, the employment in the country among males and females was totaled 4.2 million of which 56 % in the service sector, 29 % in the agricultural sector and leaving the industry with 14.5 % while the remaining unemployed population of working age made up the 13.5 % overall unemployment rate of which 26 % are females and 12.3 % are males.

These figures, however, have increased since 2014 as the population keeps on increasing. Latest data by TWB (2023a) as depicted in Figure 1.3 below showed that YLF increased to more than 6 million in 2015, to about 6.7 million in 2017 and to around 7.8 million in 2022. Similarly, the gap between male and female in terms of their YLF participation rate has increased tremendously with 70 % for male and only 6.2 % for females in 2022 (TWB, 2023c).

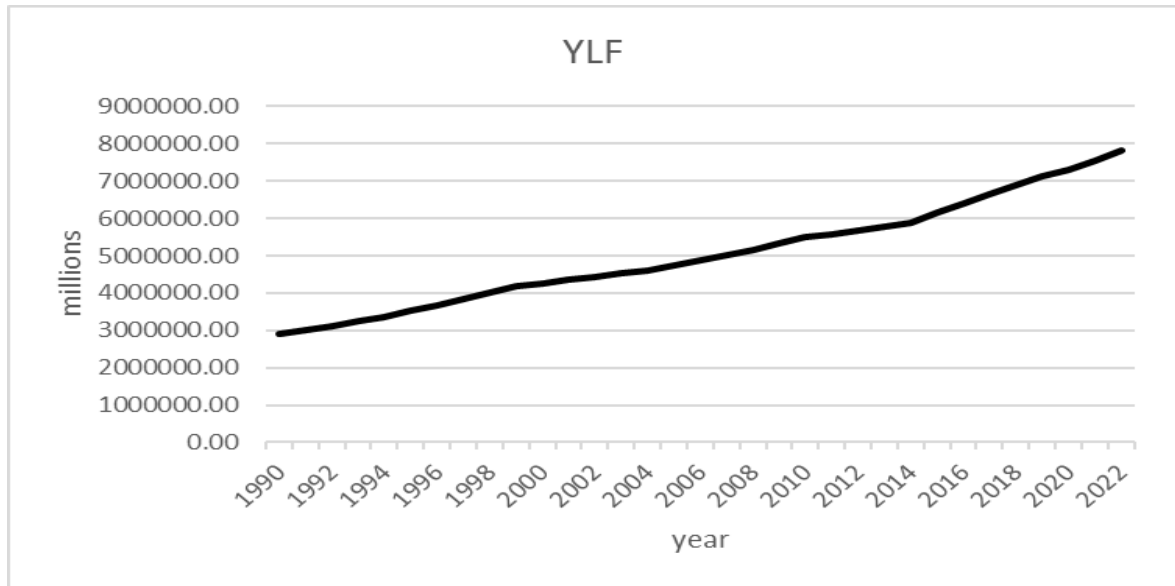


**Figure 1.3:** Yemen’s Labor Force Increase

Source: Adopted from TWB (2023a)

### 1.2.3 Yemen’s Macroeconomy

Along the Yemen history, the 90s period was a crucial period in such long history where the two Yemen “south and north” have become one and the sector of oil has rapidly improved leading to a surge in the production of oil and as so, the opportunities for and challenges facing the Yemen’s economy emerged. The reform of Yemen’s economy started right after the unification of both south and north Yemen in 1990 and along this period to present, the country economy has faced several challenges ranging from internal to external ones which with one way or another have had an impact on the economy. The following are the key macroeconomic activities at glance.

### 1.2.3.1 Economic growth

In their growth report, TWB and DFID (2015) reported that right after the changing point in Yemen's history which is the declaration of unity between south and north in 1990, the one Yemen economy increased at an average rate of growth of 6.3 % from 1990 to 1994 where it fell to 4.2 % due to the temporary unrest occurred in 1994. However, the reclaiming of stability facilitated by the development of oil production, the growth of the economy averaged at 5.2 % between 1995 and 2000.

In the same vein, IMF (2023b) latest data showed that in the 2000s (i.e., 2000-2010), the economic growth rate (i.e., GDP) was averaged at 4.4 % before it sharply declined in 2011 (-12 %) and again in 2015 (-28 %) before it witnessed slight recovery by 1.5 % in 2019 and a same slow recovery by 1.5 % in 2022 before it contracted by (-2 %) in 2023. Looking ahead, TWB (2025) reported that Yemen real GDP is projected to contract by 1.5 % while GDP per capita is expected to drop by 19 % in 2025. The depicted Figure 1.4 below illustrates the fluctuations in Yemen's GDP growth.

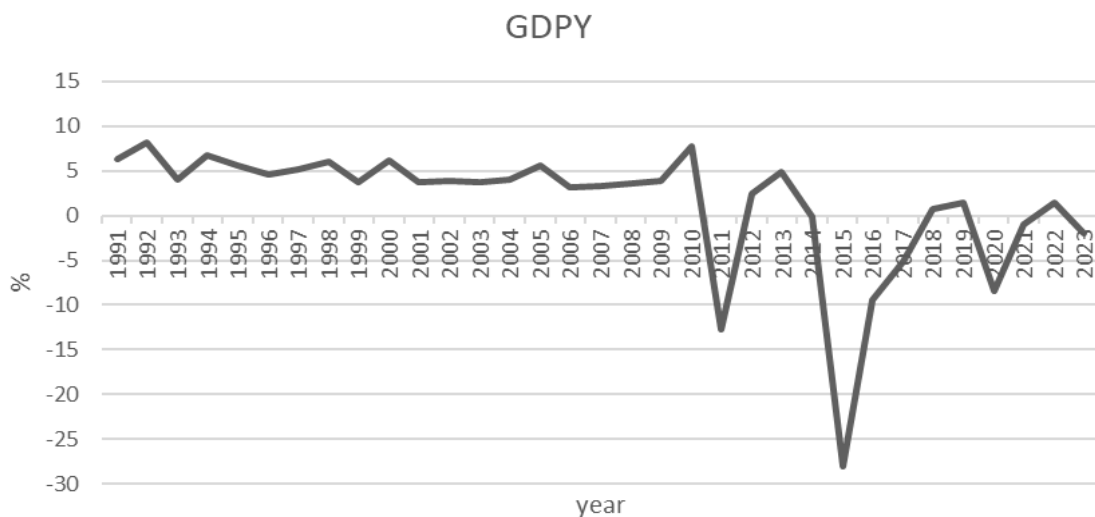


**Figure 1.4:** Annual Economic Growth Rate of Yemen

Source: Adopted from IMF (2023b)

Figure 1.4 clearly indicates a slowdown in the rate of country's economic growth across the mentioned period and particularly in recent years. The slow growth in recent years of 2020 and 2021 may be attributed to the improved price of oil which averaged above 100 \$/ barrel in response to Russia-Ukraine conflict (Hack and Troderman, 2022), as well as the calmness of the political unrest in the country that facilitate the export of Oil (TWB, 2025). This oil export, however, was halted in mid-2022, which led to a contraction in growth in 2023. For this reason, alongside the Persistent fiscal pressures, on-going currency depreciation, and liquidity shortages, the economic fragility is going to be intensified as projected for 2025 and after (TWB, 2025).

In comparison to the economic growth of oil exporters of western Asia which includes alongside Yemen, the Gulf Corporation Countries (hereafter, GCC) and Iraq. The economic growth of GCCs (Saudi arabia, UAE, Qatar, Bahrain, Oman and Kuwait) collectively as shown in Table 1.3 averaged at 1.2 % between 2014 and 2021 down from a rate of 5.4 % in the period from 1997 to 2013 and expected to grow in a rate of 5 % and 2.75 % in 2022. The Iraqi Economic growth was averaged at 1.4 % (2014-2021) and expected to recover by 6 % in 2022.

**Table 1.3:** Economic Growth Rate of Western Asia Oil Exporters

| Country     | 99-2013 | 2014 | 2015 | 2016 | 2017  | 2018 | 2019 | 2020   | 2021 | 2022 |
|-------------|---------|------|------|------|-------|------|------|--------|------|------|
| <b>GCC</b>  | 5.4     | 3.1  | 3.5  | 3.1  | 0.5   | 1.7  | 0.7  | (5.3)  | 2.4  | 5.0  |
| <b>Iraq</b> | 4.8     | 0.2  | 4.7  | 13.8 | (3.8) | 0.9  | 4.4  | (11.2) | 2.4  | 6.2  |

Source: Adopted from UN (2022)

Economic growth of Both GCCs and Iraq as shown in Table 1.3 fluctuate as well but in slower rate in the case of GCCs having their stronger economic position and larger oil production, and thereby growing oil revenues as compared to Yemen. However, in contrast to

Yemen, the region's GDP is projected to spike up 2.6 % in 2025, benefiting from a gradual rise in oil production (TWB, 2025).

### 1.2.3.2 Inflation

The macroeconomic indicator of inflation is of importance as it influences the level of income per capita and capita's ability to obtain their necessities from basic goods to housing to health to education, etc. According to MPIC (2017) waves of inflation in the country between 2014 and 2017 have been swarming all basic commodities such as F&B with a cumulative high of 38.7 %, cloths with an accumulative high of 42.8 %, education with 14.9 %, fuel and gas with 88 % and so on, blaming the political unrest and overall weak monetary of prices within this period. However, the overall annual Inflation as seen from Figure 1.5 below has recorded its all-time high in 1994 with 71 % and all-time low in 2009 with 3.6 % and averaging at about 23 % across the observed period.

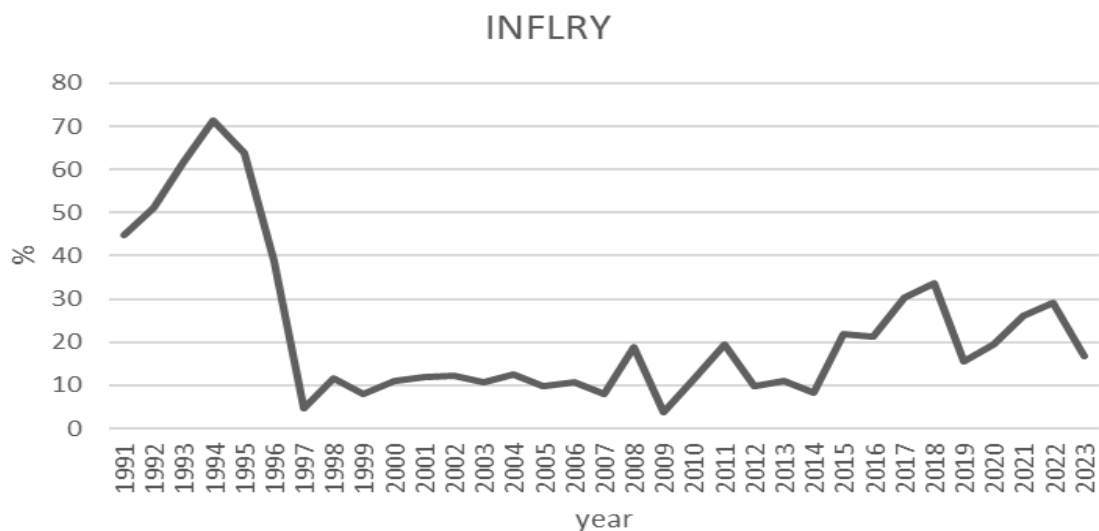


**Figure 1.5:** Yemen's Annual Inflation Growth

Source: Adopted from IMF (2023c)

However, regardless the economic growth slight recovery in 2022, as stated, the inflation rate in Yemen continues increasing to about 27 % in 2021 and to about 30 % in 2022 before it declined back to 17 % in 2023. Looking ahead, Inflation is no better than GDP, as it is projected to remain elevated beyond 30 % in 2025 for the same reasons that may lead to a bleak outlook for the country's economic growth (TWB, 2025). Hence, to better understand these ups and downs trends in Yemen's inflation over time, it is essential to consider some facts on the role of oil price shocks on inflation, particularly in fragile and import-dependent economies. To this end, Arab Monetary Fund (AMF) in its latest the joint Arab world economic report blamed the spike in oil prices in particular and energy cost in general among other reason for the higher inflation rate since 2002 in the region at whole which was even worse in some countries among of which is Yemen (AMF, 2023). In addition, a recent world bank report underscores the importance of global shocks, among which oil price shocks, in driving inflation over the period from 1970 to 2022. The impact of such shocks was significant in 75 % of the world's countries, but with different magnitudes that depend on the country's characteristics. Moreover, the effect of such shocks has increased overtime from less than 4 % before the 2000s to more than 9 % from 2001 to the present. The effect gets even stronger on countries with weak monetary frameworks and high external dependency (Ha et al, 2023).

Compared to the inflation rate of western Asia oil exporters, this inflation rate is still way far from the expected inflation rate of western Asia oil exporters which is expected to be at 1.9 % and 3.6 % in 2022, respectively. Furthermore, with an average of 5 % of inflation rate in the western Asia region as whole between 2013 to 2021, both GCC and Iraq stands not far from such an average at this observed period with 1.4 % of an average rate of inflation. Yemen, however, with an inflation of 20 % on average keeps far behind the region

average inflation rate reflecting the continues increase in the country inflation along this observed period and as Figure 1.5 above clearly showed. Thus, it can be said that GCC and Iraq fluctuate as well but in far smaller rates than to the high rate in Yemen’s case. Table 1.4 below illustrates rate of inflation of western Asia oil exporters as classified by the UN (2022).

**Table 1.4:** Inflation Rate of Western Asia Oil Exporters

| <b>Country</b> | <b>99-2013</b> | <b>2014</b> | <b>2015</b> | <b>2016</b> | <b>2017</b> | <b>2018</b> | <b>2019</b> | <b>2020</b> | <b>2021</b> | <b>2022</b> |
|----------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| <b>GCC</b>     | 2.5            | 2.4         | 2.1         | 2.3         | 1.1         | 1.6         | (0.4)       | (0.4)       | 1.6         | 1.9         |
| <b>Iraq</b>    | 1.9            | 2.2         | 1.4         | 0.6         | 0.2         | 0.4         | (0.2)       | 0.6         | 5.8         | 3.6         |

Source: Adopted from UN (2022)

### **1.2.3.3 Exchange Rate**

Riyal which was the northern Yemeni's part official currency since the 60s has become the official currency of the Republic of Yemen since the unification in 1990 between the southern and northern parts of Yemen. The sole government's body in charge of issuing the local currency and setting up policies related to its exchange and usage is the central bank (CBY). According to the latest official exchange rates by IMF (2023d) and as depicted in Figure 1.6 below, the Yemeni Riyal has continued to depreciate against the US dollar (USD), falling from as low as 12.01 YER/USD in 1990 to an oscillating exchange rate between 213 YER/USD and 250.25 YER/USD during the period 2010 to 2013.

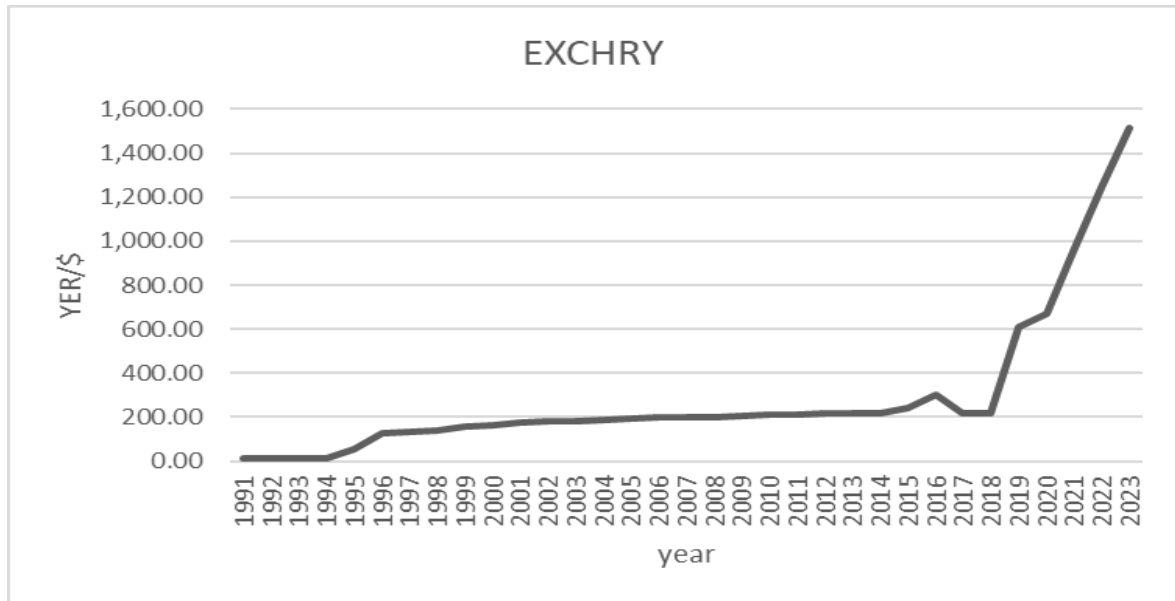


**Figure 1.6:** Annual Exchange Rate of Yemen

Source: Adopted from IMF (2023d)

However, the political instability which arouses in 2015 has paved the way for a parallel market (Black market) interference in the exchange rate. As a result, a 40 % loss in the value of the local currency against the USD in 2017, causing the trade rate to reach up to 500 YER/ USD in early 2018 in the black market (CMWG and ACAPS, 2020). Furthermore, the upward trend has persisted in recent years, with the exchange rate surpassing 1,000 YER/USD. According to the World Bank (2025), the rate climbed to around 1,536 YER/ USD in early 2024 and is projected to reach approximately 2,062 YER/ USD by the end of the year. Relating exchange rate fluctuations in general to the movement of oil prices globally, the European Central Bank (ECB) in its 2024 bulletin underscores the linkage between changes in oil prices and exchange rates against the USD, as the commodity is traded internationally in dollars. Furthermore, it indicated that linkage might be positive for exporters, as occurred with the USD, since the USA transitioned to net oil exporters in 2019 (ECB, 2024).

The Central Bank of Yemen (CBY, hereafter) uses, however, several tools to control and stabilize the inflationary and Yemen riyal trade in the exchange market among of which is the tool of interest rate, discount rate, broad money supply, interference in the exchange market, issuance of deposit's certificates. For instance, the broad money as reported by TWB (2019) In its economic monitoring brief has spiked by annual growth of about 53 % in 2018 in response to the expansionary Monetary policy by CBY jumping from just 1.3 % in the previous year scoring the second high and the biggest in the current decade as compared to 22 % growth in 2012. However, CBY official report (2022) has indicated a spike of about 30 % in the same year as depicted in Figure 1.7. Both figures though imply the high tendency of CBY on such policy in controlling for the higher inflationary rate in the country as mentioned earlier.

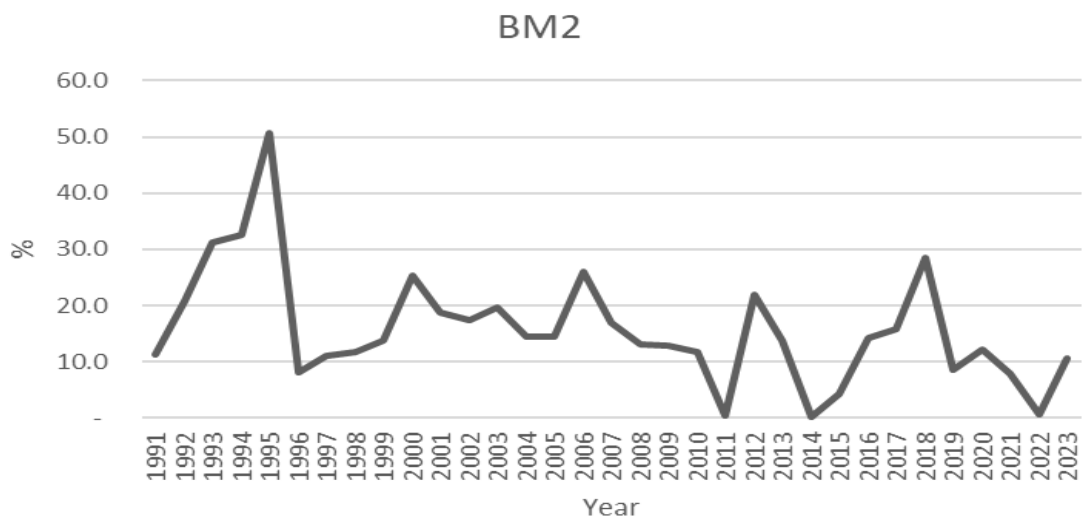


**Figure 1.7:** Annual Broad Money Growth Rate of Yemen

Source: Adopted from TWB (2019), CBY (2022)

### 1.2.3.4 Unemployment

The regular increase in the YLF shown in Figure 1.3 corresponded with a fluctuation in the unemployment rate between decrease and increase. In 1991, the unemployment rate was 8.3 % and was averaged around until 1994 before it spiked to more than 9 % in 1996 and further to around 12 % in 2000 with a slight fluctuation around 12 % up to 2010 before it spiked up to more than 13 % from 2011 onwards reaching its all-time high in 2021 with about 14 %. This high rate later declined slightly in the following year to 13.5 % before it spiked up to 17 % in 2023. (TWB, 2023b). Figure 1.8 illustrates the trend of unemployment rate in the country.

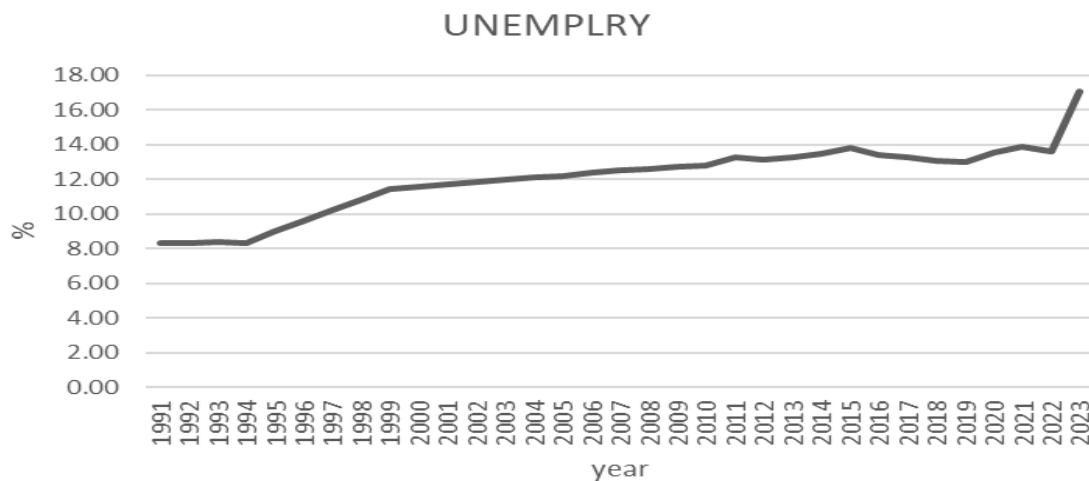


**Figure 1.8:** Yemen's Unemployment Rate

Source: Adopted from TWB (2023b)

Looking ahead, although a precise public forecast is not yet available, the severe contraction projected in GDP (−1.5 %) stated earlier, coupled with ongoing conflict and disruptions in oil production, suggests that unemployment is likely to remain high or possibly increase again. Hence, based on past responses of unemployment to economic downturns in Yemen, it would be reasonable to project a rate in the region of 16-18 %.

In comparison to the western Asia Region, the overall unemployment rate in the region according to the UN (2020) is not different from Yemen and remains high due to social unrest in the region. for instance, in Saudi Arabia, the rate of unemployment declined slightly from 12.7 % in 2018 to 12.3 % in 2019. This rate got even lower by end of 2023 reaching 8.3 % (UN, 2024). Moreover, the United Nations Economic and Social Commission for Western Asia (ESCWA) reported persistently high unemployment rates across the Arab world, which reached 10.7 % in 2023 compared to 5.8 % on average globally, with particularly alarming levels among women (19.9 %) and youth (26.3 %) (ESCWA, 2024). These facts mirror the severe labor market challenges faced by Yemen, and within such a context, Yemen's unemployment trends can be better understood as part of a broader regional crisis.

#### **1.2.4 Economic Growth's Key Sectors**

Yemen as stated earlier is least developed Western Asia economy. Since its reunion in 1990 to the present, the development of Yemen's economic growth depicted previously in Figure (1.4) relied on different sectors' revenues. According to TWB (2020a), between 1990 and 2019, Three broad economic sectors namely the industry sector with an average of 41 % contribution, the service sector with an average of about 30 % contribution, and agriculture sectors with an average of 14 % contribution. Figure 1.9 illustrates the contribution of each key sector across 30 years and the average contribution of each.

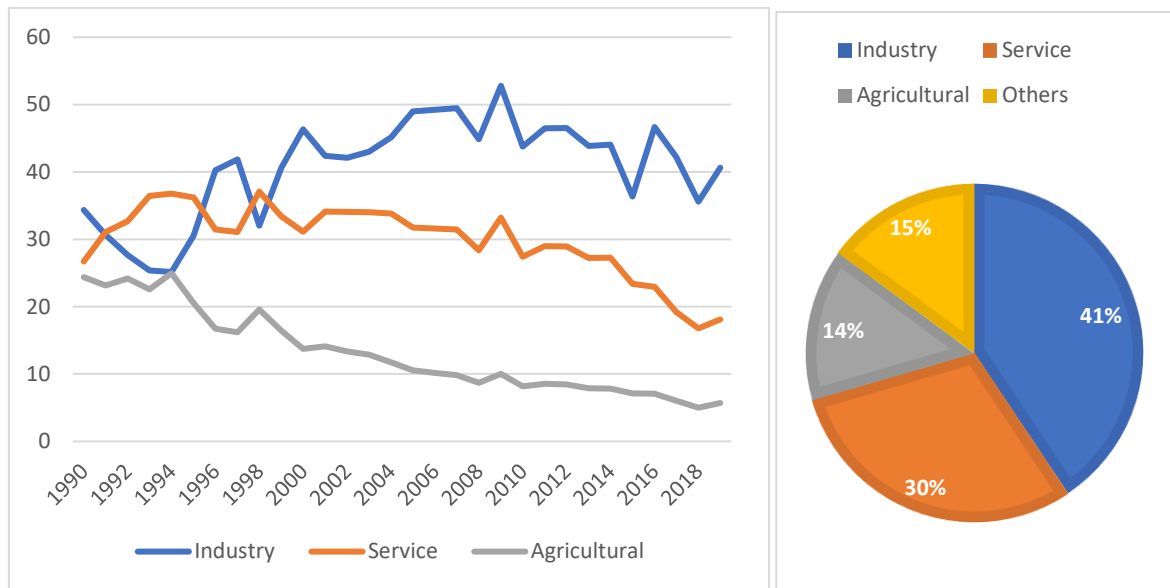


**Figure 1.9: Yemen's GDP Sectoral Contribution**

Source: Author's construct based on TWB(2020a)

The industry sector which has a significant contribution (i.e. 41 %) consists of mining, manufacturing, oil, construction, electricity, water and gas. Oil sector share to the economic growth across the year from 1990 to 2019 averaged at 28.6 % (i.e.70 % of the overall share of the industry sector to GDP) while manufacturing share averaged at 9.7 % (i.e. 24 % of the overall share of the industry sector to GDP) and the remaining components share averaged at 2.7 % ( i.e. 6 % of industry share to GDP). Figure 1.10 illustrates the contribution of oil, manufacturing and remaining components within the industry sector to country economic growth.

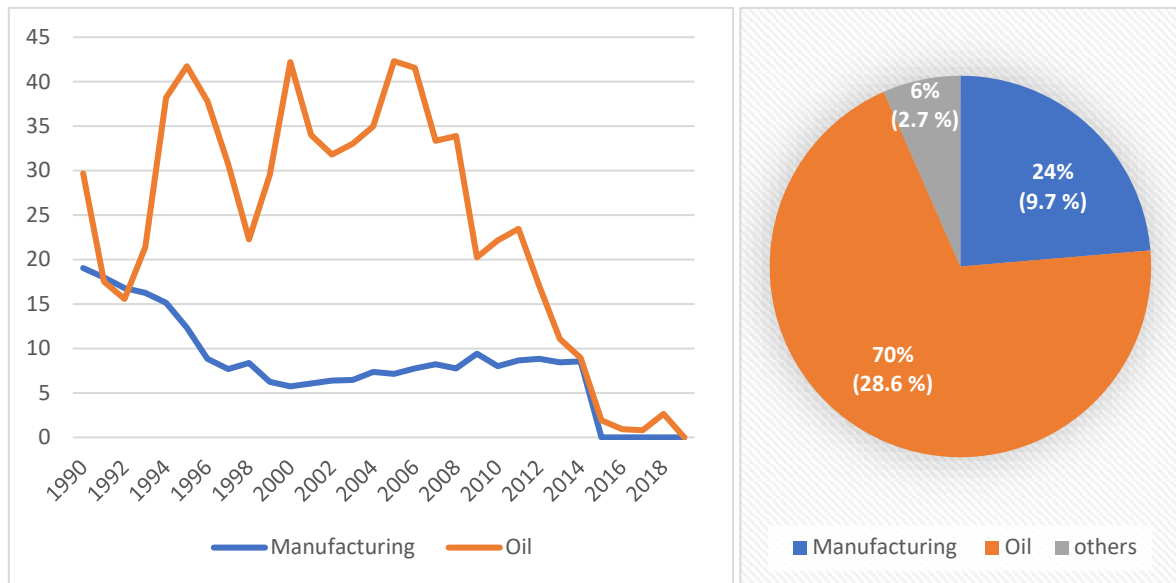


**Figure 1.10: Oil & Manufacturing Sectors Contribution to Yemen's GDP**

Source: Author's construct based on TWB (2020a)

As seen from Figure 1.10 above, the oil sector remains a core one in Yemen's economy and it is overseeded by the ministry of oil and mineral resource (MOM) through handling agreements with international companies and setting out oil's policies of exports and dis-tributions either directly or through some institutions under it such as YOGC, PEPA and YOC. With (3 billion bbl) of proved oil reserves, the history of producing oil started few years prior to the unification of Yemen in 1990, particularly in the northern part but the first significant production of (173,000 bbl) was marked in 1988 before it reached an all-time high in 2002 with a daily (440,000 bbl) (EIA, 2020). The oil sector regardless of the quantity produced from 1990 to the present, remained the main source of government revenue with 65 % and over 80 % of overall export revenues making it alone in charge of one-fourth of the economic growth (TWB and DFID, 2015). According to TWB (2020c), the average share of oil revenues of Yemen's GDP was about 29 % considering the period from 1990 to 2019 but with a fluctuating yearly contribution as Figure 1.10 showed mark-ing all-time-high in

2005 with a 43 % share of GDP. The oil sector, with this large share of GDP as an average and over the years, makes it the main source of revenue compared to other tradable sectors such as manufacturing and agriculture sectors. Worth mention-ing that though Yemen is classified as an oil exporting country, due to the unrest happen-ing in the last decade, it has been importing some refined oil products while exporting crude oil. According to TWB (2020b), in 2019, the country imported \$3 billion of refined oil products versus exporting a worth of \$1 billion of crude oil, making the country one of the unique cases that diverge from being either a net oil exporter or net oil importer.

As for the manufacturing sector, this sector includes among others, the manufac-turing of food and beverage, chemicals, textile and machinery, and transport equipment. As seen from Figure 1.10 and in contrast to the oil sector, the contribution of manufactur-ing to the country's economic growth is on a declining trend from its all-time high in 1990 of 19 % of GDP, making this tradable sector the smallest contributor to the overall economic growth.

The service sector is another key contributor to the country's economic growth with 30 % on average as depicted in Figure 1.9 above. It includes services such as gov-ernment services, hotels and restaurants, retail and wholesale, insurance and banking, social and transportation, and communication. Similar to the oil sector, the share of this non-tradable sector fluctuated over years marking its high of 37 % in 1998 and its recent contribution of 18 % in 2019. This decline in the service sector's contribution in recent years might be due to the increase in unemployment rate depicted earlier in Figure 1.9.

With a big agricultural land of around 24 million hectares and around 45 % of working Yemenis, the agricultural sector with its 14 % on average contribution plays an important role in the economic growth of the country right after the oil sector within the

industry sector and service sector. As stated by TWB (2020a), hunting, forestry, fishing activities, production of livestock, and crops' cultivation are all included under this sector. This sector though is not the main GDP contributor, but it is the income source of 45 % of Yemen's population as of 2016. As depicted in Figure 1.9, the sector is on a declining trend in its contribution to the country's GDP starting from its high of 24 % in 1994 to around 6 % in the recent year of 2019. The sector's contribution might be impacted by the higher unemployment rate recently as well.

In comparison to the western Asia region to which Yemen belongs, according to the UN (2020), The economic growth of western Asia, in general, has decreased from 2.6 % in 2017 to 2.3 % in 2018 and to 1 % in 2019 but expected to slightly recover in 2020 and 2021 with a growth rate of 2.4 and 2.8 % respectively. This economic growth depends on the revenues of export which fuel has the lion share of 41 % followed by the manufacturing sector with 32 % and agricultural as the smallest contributor with 4 % as can be seen from Figure 1.11.

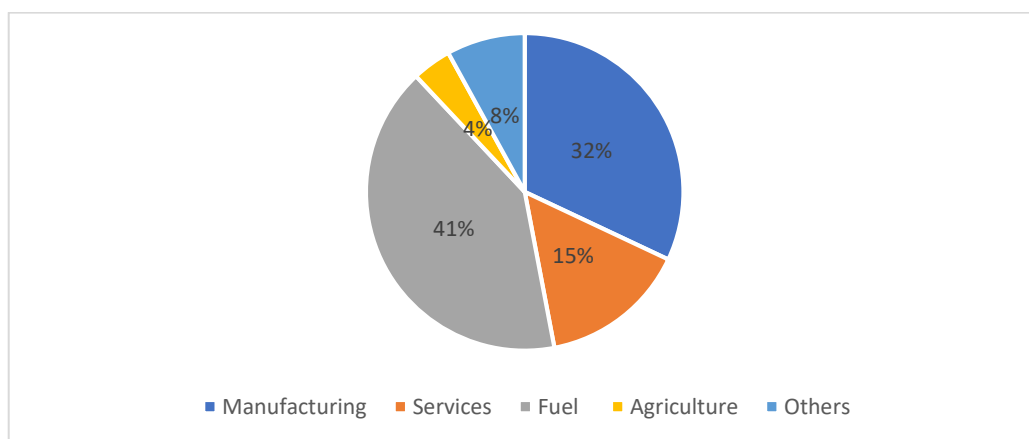


**Figure 1.11: Western Asia Economic Growth Sectoral Contributions**

Source :Author's construct based on UN (2020)

Similar to the western Asia region which depends mainly on fuel revenues followed by manufacturing and lastly by agricultural, Yemen also depends largely on the revenues of the industry sector particularly oil and manufacturing revenues in growing its economy and in lastly and lightly on the agricultural revenues.

### **1.2.5 Summary**

As a least developed country (i.e., LDC), the economy of the country which produces oil depends highly on the revenues from oil commodities with some significant contribution to other sectors, mainly the service sector and agricultural sector. More than half of the employed people work in the agricultural sector with the remaining divided between the service sector, industry sector mainly in oil and gas. Since the unification of the country in 1990 and the number of the labor force is in regular increase responding to the regular increase in population year by year. However, the unemployment rate, relative to the increased labor force, is high averaging at 12.6 % from 2000 to the present. Economic growth in the country has witnessed a sharp decrease in the last few years compared to the early years after unification (i.e., 90s) and during the 2000s but with a positive outlook for the coming five years. The inflationary which reflects the ability of people to access basic goods fluctuated across the years averaging at 21.9 % over the observed period since 1990. In relation to the exchange market, the trade of the Yemeni rial in the second decade of the current century was oscillating between 213 riyals per USD to 250 riyals per USD but the case was different in the parallel market which emerged in response to the political unrest in the last few years. CBY, which is the independent and sole handler of the local currency, and its related matters, sets the policies of monetary such as expanding broad money, increasing

or lowering the interest rate and so on which can keep the exchange rate and inflation under control. Appendix 2.4 represents a summary of the data depicted in figures above.

### **1.3 Problem Statement**

More than \$ 5 billion of oil revenues were reported in 2011 making the revenues of exported oil and gas contribute to about 63 % of the total government revenues and 89 % of total export revenues between 2010 and 2012 (EIA, 2020). These figures declined in the following years of 2013 and 2014 as reported by MoPIC (2016) with 83.3 % contribution to the total export earnings and 45 % contributions to total government budget before the oil revenues significantly dropped by \$3.7 billion in 2015 leading to a 36 % drop in GDP per capita and about 34.5 % drop in the GDP. Similarly, a 54 % cumulative contraction in GDP between 2015 and 2023 has been reported (TWB, 2024). These declines in oil revenues can be clearly seen by Referring to Figure 1.10 which clearly shows the fluctuations in the “percentage” contribution of the revenues from oil to GDP. Hence, the question is "does increase /decrease in the crude oil prices influence the returns of oil to governments and economic growth?

Apart from the oil rent as % of GDP, generally, Yemen's macroeconomic performance since unification in 1990 and as seen from facts and figures above, has been marked by persistent fluctuations, acute instability, and structural weaknesses. This is seen from the dynamics of key indicators such as GDP, inflation, unemployment, and the exchange rate. These dynamics are worsened by a prolonged political unrest, institutional fragility, and Yemen’s heavy reliance on the export of oil for fiscal and external revenues. For instance, the economic growth rate, as depicted in Figure 1.4, is fluctuating across the

observed period with a significant drop in some years, such as 2011 and 2015, and a significant increase in some others, such as in 2000 and 2010. The Figure indicates a slowdown in the rate of the country's economic growth across the mentioned period and particularly in recent years. Similarly, the inflationary rate in Figure 1.5 is highly oscillating, marking an all-time high in 2017 and 2018, respectively. Additionally, the same fluctuating case could be seen in the trend of the exchange rate and unemployment rate, with a continuing fall in the last decade as depicted in Figure 1.6 and Figure 1.8, respectively. The MoPIC ministry has blamed this sharp decline in the economic growth drivers and oil revenues to the significant deterioration in the world crude oil price particularly before 2015, and to both world oil price and political unrest aroused in 2015. This could be true as the estimation by the International Monetary Fund (IMF) showed that in order for the country to balance its budget which is highly dependent on oil export revenues, an oil price of \$215/barrel is needed (EIA, 2020). Hence, the questions now are "does the fluctuation in the country's macroeconomic indicators is due to the substantial fluctuation in oil prices? Is there any relationship between this substantial fluctuation in oil prices (i.e. oil price shocks) and these economic activities? Given the rarity of studies that has empirically answered this and proved such a nexus between world OP deterioration and the drivers of Yemen's macroeconomic, the motivation of conducting this research to explore such a relationship between oil price shocks and indicators of Yemen macroeconomic has been found.

Moreover, and given this fragile state of Yemen's economy, its high reliance on oil, and the fact that oil is price sensitive whether responding to external or internal (i.e., Market-related) causes as in Figure 1.1, It is not only timely, but also vital, to examine the ups and downs (i.e., asymmetric effects) of oil price shocks on Yemen's key macroeconomic indicators. The global oil market is highly volatile, and in an oil-reliant economy like Yemen,

spikes in oil price may have a different response than a decline in oil price due to structural rigidities in the economy, weakened fiscal buffers, and lack of diversification. For example, a temporary oil price rise (i.e., positive shocks) may not be a significant problem for the economy in general, but an oil price decline (i.e., negative shocks) is not only likely to increase macroeconomic distress unevenly, but it might also further worsen the exchange rate and inflationary pressure. The opposite might be true as well. To this end, the question now is, do macroeconomic activities respond asymmetrically to rising or declining oil price shocks? Hence, it is important to understand and capture these asymmetries and to develop policies that would be more resilient and responsive in the face of these oil price ups and downs. This study, however, aims at exploring such asymmetric impact on the macroeconomic activities in the case of Yemen, not through assuming a scenario but through analyzing the price shocks in oil prices from 1991 to the most recent ones.

At the same time, and due to the fact mentioned earlier that Yemen has become a non-net oil exporter by importing some refined products of oil, which makes it highly dependent on fuel-related imports, priced in foreign currency, primarily U.S. dollars. As a result, Exchange rate movements may directly influence domestic oil prices. When the local currency loses value, it raises the local cost of importing fuel. On the other hand, if the currency strengthens, it may not result in an equal or immediate drop in prices. This can happen because of market rigidity or the subsidy policies. This situation shows the need to look into asymmetric pass-through effects from exchange rate to oil price, while there is no need to look for the same in other indicators, as they might lack this immediate and directional influence. For example, a drop in GDP might reflect lower oil revenues, but it doesn't directly cause domestic oil prices to move. Hence, the question is whether oil prices would be impacted by the movement in the exchange rate as well?

On the other hand, sectoral contribution to the country's economic growth depicted in Figure 1.9 and Figure 1.10, respectively implied an overall decline in the non-oil tradable sectors contribution across the observed period, particularly the agricultural, service and manufacturing sectors as compared to the oil sector. Hence, the country's high reliance on oil alongside the weakening and deterioration of the contributions of non-oil sectors to the economy, puts the "Dutch disease" as a major concern for Yemen's economy, worth looking into empirically and thoroughly. The question, however, is do such declines have to do with the symptoms of what is known theoretically as "Dutch disease"? In this study, the country's economy is to be diagnosed for the possibility of having suffered from such a problem.

## **1.4 Study' Objectives**

### **1.4.1 General Objective**

The general "aim" is investigating the effect of oil price shocks in terms of asymmetry on the key-macroeconomic indicators of Yemen. Data availability was used as the main standard of selecting the sample period and macroeconomic indicators to be investigated within it. Worth mentioning that the nature and duration of such association over time (short-run vs. long-run) and the direction and magnitude of the impact (positive vs. negative) are to be considered separately. Hence, the specific objectives that can be drawn are illustrated below.

### **1.4.2 Specific Objectives**

1. To investigate the long run and short run dynamic association between oil price shocks and the major macroeconomic indicators of Yemen.

2. To examine the asymmetric impacts of oil price shocks on Yemen's major macro-economic indicators.
3. To investigate the presence of asymmetric pass-through nexus from exchange rate movements to oil prices.
4. To assess the possibility of the "Dutch disease" problem in Yemen's economy.

## **1.5 Research Questions**

Drawing on the issues highlighted in the problem statement, which also highlighted the questions this study seeks to answer, the following section is a summary of these questions.

- 1- Is there an asymmetric relationship between Yemen major economic indicators and the positive and negative oil price shocks?
- 2- Do Yemen major economic indicators respond asymmetrically to positive and negative oil price shocks?
- 3- Does Yemen's high reliance on oil and the declining contribution of its major non-oil tradable sectors demonstrate the symptoms of "Dutch Disease"?
- 4- Is there an asymmetric effect pass from exchange rate movements to oil prices in Yemen?

## **1.6 Significance of The Study**

Yemen as an oil producer that heavily reliant on oil revenues in developing its economy is vulnerable to the effects of oil price shocks either negatively or positively. Thus, this study aimed at finding the way that key macroeconomic activities in Yemen respond to

the shocks in oil prices. For this reason, along with the rarity, of such studies in relation to Yemen's economy, this study reflects a key significance for both policymakers and future researchers in the country.

As for the policymakers, more knowledge, and thereby in-depth understanding regarding the negative as well as positive results of oil price shocks on the country's macroeconomics would be gained. Such in-depth understanding can assist them effectively in designing the best and most appropriate policies such as monetary policies to counteract any negative consequences and take advantage of any positive consequences. The importance of this study findings is far more than just assisting those policymakers to decide which short-term policy is best to use at the time when the economy is hit by such shocks to temporarily mitigate any negative impact. Instead, the strength and weakness level of the economy in the face of such shocks would be clearly observed, which may assist them in designing the appropriate-long term policies based on the suggested and recommended policies drawn from this study's outcomes.

As for the future researchers and given the fact the importance of oil to the country which makes it vulnerable to potential future shocks in the prices of oil. This topic, however, is open as long as the world's economies including Yemen are reliant on oil. Therefore, and in the light of this study's outcomes and future studies' recommendations, this study can be taken as a base to go into further and deep research that concerns the macroeconomics of the country. Making use of the limitations in this study, a better and more comprehended version of this study can be developed.

Furthermore, nonlinearity which implies to asymmetry-alike behavior does exist in the relations among most if not all major economic variables as claimed by Soofi and Cao

(2002). However, an ample quantity of pervious works regarding the relationship among economic indicators and shocks of oil price have focused on the linear and symmetric relationship among variables and those who basically investigated the asymmetric type of relationship put most of their focus on the developed and major exporting countries as revealed in the review of literature chapter. Therefore, this study based on the assumption of asymmetry contributes to the existing and reviewed studies by investigating such relationship in the case of under developing economy (i.e., YEMEN) that relies mainly on the oil revenues. This study significance lies in the fact that it is among the less if not the first that focuses on Yemen which far less developed than most countries been under investigation in the literature which opens the door for new findings to be added to the existing literature in a totally different economic scenario.

Methodologically, this study in hand employed the nonlinear version of the ARDL model or NARDL to estimate the relationship between shocks of oil price and several macroeconomic indicators which distinct this study from similar studies that also employed NARDL where most of them focused on the impact of oil shocks on one economic indicator rather than on multiple indicators. Worth mentioning that, studies that considered multiple indicators to be investigated used different estimate methods than NARDL. This is another key significance of this study in hand to the existing literature that employed the same estimation method which in general are not as much as studies that employed different estimation methods such as VAR and its related estimation methods. The findings of this study, hence, would be an added value to the body of knowledge as it provides a broader insight of oil shocks' impact on several key macroeconomic indicators.

In brief, it is obvious considering the global context that countries' economies respond to shocks of oil prices differently due to different reasons among of which may be included the level of the county's economic development, the country's infrastructure, whether oil-importing or exporting, and so on. For this, it is crucial to have each individual economy studied separately. Hence, the need for this study is crucial given the fact it is one of the very limited ones on LDCs in general and on Yemen in particular.

## **1.7 Scope of the Study**

This study focuses on Yemen, a country that is a non-net oil exporter and an LDC as classified by the United Nations. In addition, the fact that the country's economy is heavily dependent on oil revenues and has been significantly affected by both global oil price movements and prolonged internal instability. These facts represent Yemen as a unique case that enables an in-depth examination of the interaction between oil price shocks and the macroeconomic performance of a country with these characteristics. Concerning this, the focus on oil price shocks to measure the response of Yemen's economy results from the importance and the vital role such shocks play in shaping the economic trend in highly oil-reliant countries such as Yemen. As for the choices of NARDL, it was due to its ability to detect possible and potential asymmetries (i.e., the idea that increases and decreases in oil prices may have different effects on the economic indicators). Hence, NARDL is well-suited for this context, allowing both short-run and long-run dynamics to be explored in a way that reflects the complex economic environment in Yemen.

## 1.8 Study's Organization

Following this introductory chapter, another four chapters were included in this study among of which are the literature review, methodology, results and discussion and conclusion. A brief description of each chapter as follows:

- Literature review: This is the second chapter in the order, and it presents a review to the theoretical as well as empirical literature related to the topic under investigation.
- Methodology: The third chapter in order covers, in general, the adopted method and all its related tests for the purpose of analyzing the secondary data used by this study. Data sources and conceptual frameworks are included as well.
- Results and discussion: It mainly focuses on the findings of this study and provides an interpretation of the results as well as a detailed discussion on every and each finding.
- Conclusions: last chapter, which provides an overall summary of this study along with some recommendations and policy implications based on the final findings.

**Table 1.5:** Summary of the Main Chapters of the Study

| Chapter )rder | Title                  |
|---------------|------------------------|
| Chapter 1     | Introduction           |
| Chapter 2     | Literature review      |
| Chapter 3     | Methodology            |
| Chapter 4     | Results and discussion |
| Chapter 5     | Conclusion             |

Source: Authors' construct

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Chapter's Introduction**

Shocks in oil prices affect the activities of both developed and developing nations' macroeconomics have been the topic of many previous studies but with great emphasis on the case of developed and major oil exporters. In regard to this, this chapter provides an overview of some of these studies and research in terms of their theoretical aspects, empirical aspects, and the methodology utilized, and results eventually obtained.

#### **2.2 Theoretical Review**

It is a well-known fact that oil demand is highly reliant on how good or bad the global economy is performing, which makes (i.e., the global economy) it sensitive to the shocks of these commodity prices. Therefore, the price of such a high demand commodity does have an impact on the economy of world countries regardless of the country's economy classification (developed or developing, oil exporter or oil importer) (Ahmed, 2016). In this regard, the earlier-mentioned first shock of oil price and its consequences that occurred in 1973 was the starting point to an ample amount of theoretical and empirical literatures concerning the macroeconomic-oil price nexus (Brown and Yucel, 2002) and (Hidhiir et al., 2007). Although at the earliest stage of this oil shock, some economists poured their doubt that this shock of oil price has to do with the recession followed the shock, but some others have linked the recession to the shocks that occurred and there were studies regarding the linkage between oil shocks and macroeconomics started to take place (Mork, 1994).

Theoretically, earlier theoretical views in explaining the nexus between oil price and macrocosmic activities considered the effect of supply and demand (Brouno and Sachs, 1982). Additionally, to supply and demand effects mechanisms, Brown and Yucel, (2002) among others, pointed out several transmission mechanisms through which the effect of shocks of the prices of oil on macroeconomics could be spotted. Not to forget the traditional theoretical view associated with “Dutch disease theory” (DDT, hereafter). The Subsequent lines, however, highlight further some of these mechanisms as well as the view associated with DDT.

### **2.2.1 Dutch Disease Theory (DDT)**

The term "Dutch disease" (DDT, hereafter) appeared in a publication of some economic magazine in the late 1970s analyzed the problem that occurred in the Netherlands post the discovery of a gas field of great reserves in the late 50s. According to Rudd (1996), Netherland and consequently to the discovery of this natural resource in the late 1950s and with the government's rapid move to make use of such great reserves, the country has become a net exporter of this newly discovered natural resource in no time and had its revenues increased tremendously and its local currency value appreciated. Adversely and in the middle of all those benefits, some negative effects surfaced including but not limited to the decrease of Netherlands non-resource tradable sectors such as the manufacturing sector which declined largely from 6.5 % (1963/73) to 0.3 % (1979/83). Additionally, employment declined by 25 % particularly in the industry sector between 1964 and 1984 causing an unemployment rate to spike up (Rudd, 1996).

However, the DDT was initially formalized by Corden and Neary (1982), who were pioneers in presenting the phenomena theoretically to be developed from a merely mentioned term in the 1970s to a theoretical framework that illustrates the negative macroeconomic impacts that resource booms can produce. Corden and Neary (1982) foundations are based on two primary mechanisms: the spending effect, which occurs when rising resource revenues increase demand for non-tradables, resulting in real exchange rate appreciation and decreasing the competitiveness of tradable sectors, and the resource movement effect, which occurs when labor and capital move from manufacturing and agriculture to the booming resource sector, leading to de-industrialization.

Over time, the "Dutch Disease" and apart from the "Gas" filed discovery in the Netherlands and its consequences, has been the description of any curse (i.e., negative effects on the economy) caused by a natural resource's discovery such as the "minerals" in Australia or the "oil" in the UK, Mexico and Norway (Neary and Wijnbergen, 1985). Thus, a new discovery of such natural resources is one of two main starts or causes of such economic disease alongside the sudden and substantial increase in the price of oil, as was the case in the 1973 shock, which motivated many countries into the exploration of oil resources (Buiter and Purvis, 1980) and (Rudd, 1996). Similarly, Wijnbergen (1984) mentioned that the problem of the Dutch disease is widely used to describe the case when a hike in the oil prices, particularly within oil exporters, leads to a fall in other non-oil tradable sectors, which in turn, negatively affects the economy in broad. This simply means, the DDT implies the negative association between countries' economic growth and their heavy dependency on natural resources such as oil.

Based on DDT, oil exporting nations tend to restructure their economies by reallocating resources in the favor of the oil sector while neglecting the traded ones as their oil revenues increased in response to oil prices' hike causing their economic growth to be adversely impacted. The increase in oil prices, thus, would inject the economy with a temporary foreign exchange but it would be harmful to the economy rather than beneficial (Moshiri, 2015). Similarly, Allegret et al. (2015) mentioned that the DDT stressed out that the rate of exchange appreciates in response to oil price rise resulting in resources' allocation being deformed. Such appreciation in the local currency may push up the consumer goods import on account of locally produced goods causing local industries to become less competitive. Thus, such appreciation in the currency is then harmful rather than beneficial. Similarly, Jahan-Parvar and Mohammadi (2008) mentioned that the DDT hypothesized a positive link between oil exporters' exchange rate and oil prices increase and vice versa.

Moreover, poor quality education which contributes significantly to the increase in unemployment is believed to be driven by the DDT effect (Cheratian et al., 2019). That is, the unemployment of oil exporters tends to increase in response to positive shocks of oil prices. Moreover, Bajwa et al. (2019) indicated that labor mobility is one of the signs of DDT alongside the resource-heavy reliance, exchange rate appreciation, manufacturing and service sector deterioration, and inflationary pressure. Though the DDT view explicitly implied the effect of oil price hike, however, the fall in oil price would just behave in a reverse way causing opposite effects to the ones caused by the hike in oil prices. that is a deterioration in the non-resource-tradable sector corresponding to a boom in the resource-tradable ones by means of exchange rate depreciation (Riman et al., 2013). This simply means, the symptoms of DDT are of possibility but not of certainty to be forfeited in the case of oil price decline.

Empirical studies on different countries other than the index case of the Netherlands were split between the support and the rejection of the DDT theoretical view. For instance, studies such Rodríguez and Sánchez (2004), Jahan-Parvar and Mohammadi, (2008) and Cheratian et al. (2019) supported the view of DDT on the effect of OP shocks on the GDP of UK, on the exchange rate of 14 oil-exporting countries, on the unemployment rate of MENA oil exporters, respectively. Others, such Ito (2017) and Bass (2018) indicated the absence of DDT effect on the economy of oil-exporting Russia. The reason for the inconsistency among studies on the view of DDT according to Moshiri (2015) is simply the huge gap among oil exporters in terms of development as they are not all of the same levels of development.

In summary, DDT is of the earliest and widely used theories reflecting the asymmetric macroeconomic effect of shocks of oil prices. The DDT hypothesized a negative effect to be transmitted to oil exporters' economic activities in response to positive oil price shocks out of oil price hike and otherwise in response to negative shocks out of oil price decline. However, while Dutch Disease offers an important historical explanation for the decline in sectoral output following resource booms, other theories, as to be explained below, may better capture the broader relationship between oil prices and the macroeconomy. Yemen as an oil exporter would be, however, diagnosed for the DDT effect.

### **2.2.2 Supply-Side Mechanism**

This mechanism is one of the channels through which macroeconomic activities are impacted in response to oil price shocks. The development of this theory can be linked to neoclassical theory (also known as neoclassical economics), which emphasizes the role of

inputs such as capital, labor, and energy (particularly oil) in determining output. According to Jahan et al. (2024), the neoclassical theory was actually an evolution of the traditional Keynesian theory that appeared during the Great Depression of the 1930s, when existing economic theories failed to explain the causes of global economic collapse. However, Keynesian theory's popularity waned in the 1970s onwards due to its failure in explaining the Stagflation (i.e., the phenomenon where many economies around the globe suffered from high inflation and slow growth), which occurred post the first oil price shocks linked to the Israel-Arab war early 1970s. The difference, according to Bruno and Sachs (1982), is that the traditional Keynesian theory focuses on demand and holds the view that rising unemployment and falling output reflect the burden of anti-inflationary policies, while the neoclassical one focuses on the supply factors and holds the view that the raw materials' price rise, particularly the oil price, may cause a drop in output growth and a rise in unemployment.

Building on the mentioned perspective, later studies incorporated energy, particularly oil, as a critical input of production. For instance, given the importance of oil as a production's input, the mechanism suggests a direct effect on the economy in response to the oil price rise (Tang et al., 2010). Thus, the output in response to the hike in the prices of this key production input (i.e., oil) may shrink down as the cost of production rises and the overall production declines (Chuku et al., 2010). This means the output responds negatively to oil price shocks out of oil price hike via the increased cost of production which may not be necessarily met with an increase in the output price. Therefore, GDP as a part of the output may reduce in response to such disruption in supply resulted from the hike in oil prices (Brown and Yucel, 2002). However, the supply-side effect through rising in OP in some

cases may be in the favor of the GDP of oil exporters (i.e., positive effect) in comparison to oil-importers (Gbatu et al., 2017).

Furthermore, labor is as important input as the oil in the production process which makes not only the GDP or the output, in general, get affected through this mechanism of transmission but also unemployment. Bruno and Sachs (1982), for instance, mentioned that the supply mechanism suggests unemployment rise alongside the output drop in response to the input of oil price increase. To ascertain this, a theoretical model developed by Bruno and Sachs (1982) based on the supply mechanism predicted that shocks in production's input prices including oil may lead to a reduction in output, productivity, and real wages. This prediction was later confirmed by applying their theoretical model in the case of the UK. Moreover, as it is not necessarily for the price of other production inputs such as labor to fall in response to OP rise. Therefore, the increased production cost causes a cut in the capacity utilization alongside the reduction in the output which in turn affects the overall productivity that eventually leads to a rise in unemployment (Tang et al., 2010). Similarly, the viewpoint of Uri and Boyd (1996) indicate that the reduction in the output resulted from the positive OP shocks may be accompanied by a corresponding reduction in the demand for labor and thereby, a hike in unemployment.

Brown and Yucel (2002) and Brown et al. (2003) stated that supply shocks subsequent to the sharp hike in oil's price while hindering the real GDP, can boost inflation. Inflation is boosted as consumers expect a temporary oil price hike which causes them to either borrow more money or save less in an attempt to loosen their consumption which may cause inflation in the price's level. However, in the viewpoint of Peersman and Robays (2009), this impact of shocks of oil price on inflation might be direct or indirect. Direct-wise,

given that the CPI represents the overall price of all goods and services within "the consumption basket" which include oil-related goods and services. How significant this direct-wise impact on inflation eventually relies on the percentage of oil-related goods and services in the consumption basket. In other words, the bigger the share of oil-related products in the overall consumption basket, the higher the impact of oil price shock on inflation. The indirect impact, however, is affined with production cost rise resulted from oil's price rise and incurred by firms, thereby, the tendency of firms to offset this rise in cost by increasing their selling prices of goods and services in the consumption basket (oil-related and non-oil related goods) causes a hike in inflation.

In this vein, the suggestions proposed by this mechanism (i.e., oil price shocks resulting from oil price rise, reduces output and increases inflation and unemployment) were empirically supported through studies including Brouno and Sachs (1982); Hamilton (1983, 1996); Mork (1989); Ordóñez et al. (2011), among others. For instance, while Hamilton (1983) found shocks of oil price "granger caused" output, as well as rate of unemployment in U.S, Brown, and Yucel (1999) explored in addition that the price shocks of oil, when price declined mid-late 1980, has stimulated GDP and reduced inflation in the US. This simply means oil shocks can be also reflected in the form of oil price fall.

In summary, the mechanism of supply-side suggests direct effect for shocks of oil prices to be transmitted to macroeconomic activities including GDP as part of the broad output, inflation, and unemployment with the latter depending on the performance of GDP more often.

### **2.2.3 Monetary Policy Mechanism**

The impact can be also transmitted from shocks of oil price to macroeconomic activities through monetary policies (i.e., anti-inflationary policies) imposed by official authorities in response to such shocks (Barsky and Kilian, 2004). Before it was gradually replaced by the supply shock channel, the role of monetary policy was prominent in early explanations of how oil price shocks affect economic activities under Keynesian theory, which emphasizes demand over supply shocks. However, a noticeable breakdown in the relationship between oil and the economy in the 1980s and 1990s led scholars to question pure supply shock models and explore other ways oil shocks might impact the economy. One such channel involved induced changes in monetary policy (Brown and Yucel, 2002). According to Bruno and Sachs (1982), the monetary policy channel posits that opposing inflationary policies associated with an oil price hike cause output loss. These policies can be either expansionary or contractionary. An instance, if a monetary policy through rising interest rate (i.e., contractionary policy) is followed, a possible increase in GDP may befall (Brown et al., 2003). This increase in GDP as mentioned by Brown and Yucel (2002) may occur as the speed of money increases in response to such tightening monetary policy while keeping the rate of aggregate money unchanged. Additionally, Chuku et al. (2010), the GDP and output, in general, may decline in the long run as the investments may negatively be affected in response to controlling monetary policies, particularly the tightening one.

Unemployment as well can be indirectly affected through this mechanism. According to Bruno and Sachs (1982), unemployment is presumed to rise in response to the burden of opposing-inflationary monetary policies. This rise in unemployment as stated by Brown et al. (2003) is the result of anti-inflationary monetary policy which leads to a

failure of real wages to fall with reduced productivity. Like GDP, the discouragement of investment following the tightening of monetary policy may affect unemployment negatively (Tang et al, 2010). Similar to unemployment, responding to oil price shocks, the inflation according to Brown and Yucel (2002) may increase in response to the expansionary policy (e.g., reducing the rate of interest) which may impose to offset the fall in the real GDP but with monetary policymakers keeping the nominal GDP unchanged. An opposing effect (i.e., an inflation rise) might occur if the aggregate money supply kept unchanged. Thus, the macroeconomic response to shocks of oil prices is rather indirectly through the responding monetary policy than directly through the shocks of oil price itself (Bernanke et al., 1997). Additionally, to this indirect effect, a direct effect on inflation can be established through the monetary policy of money supply increase responding to oil price rise (Chin and Bala, 2018).

In this vein, many earlier studies including Federer (1996), Bernanke et al. (1997), hunt et al. (2001), and recent ones including Peersman and Robays (2009), Razmi et al. (2016), among others, have empirically investigated the impact transmitted through anti-oil price shocks monetary policies into macroeconomic. Peersman and Robays (2009), for instance, found there is a difference in the monetary policies imposed in the EU in the face of shocks of oil price in comparison to those in the U.S. An explanation of asymmetry in the effect is possible through this mechanism as argued by Rahman and Serletis (2010), among others and opposed by Federer (1996), among others. In summary, this mechanism of effect transmission suggests that monetary policies can be the means through which the effect is transmitted from shocks of oil prices to economic activities and can be also used as controlling policies to control such transmitted impact.

#### **2.2.4 Income Transfer Mechanism**

Apart from the effect transmitted through supply effect and monetary policy effect, the shocks of oil prices effect can be transferred into macroeconomic through the shift of income (i.e., The buying power of consumers) from importers of oil to exporters of oil in a transmission mechanism known as income transfer effect (Mork, 1994). The first theoretical framework for this channel was developed by Golub (1983), for the purpose of analyzing the relation between oil prices and exchange rates. The model concentrates on the consequences of the income transfer effect related to rising oil prices and how these income transfers affect the exchange rate due to the differential portfolio preferences of the countries involved. However, to understand this relation, Golub assumed the world is three countries (OPEC, America, and Europe) and two currencies (dollars and marks). Hence, the direction of change of the exchange rate is determined by whether OPEC's preferences for holding dollars versus marks are higher or lower than the preferences of oil-importing countries. In simple words, the basic idea of the income transfer effect based on Golub (1983) is that the oil's shocks causing rise in the oil's price allow for income or wealth reallocation between oils' importers and exporters in a way where importers' currency falls while exporters' currency appreciates. For this, the income transfer mechanism is channel of transmitting the effect of oil's shocks to the "exchange rate" along with other channels such as term of trade mechanism (Czudaj and Beckmann, 2013a, 2013b; Habib et al. 2016). In general, this mechanism and other mechanisms indicate mostly a two-way causality varies with time between shocks of oil price and rate of exchange as stated by Beckmann et al. (2017), Taşar (2017). Empirical studies that documented such bi-directional relations include Coudert et al. (2007), Aziz (2009), Coudert and Mignon (2016), among others. However, Habib et al. (2016), opposed the general prediction of income transfer mechanism (i.e., Oil exporters'

currency appreciate while oil importers' currency falls as oil price hikes) claiming that in response shocks of oil price, oils' exporters and in order to lean against currencies' appreciation pressures, they either fix rate of exchange or pile up more of foreign exchange reserves.

Apart from the effect on exchange rate, The income shift allows a decline in goods' demand by oil importers' consumers with a corresponding rise by consumers of oil exporters (Hunt et al., 2001). That is, a hike in prices of oil causes a push up in goods' prices in the markets of oil importers which in turn pushes down the consumers 'buying power as compared to their cost of living. Thus, when consumers spend less on goods and services, the GDP might be lessened (Brown et al., 2003). According to Arnold (2008, 2018), the buying power of consumers and price level, in general, relates to each other inversely which implies an inverse correlation between the real GDP and consumers buying power. Moreover, Trang et al. (2017) described the income transferred into oil exporters as a tax incurred by consumers of oil importers and ended up used by consumers of oil exporters resulting in an unemployment's rise and a GDP's reduction. Economic activities such as GDP and unemployment can be affected as the consumers' buying power (i.e., income) is directly affected by shocks of oil prices. This direct effect as suggested by Killian (2008) is transmitted to consumers buying power (i.e., income) through four possible mechanisms including discretionary income effect (i.e., limited money in consumers hand to spend as the price of oil up) and the bigger the oil share in their income the stronger is the effect on their demand for goods. Second is the uncertainty effect over future prices resulting from oil price shocks forcing consumers to put their needs for buying some durable goods in wait. The third effect resulted from consumers deciding to spend but at the same time being cautious in their spending on goods as they expect the unemployment level to rise in the future in

response to such oil shocks. The last effect is limited to consumers' decision to avoid buying energy-related durable goods only (i.e., goods use energy such as cars).

In summary, this mechanism suggests that the shift of income from oil importers to oil exporters affect negatively the demand for goods and services within oil importers and positively within oil exporters causing a direct effect on their consumption expenditures which are reflected on the economic activities in broad. Worth mentioning, and to the best of my knowledge, there is no single, unified, and universally accepted overarching theory that fully explains these three mechanisms simultaneously in their entirety. As explained earlier, each mechanism operates through distinct channels within the economy and are typically analyzed by different schools of macroeconomic thought. For instance, the supply side is grounded in the neoclassical economics theory, which was adopted by the monetarist economists school post the failure of traditional Keynesian theory adopted by Keynesian economists to explain the great stagflation in the 1970s. Following sections review in detail the studies which empirically investigated the macroeconomic impact of shocks of oil price and particularly the asymmetric-alike impact.

### **2.3 Empirical Review**

As stated earlier, the focus of studying the asymmetric response to shocks of oil price on countries' macroeconomy started in late 1980s. Since then, great amounts of researches have been devoted to study this type of impact and been applied on different cases (i.e., countries) at different periods of time with the use of different methodologies of econometrics Including for examples but not limited to the traditional VAR methods, the structural VAR (SVAR), the threshold VAR (TVAR), ARDL, etc. Within this vein, in the

subsequent subsections, the studies which have focused on studying the macroeconomic response among which is the asymmetric response to shocks of oil price (hereinafter, SoOP) are highlighted.

### **2.3.1 Shocks of Oil Price & Gross Domestic Product**

Given the importance of oil as the main source of revenue to many countries around the globe, particularly the exporting ones, the countries' economic growth is vulnerable to the impact of shocks in the prices of oil. To this end, the impact of shocks in oil prices and how countries' economic growth react towards them, has caught the attention of many researchers. Hence and for a comprehended understanding, The following lines cover the previous empirical studies on this topic, and a summary of these studies is provided in Appendix 3.1.

Fadare et al. (2025), examined the relationship between oil price shocks and economic growth in Nigeria. Using annual time series data from 1996 to 2022, and the Autoregressive Distributed Lag (ARDL) model with an error correction method (ECM). The results of the study showed that oil price shocks, and oil revenues have a negative relationship with Nigerian GDP, both in the short-run and long-run. The study further explained how these shocks are transmitted to the economy, considering the government policies, institutional framework, and dependence of the economy on oil. Hence, the policy implications of the study are unambiguous: Nigeria's high dependence on oil revenues makes the economy very susceptible to external price shocks and has the real potential to create boom-bust cycles. The evidence that oil price volatility negatively affects economic growth demonstrated the need for structural reform. Institutional quality is of utmost priority for

Nigeria where the better the quality of such institutions, the better they will be able to mitigate the negative effects of oil price shocks, through improved management of resources and better governance. Policy-recommendation wise, Nigeria needs to do more to diversify its economy by developing other sectors of the economy e.g., agriculture, manufacturing, services in order to stabilize its economy and reduce reliance on oil.

Zhao (2024) studied the impact of oil price shocks on the economic growth of China by using the Structural Vector Autoregression (SVAR) model. The study which uses monthly data from 2007 to 2023 found an overall impact of oil price shocks on China's GDP. Specifically, the oil price supply shocks positively impact the GDP in the short term and but a slight negative impact in the long term. Thus, an increase in the supply of oil would boost the economic growth of the country in the short run but not in the long run as suggested by these findings. The study concluded that although there is an effect of oil price shocks, yet it is not the key reason for determining the economic growth of the country but rather the Chinese economy's own factors. In terms of policy implications and future development, firstly, the researchers stated that China should monitor global supply trends and adopt oil import policies based on the cause of price changes. Secondly, China must boost energy efficiency and accelerate the transition to renewable sources through regulatory reform, investment, and industrial support. Additionally, expanding domestic oil exploration and strengthening strategic reserves is vital for long-term energy security.

Using Time-Varying Threshold Model, Salem et al. (2024) investigated the non-linear relationship between oil prices and macroeconomic activity, specifically focusing on GDP and its components. The analysis used quarterly data spanned from 1995Q1 to 2023Q2 concerning a sample of 20 top oil-importing and oil-exporting countries. The findings

provided evidence of potential implications of the presence of nonlinearity and time-varying threshold effects for oil price shocks on GDP of both oil export and oil-import countries, but with the patterns depend on whether the country is a net oil exporter or net oil importer. In other words, the results concluded that lower oil prices diminish the GDP of most oil exporting countries, while higher prices enhance it and the exact vice versa in the case of oil importing countries. The policy implications of the study demonstrated the vulnerability of oil-importing economies to the impact of these shocks which hinder their GDP growth. To address this, governments in oil-importing countries need to reduce dependence on imported oil through diversification into alternative energy sources. As for oil-exporting countries, on the other hand, the priority would be economic diversification to reduce vulnerability to falling oil revenues in order to lessen their economic vulnerabilities by acting positively during oil price booms.

Using an Ordinary Least Squares (OLS) regression model, Taiwo et al. (2024) examined how oil price shocks among other factors affect economic growth in USA. oil price shocks were found to have statistically significant negative effect on the GDP. Some more, the paper offers key insights into how oil price stability and a stable labor market are vital for economic growth. The paper highlighted the need for appropriate policies that mitigate oil price volatility, enhance labor market stability, and encourage economic diversification to promote economic growth. In Ghana, Osman et al. (2023) used quarterly data from 2009 to 2020 to study how oil price shocks impact Ghana's key macroeconomic indicators utilizing the structural vector autoregressive (SVAR). According to the main findings of this study, The GDP responded positively to oil price shocks resulting from a rise in oil prices compared to some other macroeconomic activities which responded negatively. However, this positive response is limited according to the researchers due to the low

production and export of oil given the fact that the country is an emerging oil producer. To address this implication, policymakers should expand oil exploration and production simultaneously while strengthening other sectors to promote balanced economic growth and reduce reliance on imported refined oil, with the goal of becoming a net oil exporter.

Bhadury et al. (2023) examine with quarterly data stretched between 2002 and 2021, the impact of oil price shocks on GDP growth in the emerging oil-importing market of India using a linear, nonlinear, and extreme value framework including linear local projection model (LLP) and quantile regression model. The results through LLP found positive oil price shocks impact the GDP asymmetrically and negatively. More specifically, as prices exceed 70\$, GDP drops by around 20 basis points on average and the more it rises the more decline in GDP occurs. Overall, the study highlights the importance of considering nonlinearities in the relationship between crude oil prices and GDP growth, particularly during periods of elevated prices or a growth downcycle. These findings have implications for understanding the effects of oil price shocks on emerging market economies, such as India.

Taufani et al. (2022) studied the impact of rising and falling shocks of all prices on the macroeconomic indicators of some ASEAN countries using the vector error correction model (VECM) considering a quarterly data set stretched from 1995 to 2020. Generally, the results suggested that Malaysia and Brunei's economies tended to fall in response to negative shocks while Indonesia and Thailand's economies tend to fall in response to positive ones. More specifically, in the long term the results suggested that one unit decrease in the prices of oil leads to a fall in Brunei's GDP by about 14 % and Malaysia's by about 0.8 % while one unit increase causes the GDP of Indonesia to fall by 0.3 % and Thailand by 0.6 %. However, the one-unit rise will cause Brunei and Malaysia's GDP to increase by about 13 %

and 0.77 %, respectively. These results suggested that the long-term relationship between Malaysia and Brunei's GDP and both negative and positive shocks is positive and significant and more or less symmetric rather than asymmetric. Implications based on findings indicated the different impacts caused by oil shocks on targeted countries. However, the research pointed out that for designing effective policies to face the oil price shocks, the understanding of each country's own macroeconomic framework is essential. Hence, to address the implications arising, ASEAN economies are advised to strengthen regional cooperation in energy consumption policies, promoting diversification through investment in renewable fuels. Moreover, given ASEAN's natural resources and agricultural wealth, members could become exporters of biofuels and substitute energy sources.

Kriskkumar, et al. (2022) used the augmented ARDL and non-linear ARDL (i.e., NARDL) to find the asymmetric impact of positive-negative oil price shocks on Malaysian economic growth from 1981 to 1917. The results of the augmented ARDL indicated the absence of linearity in the relationship among variables suggesting the presence of nonlinear-alike association. NARDL results, however, supported this suggestion and found the asymmetric relation does exist among variables, both positive-negative shocks of oil prices were found to significantly boost the economic growth and strengthen the Malaysian GDP. This positive effect is partly explained as effective government measures taken to respond to oil price changes such as cash distributions (aid), tax relief, adhering to an accommodative monetary policy which creates low inflation, and managing costs incurred by businesses. Importantly, this doesn't give policymakers a false sense of assurance in the oil and gas sector as Malaysia should be working to decrease its reliance on the oil and gas sector. To do this the government should focus on further developing renewable sources of energy to power electric vehicles, creating cleaner forms of energy production as the world moves away from

crude oil, and expanding renewable sources of energy. Policymakers should maintain trying to provide further subsequent diversification of the economy, particularly, through innovation-led growth within the digital and technology industry. These findings, according to the authors, indicated the ability of the country to efficiently make use of such shocks in favor of the country's economy and its ability to become an oil-producing country.

The Russian GDP in the period spanned from 1996 to 2017 was investigated by bass (2019) for the impact of oil prices on it. The results obtained using the framework of vector error correction (VEC) and related tests including causality test of granger confirmed the long-term relation and statistically insignificant effect was revealed in the short-term. Somehow different results were found by Niran et al. (2018) on their study targeted Angola and Nigeria GDP and SoOP nexus with data spanning from 1980 to 2015. The results through NARDL revealed the asymmetric nexus but with significant positive and negative impact in Nigerian case and only a negative impact in the case of Angola. These are significant effects in both run (i.e., long-short term). Thus, the boost of oil revenues through the use of some expansionary monetary policies to offset the fall of prices of oil is found to have not much effect to stabilize the Angola and Nigeria economies.

Gbatu et al. (2017) employed the fixed effect model to analyze SoOP and volatility of exchange rate asymmetric impact on the real GDP of ECOWAS members (economic community of West African states) in the period between 1985 and 2015. The researchers divided their sample into three samples: the first sample which includes all ECOWAS countries, the second sample includes net-exporters members of ECOWAS, and the third sample includes net-importers members of ECOWAS. The main results revealed that there are negative linear and asymmetric relationship between SoOP and the GDP of the ECOWAS

countries (first sample countries) and between SoOP and the GDP of net-importers (third sample countries) whereas an insignificant effect for SoOP on the GDP of the net-exporters was found (second sample countries). Implications based on the results include GDP is boosted by trade regardless of type of oil price shocks, the impact varies by oil status whether importer or exporter, oil shocks hurt importers of oil stronger due to high dependency on oil. In terms of policy recommendations, it was suggested to reduce reliance on oil or diversify away from oil completely, create exchange rate stability through sound monetary policy, encourage trade and investment, eradicate corruption, support local manufacturing, and increase export competitiveness to buffer the harmful effects of oil price volatility.

Alsamara et al. (2017) applied NARDL to test the asymmetry in the impact of SoOP on the GDP of the major oil-exporting country of Saudi Arabia in comparison to the major importing-oil country of turkey. The overall finding did evidence the existence of the asymmetry in the nexus and impact but not in the same manner in the two countries. The reaction of Saudi's GDP to the positive shocks was more significant than its response to the negative shocks while Turkey's GDP responded significantly to the negative type shocks as compared to the positive shocks.

Nusair (2016) used panel-NARDL to find the response of GCC countries' GDP to shocks of oil prices. The overall results revealed a bigger significant impact for positive shocks on GCC's GDP as compared to negative ones. That is, GDPs of the countries under consideration go up in response to positive shocks whereas negative ones lead to a GDP decline in two countries (Qatar and Kuwait) only and have no significant impact on the remaining three countries. The results, however, suggested the asymmetries in the impact transmitted to GCC's GDP.

Considering the fact documented by previous studies that asymmetry exists in the effect of SoOP on the oils' importer economic growth, Moshiri (2015) targeted several major oils' exporters from OPEC among of which six developing and three are developed ones to explore whether such asymmetric impact also exists in the case of oils' exporters as well. The researcher first neglected the asymmetry assumption and tested the model for the overall impact using VAR and found no significant impact between variables. With the assumption of asymmetry (i.e., decomposing shocks into positive shocks and negative shocks), the researcher used two types of tests namely granger casualty test and the long-run multiplier of VAR to confirm the asymmetry in the effect. The results of both tests showed that the negative shocks were found to significantly affect the developing countries' economic growth whereas positive ones' effect is insignificant. Additionally, both shocks (i.e., positive and negative) have no significant "impact" on the three developed oil exporters' economic growth included in the study namely Canada Norway and the UK. Thus, a clear asymmetry was evidenced in the case of developing countries and a neutral asymmetry in the case of developed ones due to their well-diversified economic structure as compared to developing economies. This study, however, was an extension of a previous study by Moshiri and Banihasehm (2012) where they targeted only the six developing exporting countries. The researchers used the same methods and the results obtained were in line with those stated above.

Aziz and Dahalan (2015) applied VAR of panel to investigate the asymmetric impact of SoOP over the indicators of ASEAN members' countries' macroeconomic in terms of inflation, GDP, export, import, considering a time series spanned between 1991-2014. Both results obtained from IRF and VDC proved asymmetry in the relationship and impact of SoOP on ASEAN members' countries' macroeconomic variables that were investigated

as there is a difference in the impact depending on the type of shocks whether negative or positive with higher effect for the positive shocks in comparison to the negative type of shocks. More precisely, SoOP in terms of a higher increase in the price of oil was found to significantly impact ASEAN GDP and inflation in both short and long-run in a greater manner than negative SoOP do (higher decrease in oil prices).

Through the use of near-VAR model, Blake et al. (2015) found that the USA's output and interest rate respond asymmetrically to both positive type and negative type shocks of oil prices. Thus, the asymmetry in the impact was evidenced which made the researchers think that the increased financial stress caused by the oil price fluctuations is one reason for such asymmetry in the impact of SoOP on GDP and interest rate. Additionally, In the oil-importing economy of turkey, both impacts (i.e., asymmetric and symmetric) were analyzed by Ozturk (2015) employing VAR model and "Granger causality" test. The overall findings of all conducted tests evidenced the asymmetric response of Turkish macroeconomic to negative and positive SoOP.

In the US as well, An et al. (2014) used the asymmetric version of Factor-Augmented Vector Autoregressive (FAVAR) on quarterly data between 1959 and 2006. The investigation was carried out to explore the effect of both positive and negative SoOP on US's economic activities. The results through IRF within FAVAR found that the larger the shocks the clearer the asymmetries in GDP's response to shocks and it is (i.e., asymmetric impact) greater in the short term as compared to the long term. Thus, the higher the oil price, the more significant the negative impact on GDP and other activities.

Lwayemi and Fowowe (2011) applied the unrestricted VAR in an attempt to find the SoOP's impact on the macroeconomic indicators of Nigeria in terms of output, exchange

rate, inflation and government spending. Results obtained through Granger causality revealed the asymmetry in the impact as positive shocks were found affectless meanwhile negative shocks were found to significantly impact the output and exchange rate indicators in Nigeria. Number of policy implication derived from findings. For instance, it was evidenced that negative shock causes more damage to macroeconomic activities in Nigeria reflecting ‘Dutch disease’ on the wider economy. Hence, Policies to mitigate external shocks should have diversification, lower debt, and sound oil revenue management as their core principles. In another study, Lardic and Mignon (2008) investigated the asymmetric long-run relationship between oil price shocks and the GDP of G7 countries as well as euro area countries. The researchers applied the asymmetric cointegration approach. The main results indicated the existence of no standard relationship (symmetric relationship) in the long run between both variables, but the existence of asymmetric long-run relationship was evidenced with the asymmetric impact even greater in the case of oil price rise than in the case of an oil price drop.

Cunado and Gracia (2005) studied the asymmetry as well as symmetry that could be existing in the relationship between SoOP and some Asian economies’ (Japan, S. Korea. Singapore, Malaysia, and Philippines) inflation and economic growth. The symmetric results obtained through the cointegration analysis showed that there is no long-run relationship among variables but rather there is a short-run relationship. Granger causality test was then used to find whether there is a causal relationship or not and the results revealed that there is a short-run causal relationship between SoOP and both economic growth and inflation rate and the impact is clearer and significant when the Oil prices were expressed in the local currency rather than USD. The asymmetry was also found in the impact of SoOP on the inflation rate in Malaysia, Philippines, Japan, and South Korea and between SoOP and

economic growth of South Korea only. Following this implication, policymakers in these Asian countries need to pay more attention to the short-run impact of oil price shocks on inflation and economic growth. for instance, monetary policies in use to be amplified to oil-related prices pressures and supporting vulnerable sectors from increase in oil price. Furthermore, as there are country-specific fine distinction and no long-run relationships, policy design should be based on the structural characteristics of each country with the need for more research to inform long-run policies.

### **2.3.2 Shocks of Oil Price & Inflation**

Oil is not just a key source of revenue to many countries as previously stated but also a key input in the production of many consumers' products. In addition to being key production input, the consumption basket contains oil-related consuming products as well. Theoretically and as stated, the effect of oil price on inflation is assumed to be direct considering oil-related products in the consumption basket or indirect considering the oil being an important production input. Thus, it is imperative to empirically understand the association between the shocks in the price of oil and inflation. To this end, a bulk of studies have been conducted on this topic of interest. The following lines of this subsection go through some of these studies and a summary of these studies is provided in Appendix 3.2.

Kamara et al. (2025) studied Egyptian inflation asymmetric response to exchange rate and oil price shocks over a yearly period from 1975 to 2023 using a nonlinear ARDL (i.e., NARDL). Both positive and negative oil prices shocks were found to increase inflation in the country in the long run as well as the short run which indicate the asymmetric impact. other results found that higher money supply fuels the inflation in the country due to the

expansionary policy in use. Hence, policy implications highlight the need for contractionary monetary policies to control liquidity and inflationary impact. To this end, Central Bank of Egypt is recommended to combine exchange rate stabilization with tighter monetary discipline to mitigate inflationary pressures and enhance macroeconomic stability.

Based on annual Moroccan data from 1990 to 2022, Ritahi and Echaoui (2025) employed the Vector Error Correction Model (VECM) with impulse-response function (IRF) to examine how Brent oil price shocks impact some macroeconomic indicators in the country including inflation, and exchange rate. the findings revealed long run cointegration among variables under study. More specifically, inflation was found to respond negatively (i.e., increase) to rise in oil prices with the effect being persistent in both long and short run. There are considerable implications for policy in Morocco. In order to alleviate some of the negative impacts of rising prices of oil, Morocco should pursue a diversified energy encountering. Developing renewable energy projects, establishing energy efficiency measures, and promoting alternative domestic energy resources, is a sensible way to better enable Morocco to reduce its reliance on imported oil.

Gago and Vale (2025) investigated the influence of oil price fluctuations on inflation in some European countries namely France, Germany, Portugal alongside the United States. Using a Structural Vector Autoregression (SVAR) model with a sample period from January 1990 to January 2025, they analyzed the effects of different type of oil shocks on these counties' inflation. The results demonstrated that an oil price rise has a marginally greater impact on all consumer and producer prices in each country, with emphasis on the US. Moreover, the temporary effects (i.e., short-term) of oil shocks on inflation are greater than the persistent effects (i.e., long- term), which implies that prices do not inflate as a result of

oil price shocks for a long time. The findings suggested three key policy implications. Firstly, if controlling inflation is the priority for central banks, more attention needs to be paid to indicators like the Producer Price Index (PPI) due its relevance to inflation. Secondly, policymakers should identify the type of oil shocks that are causing inflation in order to judge the usefulness of monetary policy responses particularly European countries. Thirdly, because of geopolitical risks such as the Russia–Ukraine war, there needs to be a rapid transition into renewable energy, not only from a climate change perspective but also to take away reliance on oil and reduce uncertainty associated with oil prices in particular and price shocks more broadly for European countries that are not also oil exporters.

Cao et al. (2024) investigated whether oil price shocks drive inflation in selected G20 economies (Canada, Mexico, Russia, Japan, Brazil, and Italy) with yearly data over the period 1990–2019. Using a dynamic simulated ARDL model, they analyzed short and long-run relationships stimulating and plotting the positive and negative changes of the variables. ARDL bounds test confirmed a long-run relationship between oil price shocks and inflation. The results indicated that oil price shocks had a significant negative impact on inflation. Conversely, the money supply was positive and significant with respect to inflation in the long run, highlighting its importance in price dynamics in G20 countries. The study suggested that monetary authorities should consider the movements in commodity prices and money supply when devising policies to control inflation. Another research by Kudabayeva et al. (2024) analyzed the relationship between oil prices shocks and inflation in 20 oil-importing countries. The study utilized quarterly data from Q1 1980 to Q4 2022. The research demonstrated that the influence of oil prices on inflation differs from country to country, and that the largest impacts appear to be in Italy and France. The study concluded

that the higher the changes in oil price increases, the lower level of output and the higher cost inflation in these countries.

Sa'ad et al. (2023) adopted non-linear ARDL(NARDL) to analyze yearly data collected for the period from 1970 to 2020 aiming to find the asymmetric impact of oil price shocks on Nigerian inflation. The results suggested that the presence of asymmetry among variables with rising positive shocks of oil prices showed a bigger impact as compared to the declining negative ones. In light of these results, a key implication came into consideration, which is that exchange rate policy, depending on devaluing the local currency, may not do well in an import-elastic and export-inelastic economy such as the Nigerian economy. This may be overcome by policymakers by setting a fixed exchange rate and setting oil prices within a reasonable limit. Another study by Kilian and Zhou (2023) examined the effects of oil and energy price shocks on inflation in major economies, including the U.S., Canada, the Euro area, the U.K., and Japan. The analysis used a structural VAR model and monthly data from April 1990 to June 2023. The findings concluded that the substantial rise in inflation in the Euro area and the U.K is clearly associated with oil price shocks, but the relationship is less in US and Canada and even lesser in Japan. The results suggested a key policy implication, that is, there is no evidence that oil price shocks have materially changed long-run inflation expectations, given that positive oil price shocks in the U.S. do not lead to persistent increases in inflation as suggested by study findings.

Wong et al. (2023) studied the impact of positive and negative oil price shocks on disaggregated consumer prices in Malaysia. The study employed a Structural Vector Autoregression (SVAR) model using quarterly data from 1991 to 2020. Overall findings indicated that the inflationary pressure is imposed on the Malaysian economy in response to

both positive and negative oil price shocks. More specifically, the findings confirmed the asymmetric effects of oil price shock on inflation, but different effect is noted on some sub-groups of consumer price index, such as food prices, communication, and transport, where it was symmetric rather than asymmetric. Lastly, the results provided important policy implications, indicating that government regulation is warranted, given that the prices for essential food, transport, and communications are highly responsive to oil price shocks. Additionally, diversifying economies toward services and broader energy sources can reduce vulnerability, and consumers should manage spending wisely and adopt energy-efficient technologies to offset rising living costs. Furthermore, central bank independence, coupled with fiscal restraint, is essential to ensure low inflation that limits pass-through.

The study by Taufani et al. (2022) used VECM and quarterly data from 1995 to 2020 and targeted the economies of Malaysia, Brunei, Thailand, and Indonesia's responses to negative and positive shocks of oil prices. the inflation of Brunei and Malaysia tended to fall down by about 0.6 % and 2 % in response to positive shocks in the long term while it rose by around 2 % and 2.5 % in Indonesia and Thailand in response to the same positive shocks in the long term. As for the response to negative declining shocks, Brunei's and Malaysia's inflation spiked up by 1.9 % and Indonesian inflation declined by about 3.5 %. These results suggested asymmetry due to the difference in response rate to the decline or negative shocks from the response rate to the rising or positive shocks. Furthermore, to address the implications, the study suggested that policymakers in ASEAN need to consider the response of inflation to shocks through interest rate adjustments while maintaining exchange rate stability. Countries may adopt hedging strategies, and Brunei, in particular, may consider income diversification.

Lacheheb and Sirag (2019) used NARDL to investigate the nexus between SoOP and inflation rate in Algeria which is an exporting-oil country considering the period from 1970 to 2014. The results confirmed the asymmetric type of nexus between the variables put under investigation particularly in the case of OP increase as compared to the case of OP drop where there was no asymmetry found in the relationship. More specifically, in both LR and SR, Algerian inflation tends to rise in response to positive shocks out of OP rise but no impact for the negative shocks out of OP decline neither in LR nor in SR. Policy-wise, several strategies and approaches have been utilized by the policymakers in Algeria to account for rising inflation. For instance, supporting small businesses financially and improving the productivity of agriculture by adopting high technologies. Nonetheless, the policy focus must shift towards limiting market power, and to be more effective, cover all providers (importers, wholesalers, and retailers). Additionally, the use of productive technology in the domestic market is suggested to take advantage of low-priced oil products to increase the balance of payments surplus by lowering imports.

The inflation of Central and Eastern European economies (CEECs) response to OP shocks was investigated by Živkov et al. (2019) through the use of the Markov switching model and monthly data between 1996 and 2018. The results indicated 1-6 % changes in inflation of all countries being investigated in response to 100 % change in oil prices. The exchange rate was found insignificant in determining the impact transmitted from shocks to inflation except at times of higher depreciation. Implication according to findings that oil price changes have a relatively low effect on inflation in the majority of CEECs. This suggests that monetary policy is well anchored against external shocks. In most countries, indirect effects of oil price changes are stronger over longer horizons, and severe currency depreciation, in particular in Bulgaria and Romania, can significantly increase both the direct

and indirect effects. Policymakers in the CEECs should stress the importance of maintaining a credible inflation-targeting framework, the need to strengthen exchange rate stability, and the need to continually update estimates of the pass-through effect to be able to monitor changes in transmission patterns. Countries with a high reliance on oil, such as Slovakia and Bulgaria, should be cautious and reduce vulnerabilities by diversifying and increasing energy efficiency, and provide routine public communication on responses to markets to strengthen credibility and expectations.

With Quarterly time series stretched from first quarter in 1998 to first quarter in 2014, Long and Liang (2018) employed ARDL and NARDL models to study the asymmetric response of China's inflation to SoOP in terms of consumers and producers. (I.e., PPI and CPI inflation). While the impact was not clear through the results of symmetric ARDL, the NARDL model results clearly indicated the existence of asymmetry in the effect of SoOP on the inflation of China in the long run but with oil price increase having a bigger effect in comparison to the decrease of it. In other words, rising oil prices increase costs and inflation, whereas falling oil prices result in less reduction in cost and therefore lower than maximum benefit to consumers. As a solution, authors believe the government should impose a differentiated monetary policy response to price increases versus decreases; progressively unwind domestic oil price controls; and limit monopoly power in the petroleum market. Several other options to reduce vulnerability to external shocks for oil prices include increasing domestic oil exploration, expanding petroleum reserves, diversifying alternative energy, and boosting domestic energy efficiency.

Chin and Bala (2018) used NARDL to explore the asymmetric impact of shocks in oil price on the inflation rate of four African countries which are members in OPEC. In order

to test the asymmetry, the changes in price of oil were split to negative shocks and positive shocks by researchers. The results indicated both type of shocks positively impact on the four African countries' inflation but with negative shocks (oil price decrease) having a more significant effect. Comparing this to above-mentioned research by Long and Liang (2018), the results are more or less the same (asymmetric impact was evidenced) but only differ in which type of shock impose more significant impact.

Unlike his earliest research in 2015, making use of monthly data stretched from 1993 to 2016, Jiranyakul (2018) utilized the unrestricted model of VAR to investigate the asymmetry in the shocks of oil price's impact on Thailand's inflation. The findings indicated the absence of asymmetry in the impact of both types of shocks on the inflation in Thailand as the results indicated to the similarity in response of inflation to both negative-type and positive-type shocks of oil price which revoke the condition of asymmetry. Similar results regarding the analysis of asymmetric impact were obtained by Jiranyakul (2016) in earlier research that considered the time series from 1993 to 2015.

Kose and Baimaganbetov (2017) studied the macroeconomic asymmetric influence of SOOP on some macroeconomic indicators of Kazakhstan. The researchers utilized the structural VAR model (SVAR) and the main findings revealed that the kind of negative shocks in oil price imposes a greater impact on the overall performance of the country's economy. More specifically, both negative and positive types of shocks were found to have no inflationary impact, but negative-kind shocks significantly influence the rate of exchange, unlike the positive shocks which have no significant impact on the country's rate of exchange similarly to the case of inflation.

Choi et al. (2017) through an unbalanced panel analyzed annual data (1970-2015) of 72 developed and developing countries to explore the OP Shocks' impact on their domestic inflation. The overall results obtained from IRFs revealed an asymmetric impact but with a larger share for the positive type shocks in comparison to negative ones. Moreover, 0.4 % on average is the increase in local inflation of countries under investigation responding to a 10 % hike in oil prices (i.e., positive shocks) but such impact turns out to be insignificant 2 years after the occurrence of the shock (i.e., Disappears). There is no difference in the impact of whether the country is developed or developing as the results suggested.

Malik (2016) employed the framework of the Augmented Phillips curve with the aim of finding the oil price changes' effect on Pakistan's inflation considering a period spanned from 1985Q1 to 2014Q3. Overall results evidenced the existence of strong nexus between inflation and oil prices' changes. More specifically, it was suggested by the results that small changes or fluctuation in oil prices have no impact on Pakistan's inflation, but the impact becomes significant as the price of oil continues to increase past four quarters. The "Fall" in oil price only, however, found to be significant in the period following 1998 due to the huge hike in oil prices around the globe in this period. Thus, there is asymmetric impact particularly when oil price changes continue increasing over every four past quarters.

Considering "quarterly" data (Q1-1987-Q2-2015), Al Rasasi and Yilmaz (2016) found through the use of the VEC-VAR model that inflation and some other macroeconomic indicators in turkey respond asymmetrically to shocks of oil price. More specifically, shocks of oil prices resulted from the hike in oil prices positively impact Turkish inflation (i.e. inflation rises as the price of oil rises). The study findings highlighted that inflation and other macroeconomic indicators are affected by oil price shocks, but with a delay, yet a significant

impact. Hence, policymakers need to design a timely monetary policy, such as the use of a tightening or expansive monetary policy through adjusting the interest rate, to mitigate such a rise in inflation. Also, deregulating the oil market to allow price changes to flow freely would help facilitate smoother adjustment of shocks, but it would need complementary measures to protect consumers and ensure the stability of the economy as a whole.

Sek et al. (2015) used ARDL on annually collected data from 1980 to 2010. The analysis aimed at finding oil prices impact on inflation at ten countries that are low-oil reliant versus some ten countries that are high-oil reliant. Outcomes revealed that inflation is directly affected by changes in prices of oil at oil low-reliance countries under investigation and indirectly affected in oil high-reliance countries with the exchange rate and cost of productions playing a key role in determining inflation in countries of higher-oil reliance. Accommodating some monetary policies may help in mitigating such impact in both sets of countries, considered by the study as recommended by the researchers.

Chou and Lin (2013) found a long-run impact for SoOP on the PPI inflation (producers' price index) in Taiwan. Further, they found through the employment of the non-linear error correction model a short-run impact as well. Moreover, and in Taiwan as well, Huang and Chao (2012) investigated by the mean of multivariate threshold model both local and global oil prices' effect on the price indices. The results revealed that domestic oil prices exert no impact on the price indices in the "short run" when changes in the price of oil exceed the threshold level, but the global oil prices do impose an impact on the prices in Taiwan. Hence, it has been found that international prices of oil have a greater effect in shaping the country's inflation compared to local prices, which means the government intervention through local prices is ineffective. The better option would be to allow the local price of oil

to follow market mechanisms that would curb overconsumption of oil and lead to the use of alternative energies. Policymakers must build public confidence in price stability and inflation expectations to prevent escalated oil shocks.

SVAR model was used by Cologni and Manera (2008) on data collected quarterly from 1980 to 2003 for the G-7 countries. The study aimed at finding the shocks of oil price effect on the inflation rate of the G-7 countries. The results found an increase in the inflation rate of the countries alongside output decline following unexpected OP shocks. However, the impact following 1990 OP shocks was found to be indirect through the monetary policies of some countries. Most countries faced such a rise in inflation through tightening their monetary policy. Based on these findings, the main implication is that shocks to oil prices do not solely impact inflation, but on the economy in broad through monetary policies, with a different impact across G-7 countries. This calls for designing a flexible monetary policy that could account for both the oil price shock impact on output as well as on inflation.

Hooker (2002) used the Philip curve framework on quarterly data collected between 1962 and 2001 to find the US inflation-OP shocks nexus. The results revealed a direct stronger impact for the OP shocks on the US inflation particularly in the period before 1981 in comparison to the smaller or no impact in the period after it. Reduced energy intensity, deregulation, or shifts in monetary policy. are not to be blamed for such a decline; instead, it can be explained by the low inflationary environment that is driven by changing monetary regimes as a major factor, with some other factors may also contribute to such reduced inflation sensitivity to shocks of oil price.

### **2.3.3 Shocks of Oil Price & Unemployment**

Unemployment is a macroeconomic issue that is of importance to be addressed by governments and their policymakers. As stated earlier, Oil as a key input in the production process is assumed to impact the number of employees during price shocks due to the direct effect on the cost of production. Hence, the issue (i.e., oil price shocks impact on the rate of unemployment in the countries) has received a great deal of previous studies as the following lines show. A summary of these empirical studies is provided in Appendix 3.3.

Zumba et al. (2025) examined the impact of shocks of oil prices on 29 oil-importing African countries using the symmetric ARDL and quarterly data from 1991Q to 2019Q4. Findings indicated a negative but significant association between variables in the short run and a weaker association in the long run. Hence, it was found that unemployment responds negatively to positive shocks and positively to negative shocks, indicating that positive shocks lead to an increase in the rate of unemployment as compared to negative ones. The paper explains that the price of oil in oil-importing countries in Africa is determined by the international market, which means that they have very little ability to influence or control oil price changes, which will limit any policies to reduce unemployment rates. Therefore, given the significance to the economy of oil prices, the paper recommends that these governments use global oil price trends in their planning or forecasting of policy measures and provide both short- and long-term solutions to minimize the adverse employment effects of oil price increases facing consumers or businesses. Short-term solutions broadly include programs for immediate job creation, job training, and unemployment insurance during periods of heightened oil prices. Long-term strategies may include diversifying the economy in less oil-dependent industries and the development of renewable energy.

Bamaiyi (2024) used yearly data from 1990 to 2021 and vector autoregressive (VAR) model to study the impact of oil price shocks on selected macroeconomic variables in Nigeria. The findings indicate that oil price shocks significantly affect the selected macroeconomic variables such as exchange rates and unemployment rates. Specifically, the study finds that oil price shocks have a positive impact on unemployment rates in the short term but a negative effect in the long term. The implication based on findings is that Nigeria's over-reliance on crude oil revenues exposes the economy to significant vulnerability during periods of global price change. Hence, policymakers are called upon to initiate income diversification to mitigate the effects of such vulnerability. Furthermore, it would increase foreign exchange earnings and create more employment opportunities

Alfalih (2024) examined the impact of several factors on the Saudi unemployment rate, among which is the impact of oil price changes. The study adopted the Autoregressive Distributed Lag (ARDL) model on time series data from 1991 to 2019. Overall results indicated the significant long-run impact of oil price shocks on the unemployment rate, and that impact is negative. More specifically, a non-linear relationship between oil prices and unemployment was found, where the oil price effect on the labor market is positive when oil exceeds a threshold of \$41.2 per barrel. Below that price, the labor market situation in Saudi Arabia gets even worse. Policy implications stress the importance of the fact that while oil revenues will always be important, the fact that Saudi Arabia is reliant on oil makes it vulnerable to exogenous shocks, meaning that it should be seeking to diversify its economy beyond oil exports. Hence, policy suggestions include but are not limited to continuously implementing Vision 2030 and all its related development plans, rationalizing spending in growth-enhancing areas, promoting labor-intensive industries to absorb the workforce, and continuously reviewing economic regulations to foster job creation. Lastly, the paper

concluded that Saudi Arabia should diversify its economy to generate employment and moderate unemployment.

Ahmed et al. (2023) examined how oil price shocks uncertainty affects the U.S. unemployment rate. The analysis was carried out with monthly data from January 1974 to December 2019 and with the use of a logistic smooth transition autoregressive model. The results indicated that unemployment rate increases during uncertainty of positive oil price shocks. Moreover, results out of generalized impulse response also found shocks to oil price raise unemployment only in the high-uncertainty state and the response is said to be asymmetric. Findings suggested that when protecting the labor market from oil price shocks, policymakers should develop nuanced strategies that address state-dependent effects. Another study used yearly data from 1999 to 2020 by Thuy Tien (2022) with the aim of finding the asymmetric impact of oil price shocks on the Vietnamese economy including the unemployment rate. The results obtained through the use of quantile-on-quantile regression indicated that there is an asymmetrical association between the variables that indicate a negative and significant effect, particularly in the case of unemployment rate response to the positive oil shocks. These results are similar to the finding by Taufani et al. (2022) who found through the use of VECM that Indonesia and Thailand unemployment increased in response to positive rising oil price shocks. Implications indicate that the susceptibility of the Vietnamese economy to oil price shocks is primarily attributed to structural weaknesses and a heavy reliance on oil as a source of energy, and insufficient economic diversification away from oil. Hence, to build resilience, Vietnam should diversify its export base. The best way to do that is by attracting investment away from oil and toward other sectors with potential for export growth. Furthermore, reducing oil dependence and securing energy will reduce unemployment risk by mitigating the sensitivity of the labor market to oil price shocks.

Nusair (2020) used both ARDL and NARDL to investigate data collected monthly from 1969 to 2018 with an aim of finding the asymmetric response of the US and Canadian unemployment rates to the positive and negative oil shocks, the ARDL results evidenced the absence of short-run effect and the presence of long-run one among variables. the results through NARDL, however, indicated that only negative shocks have a significant impact on the unemployment rate in the short run while in the long run, both shocks have a significant impact on the unemployment rates in both countries. These results suggested the presence of asymmetric impact in the long-short run with negative shocks magnitude is stronger than the positive ones. To address such implication, there is a need for a policy response to lessen the impacts to labor markets from the negative impacts of positive oil shocks, and to ensure that negative shocks promote gains in employment. Governments should work to diminish the reliance on fossil fuels through the advancements in energy sources towards renewables, improvements to alternative energy infrastructures, and advancements to improve energy consumption efficiencies through the use of energy saving technologies. Activities towards these policies would enhance resiliency to economic shocks and lessen the impact that oil price shocks have on unemployment.

Kocaarslan et al. (2020) targeted the US unemployment rate response to SoOP, and the price of oil uncertainty employing NARDL model. The asymmetry in the impact was found as revealed results implied the significant increase in US unemployment as the price of oil increases but with no significant response to oil prices decline. Differently, the rise in uncertainty about oil prices affects unemployment insignificantly as compared to the decrease in uncertainty of oil prices which causes unemployment to decrease. Similar results were found by Kocaaslan (2019) by the means of GARCH within VAR model on US unemployment data collected quarterly from 1974(Q2)-2017(Q4). US unemployment spikes

up in response to positive SoOP and negatively reacts in response to negative SoOP. Hence, an asymmetric impact of both positive SoOP and negative SoOP on unemployment is revealed. Based on these findings, policymakers need to consider both The directionality of oil price shocks and the uncertainty surrounding them, given that the uncertainty poses an underestimation of their consequences for employment. Hence, and taking into account the amplifying effect of oil price volatility, reducing uncertainty should be the aim of energy policies to mitigate adverse impacts on investment, output, and the labor market. This can be done through polices including strategic reserves, diversifying portfolios, and stabilization mechanisms.

Algerian unemployment response to SoOP was examined through NARDL by Driouchi and Hamrit (2020) using annual data from 1990 to 2017. The cointegration (i.e., Long-run relationship) was found to be asymmetric, and the asymmetric impact was also found in both short and long run but with negative shocks imposing greater impacts compared to positive ones. The GDP was found to have significant relation with unemployment as well. The nexus between variables documented in these results were supported by Safia and Selma (2019) who found through ARDL that a 1 % increase in the prices of oil could cause the Algerian unemployment rate to rise by 69 %. Some implications can be drawn from the findings pertaining to the strong long-run impact of oil price shocks, particularly the negative ones on the Algerian unemployment rate. To address such implications, the country needs several strategies, including a structural reform strategy to strengthen non-oil sectors, diversification, improving public and private sector efficiency, enhancing the financial sector, and promoting sustainable private employment. Furthermore, it is advised to adapt Norway's model of prudent management and investment to manage the Volatile oil revenues to build long-term economic resilience.

Both oil importers and oil exporters of the MENA region were targeted by Cheratian et al. (2019) aiming through Panel NARDL to analyze annually collected data from 1991 to 2017 for investigating the shocks of oil prices' impact on MENA's unemployment rate. Outcomes of the study implied an overall insignificant impact on the rate of unemployment neither in the short term nor in the long term. Differently, the positive shocks (i.e., Oil price increase) were found to be positively impacting the unemployment of oil exporters only in the short-term, yet in the long term, both importers and exporters of oil impacted positively. The key policy implication is that rising oil prices can increase unemployment in oil-exporting MENA countries by crowding out tradable sectors and reducing labour absorption. To mitigate this, policymakers should strengthen economic diversification strategies, invest oil windfalls into productive, job-creating sectors (such as manufacturing, agriculture, and services), and establish or reinforce oil stabilisation funds to smooth price shocks. Stronger institutions and prudent fiscal management are essential to channel oil revenues into sustainable growth and employment rather than fuelling dependence on non-tradable sectors.

Using quarterly data from 2000 to 2015, Countries of the central, as well as eastern Europe, were targeted by the study of Cuestas and Gil-Alana (2018) which aimed at finding the impact of SoOP on the targeted countries' unemployment. To accomplish this objective, the researchers applied the method of ARDL-bounded test in order to find SoOP and unemployment rate-relationship in both the short and long run. the existence of no relationship was found except for Slovenia on the long term and Slovakia on the short term. Furthermore, the researchers employed NARDL model to see whether the type of shock negative or positive can affect the rate of unemployment in the targeted countries. The findings here indicated the existence of direct relationship but between the SoOP and natural unemployment rate (the type of unemployment caused by factors other than bad economy-

related factors) rather than unemployment rate. In other words, any increase or decrease in the prices of oil leads to an increase or decrease in natural unemployment.

Trang et al. (2017) in a study covered a period from 2000 to 2015, found that the SoOP imposes an unclear effect on Vietnam's unemployment and GDP growth in the case of a higher hike in the price of oil. However, the results found through the employment of VAR revealed a direct-wise nexus between inflation, budget deficit and the rise of oil price (i.e., a higher increase in the price of oil increases inflation). These results are different from an earlier one found also by Trang and Hong (2016) through the employment of Threshold VAR (TVAR). TVAR results revealed a clear effect transmitted to the unemployment rate of Vietnam when prices of oil hikes where an increase in the unemployment rate is caused whenever oil prices pass the detected threshold of \$27.6 / barrel meanwhile the effect on GDP still insignificant.

Rahma et al. (2016) employed a VAR model to examine SoOP's impact on unemployment in the African country of Sudan from 2000 to 2014. While the results revealed negative shocks (oil price drop) significantly affect the country's GDP, a positive significant influence is imposed on Sudan's rate of unemployment which is according to the researchers a surprising result. This result, however, is different from the ones obtained in the case of Vietnam where positive shocks rather than negative ones affect the unemployment rate. This implication, according to authors, is a sequence of several factors, including the separation of Sudan led to a 20 % loss of total population, waves of immigrants to the Gulf and other countries, and most importantly, the recent recruitment policy used by governments

Bocklet and Baek (2016) used quarterly data stretched from 1987 to 2014 to investigate how the unemployment rate in the state of Alaska, US is impacted by shocks in prices of oil. The results obtained through the application of NARDL revealed that there is a short-run asymmetric response of the Alaska unemployment rate to SoOP and this response is greater to the rise in OP in comparison to the decline in the OP with no evidence that such response would pass into the long-run from the found short-run. In conclusion, the study's findings indicated mixed impacts of oil prices on unemployment in Alaska, with 30 % of jobs being oil-industry related, which are at risk when there are negative shocks. However, other non-oil sectors may benefit from negative shocks where prices of oil go down by being further promoted in order to sustain employment. Additionally, it is known that over time, employees typically migrate to different sectors eventually. However, policy efforts should reduce the amount of time job migration takes by addressing skills gaps with training. To reduce the state's reliance on global crude oil prices, creating a favorable business environment for businesses outside of oil is critical.

Ahmad (2013) investigated the unemployment in Pakistan's response to oil prices considering monthly data gathered between (1991 and 2010) and analyzed with the causality test of Toda Yamamoto. The findings revealed a significant positive impact transmitted from shocks of oil prices to the Pakistani unemployment rate, particularly in the long-term. That is, a hike in the price of oil pushes Pakistani unemployment up. The researcher based on the results suggested the use of oil prices as a forecasting mechanism for unemployment in the long term. Similar results were found by Doğrul and Soytas (2010) in the case of turkey on a monthly data stretched from Jan-2005 to Aug-2009. The researchers used the method of Toda Yamamoto as well.

Ordóñez et al. (2011), used the Smooth Transition Autoregressive (STAR) model to investigate the U.S labor market volatility in response to OP shocks in the period from Q1 1957 to Q3 2003. The outcomes of the model implied the importance of OP shocks in driving volatility in the US labor market. In particular, the positive shocks can cause a spike in the rate of unemployment by 12 % whereas employees' productivity may increase by 33 %. Though the findings confirm how important the oil price shocks are in shaping the labor market, the model failed to capture the gradual variable responses. This failure calls for an extension to distinguish between skilled and unskilled workforce, account for oil price shocks of all types, to provide a better understanding of the asymmetric impacts of oil price shocks on the economy. Another study used monthly data collected from 1973 to 2008 on Germany unemployment was analyzed by Löschel and Oberndorfer (2009) through the VAR model. The results revealed positive shocks resulting from the hike in OP tends to increase the rate of unemployment in Germany. This impact was found to be significant even post the unification of Germany disagreeing with the claims suggesting a weak macroeconomic-OP relation emerged since the 80s. Hence, energy prices based on the findings were found to be a critical driver of the labor market, as well as the rising or sustained oil prices will still impose a burden on employment. Therefore, to hinder these impacts, policymakers are advised to consider targeted economic and energy strategies.

#### **2.3.4 Shocks of Oil Price & Exchange Rate**

The link between oil prices in the global market and the exchange rate of countries cannot be neglected considering the fact that oil is a global commodity of export and import among countries. For this reason, this topic has been taken into consideration in literature whether theoretically as previously shown or empirically as to be covered in the following

lines of this subsection. A summary of these empirical pieces of literature concerning this topic is provided in Appendix 3.4.

The Moroccan exchange rate also among other indicators, as stated, was studied by Ritahi and Echaoui (2025) utilizing annual data from 1990 to 2022. The cointegration results through the Johansen cointegration method revealed the long-run relationship between the exchange rate and oil price shocks due to the oil price rise. Furthermore, VECM results indicated a depreciation in the exchange rate responding to positive oil price shocks. Following these findings, the policy implications for Morocco are substantial. Hence, to counteract the impact of the positive oil price shocks that lead to exchange rate depreciation, policymakers are advised alongside the diversification energy resource strategy, to establish and hold considerable foreign exchange reserves. This is to enable the stabilization of the currency and to act as buffer to the volatility of the world prices of oil.

Hajebi and Samadi (2025) studied the macroeconomic impacts of oil price shocks in large OECD oil-exporting countries for the time period of 1990 to 2022. The findings through Panel Vector Autoregressive (PVAR) analysis revealed that while GDP is negatively affected by oil price shocks, the exchange rate also reacts negatively at first but slightly turned to a positive impact over time. The authors' conclusions also indicate that oil-rich countries' national currencies are dependent on oil prices in the long run. In general, there is evidence to justify the need for flexible and forward-looking macroeconomic policies in oil-exporting economies. Policymakers need to pay attention not only to short-term volatility but also to how they build long-term structural robustness while diversifying the economy, adopting sound fiscal frameworks, and flexible yet appropriate rules of monetary policy.

Bamaiyi (2024) also considered in his study of the yearly data from 1990 to 2021 the impact of oil price shocks on the Nigerian exchange rate. The findings through VAR indicate that oil price shocks significantly affect the exchange rate in Nigeria. Specifically, the study finds a negative trend in the exchange rate in response to oil price shocks indicating potential implications for foreign exchange in Nigeria. These findings suggested that Nigeria's economy is affected significantly, with implications for to exchange rate, which requires effective policy measures to reduce such effects. Of these measures, the government is advised to encourage local production for a favorable environment for foreign direct investment to be established. This would boost the country's exports and improve the country's local currency (Naira) and the exchange rate.

Nandi et al. (2024), Targeted Bangladesh with the use of daily time series data from 2015 to 2023 and with the adoption of Generalized Autoregressive Conditional Heteroskedasticity (GARCH) and exponential GARCH (EGARCH) models to address the impact of oil price shock in terms of its hike on the country's exchange rate. According to results, Taka (i.e. Bangladeshi local currency) depreciates in response to positive oil price shocks with a long-lasting impact on exchange rate volatility. This effect is found to be asymmetric, and negative shocks impose a bigger effect compared to positive ones. To address these implications, the paper suggests that policymakers consider floating exchange rates during prolonged depreciation tied to oil price shocks. Instead, policy measures should aim to mitigate volatility and shield the economy from sustained external price pressures to maintain exchange rate stability.

Bigerna (2024) investigated the relationship between oil price shocks, inflation, and exchange rates in the Middle East and North-Africa (MENA) region. The author utilized

Vector Auto-Regression with exogenous variables (VAR-X) on monthly data from January 2010 to December 2022. The results suggested that the effect of oil price shocks on exchange rates and inflation is asymmetrical, varying with the direction and duration of the shock. Furthermore, the results showed that there exists asymmetric impact on the exchange rates for certain countries. The policy implications suggested that authorities may want to enhance macroeconomic stabilization policies since spillover intensity increased following the COVID-19 pandemic. Hence, to improve policy, The author suggested an additional way for policymakers which is to think about enhancing international financial cooperation to lessen exchange rate risk and encourage economic diversification.

Gulaliyev et al. (2024) studied the effects of oil price changes on the exchange rate for some Arab oil-rich countries, including Saudi Arabia, Iraq, Kuwait, UAE, in addition to Azerbaijan. The study used Multiple regression analysis and panel analysis of annual time series data from 1996 to 2020. Findings concluded that the local currencies of these oil-rich countries are dependent on oil prices in the long run, but not in the short run. This is according to the authors because those local currencies are regulated by the country's policies themselves, rather than by market demand and supply. In other words, this is a result of the fact that oil rents from these countries are not added directly to the local economy. Instead, there are various mechanisms to limit the immediate transfer of fluctuations in oil prices and rents to the exchange rate, such as sovereign wealth funds (e.g. the State Oil Fund of Azerbaijan).

With monthly data spans from July 1998 to August 2023, Chen et al. (2024) studied the relationship between oil prices and exchange rates in both oil-exporting and oil-importing countries. Using the time-varying parameter VAR model. The study demonstrated

a bi-directional association between oil prices and movements in exchange rates (i.e., oil prices impact and are impacted back by exchange rate movements). However, the relationship was found to be stronger during crisis such the global financial crisis, the European sovereign debt crisis, and the Covid-19 pandemic. For policymakers, the findings implied that viewing oil and exchange rate assets as natural portfolio diversification may in fact not reduce risk during crisis periods but rather designing more effective risk management and policy responses would.

Deheri and Ramachandran (2023) studied whether the Indian economy responds asymmetrically to global oil price shocks or not. The authors used data from April 1994 to October 2021 and by the means of the Wald-test and slope and impulse response-based symmetry test by Kilian and Vigfusson (2011a). Overall results indicated the presence of asymmetry in the response of most macroeconomic indicators considered by the investigation to oil price shocks whether small or large. The exchange rate, in particular, was found to be asymmetrically affected by shocks in oil prices where it is appreciated in response to positive shocks type. The authors implied serious danger to the macroeconomics of India if these asymmetric impacts caused by global oil price shocks are to be ignored by policymakers of the country.

Gao et al. (2022) investigated monthly data collected from July-1983 to June-2018 to find the nexus between some Southeast Asian countries' exchange rates and the oil price shocks by the means of non-causality tests and the Wavelet coherence method. The overall results indicate that oil price shocks have a positive effect on the exchange rate in all countries; however, the direction of causality differs across countries. More specifically, the bi-directional relation was found among variables in India and Bangladesh, and

unidirectional was found in Pakistan and Sri Lanka. The paper highlights an important implication that southeast Asian countries' exchange rate is affected significantly by oil price shocks with flexible exchange rate regimes showing greater fluctuation compared to managed systems. Hence, it is advised that monetary authorities set measures to minimize this impact, such as managing exchange rate flexibility and increasing domestic oil production. As a result, the exchange rate would be stabilized, and currency depreciation would decrease.

Zhang et al. (2022) analyzed the time-varying effects of three types of oil price shocks on exchange rates. The study employed time-varying parameter structural vector autoregression stochastic volatility (TVP-SVAR-SV) on daily data from 9 December 2005 to 19 October 2022. According to the study's outcomes, oil price shocks, when simultaneously estimated, have a time-varying impact on the exchange rate. The demand shock for oil has by far the largest impact when estimating these shocks. Additionally, while the time-varying impact of oil price shock on exchange rates is evident, it appears that impact is more pronounced during periods of overall global economic and political instability. From policy perspective, the study provided some policy implications. First, both investors and policymakers should account for the short-term and heterogeneous effects of oil shocks on exchange rates when making decisions. Policymakers in both oil importing and oil exporting economies need to implement policies to reduce their economy's vulnerability to each of these immediate negative oil price shocks on currency markets. Moreover, and beyond these implications, the absolute requirement for political and economic consistency is important in mitigating the transmission of oil shocks into financial markets.

Li et al. (2022) examined oil price shocks impact on the exchange rates of the Canadian dollar, Euro, Japanese yen, and British pound during the COVID-19 pandemic. The study employed structural vector autoregression (SVAR) framework and hourly data from 1 July 2019 to 29 July 2021. The study findings indicated that both oil price and volatility spillover became more important in assessing exchange rate behavior during the pandemic. The results also revealed that these impacts are time-varying and suggest oil price considerations are important when analyzing currency movements, especially during periods of global uncertainty. Moreover, the findings carried significant implications for both investors and policymakers. For policymakers, especially at central banks, the findings demonstrate the importance of enhancing attempts to stabilize exchange rate by adding some systematic account of spillover effects to their policy framework. This understanding can help in writing new regulations and amending existing policies, helping monetary authorities to manage risks and contribute to financial stability.

Baek (2021) used NARDL to investigate the association of asymmetry between oil price shocks and some OPEC member countries' exchange rates with the help of monthly data spanning from 2000 to 2017. The results of symmetry were found to vary according to the exchange rate regime adopted by each country. the asymmetric nexus was found in the long-short run for countries adopting floating regimes of exchange rates while there was no presence of asymmetry in the countries practicing the fixed exchange rate regime.

Sanusi (2020) conducted study targeting some emerging oil-exporters with an annual data from 1995 to 2018 aiming at finding the asymmetric impact for oil price shocks on these emerging countries exchange rate. The results which were found through the application of NARDL suggested the presence of asymmetry in both long run and short run.

However, the negative SoOP was found to be more significant in explaining the exchange rate compared to positive ones which has insignificant effect in both short and long run. The researcher concluded that negative shocks have a greater and significant impact on the targeted countries exchange rate while insignificant impact for the positive ones. Overall implications suggest that the asymmetrical nature of the results indicates that declines in oil prices may be an important source of macroeconomic instability and can negatively impact currency stability and general economic performance. Therefore, policymakers in oil-exporting developing countries should give priority to protecting exchange rate stability from oil price downdrafts through developing fiscal cushions, diversifying export bases away from oil revenues and establishing a sovereign wealth fund for buffers. In addition, they should also focus on traditional monetary policy strategies, such as a flexible exchange rate regime around these changes in commodity prices, with a willingness to intervene.

Mohammed et al. (2019) collected daily data between July 2010 to August 2017 and applied GARCH along with EGARCH to investigate the SoOP-Nigerian local currency association. A positive association was found between the variables under study which implying a rise in the Nigerian currency as prices of oil go up and vice versa in the case of oil price fall. These results according to researchers are not surprising, given the fact that the country is a major exporter and thereby an oil revenue- reliant which calls for diversifications in the source of revenues as shocks of oil prices have a serious effect on the country's oil-reliant economy.

Using daily data from Feb-2015 to Feb-2018, Sharma et al. (2018) studied the impact of SoOP on the Indian's rate of exchange applying the approach of Toda and Yamamoto which is a special version of the granger non-causality test. The collected daily

data from 2015 to 2018 were analyzed and the results indicated to the existence of causality relationship between variables as SoOP were found to Granger cause the fluctuations of Indian Rupee exchange rate against USD. The usage of USD to determine oil price is one key reason for such effect as claimed by the researchers which require India to improve its oil trading in the local currency.

Taşar (2017) studied the Romanian exchange rate-oil price asymmetric nexus considering monthly data by applying several econometric methods to test for both symmetric and asymmetric nexus between the two variables. The results of Hatemi J (2012)-Roca (2014) asymmetric causality test indicated that negative SoOP effect Romanian currency negatively while the positive ones do not, which evidenced asymmetry in the nexus. However, the Toda-Yamamoto tests' results suggested unidirectional causality from oil price to Romanian exchange rate. The study in general implies the importance of close monitoring of oil price shocks, particularly during high fluctuation periods. This is for the government to make use of in setting up effective policies to stabilize the country's exchange rate. Out of these policies could be the building of safeguards against negative shocks (e.g., exchange rate management tools and foreign reserve buffers), diversifying the economy, and integrating oil price dynamics into monetary and fiscal policies to ensure stability.

Considering the daily exchange rate from January 2013 to October 2014 for the most traded currencies of 40 nations, the relationship between oil prices and those 40 currencies were investigated by kim and jung (2017) through the application of functional data analysis (FDA) and copula methods. The overall results revealed a significant dependence of all 40 currencies and both brent and West Texas Intermediate (WTI) oil benchmarks except for the Mexican currency. Moreover, the results suggested that the fall

in the considered currencies against the euro pushes the oil prices up while an increase in the American West Texas Intermediate (WTI), benchmark causes the USD to depreciate. Hence, a clear implication can be seen through the interconnected dynamics of oil price shocks and movements in exchange rates. Such dynamics need to be examined closely by policymakers when examining sources of energy price risk and considering cooperative fiscal, monetary and exchange rate policies to mitigate the negative impacts of oil price shocks on trade balances and inflation.

Abed et al. (2016) studied selected MENA countries namely Tunisia, Morocco, Egypt, Jordan, UAE, Qatar, and Saudi Arabia for the asymmetric impact of OP shocks on the exchange rate and the nexus between them. Researchers employed daily data (2001-2015) using the GJR-GARCH model (Glosten, Jagannathan and Runkle-GARCH) to examine the asymmetry in the response and IRF associated with the VAR model to find the nexus between variables. The results evidenced the existence of asymmetry in response to both positive and negative OP shocks. The results of IRF within VAR indicated the dynamic association between the variables with OP shocks affecting exchange rates more significantly in the short term. The results concluded that appreciation in exchange rate occurs in response to positive shocks in OP in the case of oil-exporter (UAE, Qatar and Saudi Arabia) while occurs in response to negative shocks in the case of oil importers (Tunisia, Morocco, Egypt, Jordan).

Volkov and Yuhn (2016), used the GAARH-M method on monthly data stretched from 1998 to 2012 to investigate the fluctuation of exchange rate-OP shocks nexus in five-oil exporting countries which are of a mixture of advanced economies, emerging and in transition economies. The results revealed an appreciation in the local currencies exchange rate against USD \$ of all countries under investigation in response to positive OP shocks

resulted from OP rise. However, how significant is the impact differs between in emerging economies (Russia, Brazil, and Mexico) and advanced ones (Canada and Norway) where it is more significant in the case of Russia, Brazil, Mexico as compared to Canada and Norway. The fluctuation of the exchange rate in Russia, Brazil, and Mexico depends on the fluctuation of OP where the fall in OP leads to a rise in the exchange rate volatility in these countries. Researchers related such differences in volatility between developed and developing economies being studied to financial market efficiency and not due to how important the revenues of oil in their economies are.

Basher et al. (2015) analyzed monthly data from 1976 -2014 by the use of Markov-switching method to determine the SoOP (i.e., negative demand and positive supply shocks) impact on exchange rates targeting several oil exporters (Brazil, UK, Russia, Norway, Canada) and importers (India, S. Korea and Japan). Negative demand shocks were spotted having an impact on the exchange rate of oil exporters as well as importers but with stronger appreciation pressure in the case of oil exporters while the impact of positive shocks on both oil exporters and importers was found to be insignificant. The magnitude of the significant impact in the case of negative shock, however, depends on the competitiveness of countries under study in the global market.

Benhabib et al. (2014) used VAR to analyze the impact of oil prices on the Algerian exchange rate considering yearly data from 2003 to 2013. The results revealed the absence of a cointegration link (i.e., long-run relationship between variables is not detected) between oil price shock and the dinar of Algeria. However, in the short run, the positive oil shocks caused by oil price rise were found to negatively impact (i.e., Lead to depreciation) the

Algerian local currency of Dinar which is according to the researcher is normal giving the dinar is non-oil currency.

Fratzscher et al. (2014) through SVAR and with the use of daily data between January 2001 and October 2012 investigated Vietnam's exchange rate-oil price nexus. Negative bidirectional nexus was revealed by the results between the variables under investigation. In other words, the USD\$ exchange rate depreciates as OP rise, and OP rises as the USD\$ exchange rate depreciates. More specifically, a 10 % spike in OP causes a 0.28 % exchange rate decline and a 1 % decline in the exchange rate may push OP up by 0.73 %. The causes of such negative nexus as claimed by researchers are the financing of the oil market since the mid of the considered period and the uncertainty following the global financial crisis.

The variance decomposition (VDC) and the impulse response function (IRF) associated with VAR were applied by Riman et al. (2013) on an annually gathered data from 1970 to 2010 to investigate the asymmetric influence caused by the SoOP on Nigerian exchange rate fluctuation and investment. As revealed by the results through cointegration test, a relationship in the long run was found among variables of interest. The results revealed a 10 % drop in global oil price could cause a 56 % decrease or depreciation in the local currency of Nigeria. Moreover, VDC and IRF results did confirm that exchange rate fluctuation is significantly impacted especially in the short-term by shocks of prices of oil. In summary, the exchange rate, in the long-term, is negatively impacted by SoOP which leads to depreciation in the local currency's rate of exchange while it is positively responding to SoOP in the short run which may cause an appreciation in the exchange rate of Nigerian currency. Thus, the difference in the impact and response to positive type as well as negative

type shocks confirm the existence of asymmetry in the impact exerted on Nigerian exchange rate volatility.

Coleman et al. (2011) used both VECM and the smooth transition regression (STR) to explore the shocks of oil price importance in investigating the exchange rate of thirteen African nations. The results of cointegration carried out using VECM revealed the availability of long relation (cointegration) between shocks of oil price and some of the countries' rate of exchange under investigation and the absence of cointegration between both variables in some others. The STR model was then applied to the economies that were found to have OP shocks and exchange rate cointegration to test the nonlinear response of each country's exchange rate to oil prices. The impact on the exchange rate was found to differ from country to another where some currencies fall as oil prices rise such as in Morocco and South Africa rise and some currencies appreciate as oil price rise such as in Kenya, Madagascar. This different effect as stated by researchers might be due to the different structures of countries' economies and whether it exports oil as well.

In the case of India and on daily data stretched along July-2007 and November-2008, Ghosh (2011) used Generalized autoregressive conditional heteroskedasticity (GARCH) to investigate the impact of oil shocks in terms of prices on the local Indian currency exchange rate against the US dollar. Both positive, as well as negative type shocks, were found to have similar impact in terms of impact's magnitude on the Indian exchange rate. Thus, the asymmetry in the impact was not detected, and rather, the impact found was said to be symmetric. The rupiah, however, depreciates against the US dollar as the return of oil price increases. Such deprecation in the case of oil importers such as India is normal as justified by the researcher as India needs to buy more dollars to get its costly imported oil.

As for the pass-through nexus from exchange rate to shocks of oil prices, Sulaiman and Abid (2020) and with the help of monthly data in the timeframe January-1986 to March-2019 targeted the exchange rate of Saudi Arabia aiming to find the impacts of OP on the country's exchange rate and the direction of the nexus between them. The results through ARDL indicated the existence of long-term relationships with a bi-directional pass-through relation but in the short-term, there was no evidence of causality between the exchange rate and OP and instead, unidirectional relation from OP to the exchange rate was evidenced.

Bal and Rath (2015) used monthly data between January-1994 and March-2013 to study the asymmetric causality between OP and Indian and Chinese exchange rate. Using the Hiemstra and Jones (1994) test, evidence of a bidirectional asymmetric relationship was found between the variables in both countries. Similarly, Benhmad (2012) through linear and non-linear causality test studies the nexus between the dollar in the US and OP with monthly data from February 1970 to February 2010. The results suggested bidirectional and unidirectional from OP to US dollar. The two-way relation starts after the first three months' time-horizon. The implication is that oil price shocks and exchange rate dynamics are time-frame dependent, whereas unidirectional is dominant in the short run, while bidirectional is dominant as the period gets longer. Hence, it is clear that findings emphasize the vitality of different time horizons to be considered by policymakers when dealing with the dynamics of oil price changes and exchange rates.

Energy prices (i.e., oil and gas prices) asymmetric causality with USD exchange rate were investigated by Wang and Wu (2012) by collecting monthly data from January-2003 to June-2011 and applying the Diks and Panchenko (2006) asymmetric causality test. The results indicated one-way causality from OP to exchange rate particularly before the

2008 financial crises and two-way nexus after the financial crises. Findings highlighted an important implication (i.e., volatility spillovers, rather than regime changes, are the main driver of nonlinear causality between the variables). Hence, there should be more focus on measures that reduce market volatility, including but not limited to improving market transparency, enhancing information flow, and implementing stabilization mechanisms. Another study with monthly data stretched from January-1974 to November-2011, Bénassy-Quéré et al. (2007) targeted eurozone countries along with Japan, USA and China with their study to find the nexus between China's exchange rate and OP. The results through Johansen and Juselius Cointegration (1990) suggested that the nexus is unidirectional (i.e., OP to the exchange rate). However, there is a possibility for a reverse nexus (i.e. from exchange rate to OP) in the future due to the fact that China is becoming a big player in both markets (i.e., exchange rate and oil). Hence, as the authors state, "This analysis has strong policy implications for the Eurozone since a negative relationship between the oil price and the dollar tends to stabilize the oil bill of the zone".

## **2.4 Study's Gap**

As stated previously that most of the focus since the 1980s has been put on the developed, importing and major exporting countries and very limited studies have targeted the LDCs countries and small exporter ones. A summary of these studies is provided in appendices 3.1-3.4. To author's best knowledge, there are very limited number of studies on the LDCs in general and even lesser if there is any on the case of Yemen. Thus, this study fills this gap in the existing literature and covers a very long-neglected economy by the studies previously investigated the overall impact of oil shocks on countries' macroeconomic. Worth mentioning that, the case country though oil exporter but it started to import some

quantities in the last few years which can be called “non-net exporter. Hence, filling such gap contributes to the huge existing literature on oil importing nations and the limited literatures on oil exporting nations, the very limited literature on such case (i.e., non-net exporting countries) in the case of single country.

In literature, most of the studies that investigated the asymmetric-like response of macroeconomic activities to shocks of oil prices targeted the oil-importing nations as compared to the oil-exporting ones particularly LDCs of them. To fill in this gap and enrich the existing literature, the asymmetric-like response of macroeconomic indicators to the shocks of oil price is emphasized through this study. Additionally, many studies as well, however, have not been taken into consideration to clarify whether the effect is symmetric or asymmetric which this study through its objectives and method utilized aims to clearly reveal.

The period spanning from 1990 to 2023 (i.e. the period to be covered by the analysis in this study) is the period which has witnessed most of shocks in oil prices (Figure 1.1 and Figure 1.2) resulted from different political and economic related events such as Iraq war, Asian financial crises, global financial crisis and most recently Arab uprisings and Covid-19 pandemic .Thus, the importance of investigating such an important time period lies in the fact that most of these events which were responsible for these shocks were originally taken place in the Middle East region or western Asia to where Yemen belongs. There are few studies and most perhaps none in the case of Yemen that have covered this time horizon particularly the Arab uprisings period and mostly focused on countries that were not directly affected by these revolutions (i.e., None-Arab uprising countries). Therefore, the contribution of this study to the existing literature is the inclusion of shocks caused by Arab

uprisings in the case of Yemen which is one of the Arab uprisings' countries. The Arab Uprisings were rising protests and political movements that emerged in late 2010, spreading across a number of countries in North Africa and the Middle East in pursuit of political reform, economic opportunity, and social justice. Many countries, such as Tunisia, Egypt, Libya, Yemen, and Syria, clearly experienced disruptive events, with varying results ranging from peaceful political transitions to longer-term states of conflict. Furthermore, the period associated with latest shock due to COVID-19, where the oil prices went sharply down is considered. This is an added advantage to the literature concerning oil price shocks-macroeconomic nexus.

This study adopted the Nonlinear ARDL (NARDL) model, which by default as a relatively new model has not been used extensively in exciting literature as compared to other estimation models such as ARDL (i.e., Linear version of NARDL), VARS, SVARS among others that were mostly adopted. However, studies that utilize NARDL can be divided into two categories. The first category (i.e., reviewed in the literature) includes studies which studied the effect of SoOP on the macroeconomy indicators but mainly focused on the GDP followed by the exchange rate with limited studies on inflation and even less on the unemployment rate. Second category (i.e., Not in the reviewed literature) which contains more studies as compared to the first category has put their focus on studying the nexus between two macroeconomic variables such as the output-unemployment nexus, GDP-inflation nexus, inflation-exchange rate nexus, and so on. Hence, the gap filled in here is this study uses NARDL to investigate the response of four different macroeconomic indicators to shocks of oil price rather than one among which is those with limited studies on such as unemployment rate. However, the actual contribution to existing literature is through the use of two tests for finding cointegration, among of which is the novel bootstrap NARDL-

cointegration test to avoid the violation of NARDL model assumptions as occurred in some studies. As far as my knowledge is concerned, few studies have adopted the use of these tests together to decide for the non-linear cointegration. Few studies however used bootstrap to detect the linear cointegration related to ARDL. Hence, by filling this gap this study would be of great use to future studies on such nexus to ensure NARDL assumptions are perfectly met.

Related to NARDL as well, several stationarity tests as mentioned were developed to identify breakpoints (i.e., structural changes) in the data utilized. plenty of studies reviewed which use NARDL and even some other methods have neglected in one way or another the effect of breakpoints (i.e., structural changes) in the time series data going with only the basic stationarity test results such as common ADF and PP ones (Appendices 3.1 to 3.4). This study, however, and contrarily to lots of other researches did consider testing the model with breakpoints to ascertain the extent to which breakpoints do affect asymmetric-alike behavior that is presumed to be transmitted from OP shocks to macroeconomic indicators. In addition to this, considering the breakpoints across the proposed period allows spotting whether shocks of oil price and structural changes relate to one another. Thus, filling this gap contributes to the relevant literature significantly.

Last but not least, this study fills another gap in the literature which is the diagnosis of Dutch disease symptoms on an LDC economy. To Author's best knowledge, literature concerning this topic has focused mainly on major oil exporters. Hence enriching the literature with such investigation is definitely an added contribution to DDT's literature and oil-exporting nations relationship. Moreover, the pass-through nexus from exchange rate to oil prices has not discussed widely in the literature compared to the nexus from oil price to

exchange rate, particularly on least developed countries. Hence, this gap is filled through the analysis of the existence of such pass-through relation.

## **CHAPTER 3**

### **METHODOLOGY**

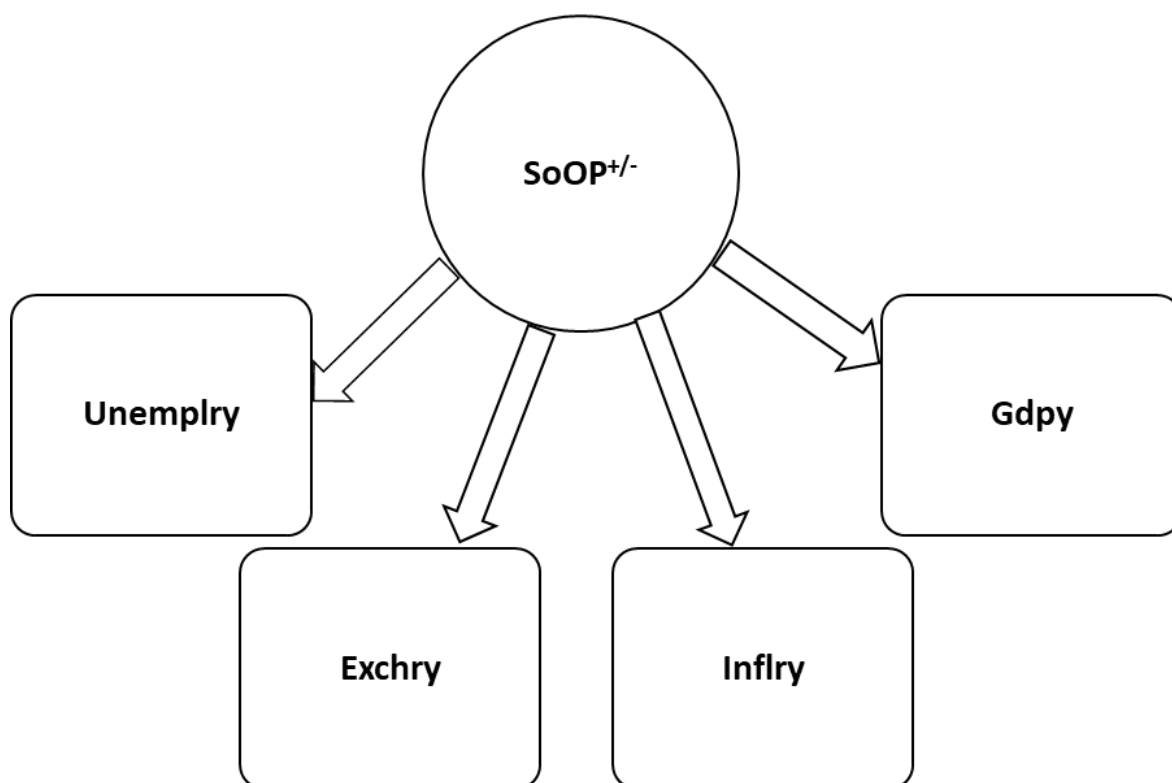
#### **3.1 Chapter's Introduction**

According to Zikmund et al. (2012), methodology of research is major section in the body of any study where it emphasizes mainly on the research design in terms of study's type, source of data and method of collecting them, sample design, data collection and lastly data analysis in terms of statistical methods utilized. In regard to this, this chapter discusses in detail the method adopted along with all related tests and methods which are to be carried out for the examination and analysis of the data collected. In addition, it highlights this study's conceptual framework along with the model's specifications, the source of data and the measurements of variables under investigations.

#### **3.2 Conceptual Framework**

The framework depicted in Figure 3.1 is drawn based on the reviewed theoretical and empirical studies presented in the previous chapter. Notably, theoretical reviews, particularly supply-side and monetary policy channels suggested an effect that can be directly transmitted from SoOP to different macroeconomic indicators and an effect that can be indirectly transmitted through other channels like monetary policy rather than directly from SoOP. The empirical applications of theoretical views, however, varied between supporting studies and opposing ones due to the different cases (i.e., countries) being considered by the studies. Thus, to find out how would it be in the case of Yemen, the explanatory variables (IVs) [(positive shocks (SoOP+) and negative shocks (SoOP-)] are

presumed to have an asymmetric effect on the explained or dependent variables (DVs) of GDPY, INFLRY, UNEMPRY and EXCHRY. This asymmetric effect, in turn, may be direct from explanatory variables to the explained ones, as suggested by the supply side mechanism, which serves as the core theoretical framework, justifying the direct causal link from oil price shocks to key macroeconomic variables. This theory is particularly relevant for Yemen, an economy where oil is both a primary export and a critical input for production. This core framework is complemented by the monetary policy mechanism and Dutch disease theory. The first is crucial for understanding the inflation dynamics and provides the rationale for including money supply as a control variable to account for central bank reactions to amplify or dampen the inflationary effect. The latter is particularly relevant in the Yemeni context, as it explains how shocks in oil prices exert direct pressure on the exchange rate in resource-dependent economies. By integrating these distinct but complementary perspectives, a coherent and theoretically grounded justification for the study's framework is provided. These links are visualized in the depicted Figure 3.1.




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Notes:

SoOP<sup>+/-</sup> denotes positive/negative Shocks of oil prices, Gdpy denotes Yemen's gross domestic product, Inflry is Yemen's inflation rate, Exchry is Yemen's exchange rate, and Unemplry is Yemen's unemployment rate.

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**Figure 3.1: Study's Conceptual Framework**

Source: Author's construct

Figure 3.1 above visualized the links between dependent variables (DVs) namely gross domestic product of Yemen "Gdpy", Inflation rate of Yemen "Inflry", Exchange rate of Yemen "Exchry" and Unemployment rate of Yemen "Unemplry" and the independent variable (IV) which is the shocks of oil price in its positive and negative form "SoOP<sup>+/-</sup>". Hence, based on the reviewed literature, GDP is expected to decline, while inflation and unemployment rise in response to positive oil price shocks, since higher oil prices increase production costs, reduce output, and lower labor demand (Bruno & Sachs, 1982; Huri &

Boyd, 1996; Ordóñez et al., 2011). Conversely, an oil price decline may stimulate growth and reduce unemployment (Brown & Yücel, 1999). The exchange rate is expected to appreciate with positive oil shocks, consistent with DDT, due to larger foreign currency inflows (Jahan-Parvar & Mohammadi, 2008; Allegret et al., 2015). However, the actual signs may vary depending on factors such as economic diversification, dependence on oil, importer/exporter status, and stability etc.

In summary, while a direct relationship is posited between oil price shocks and the dependent variables, some control variables, such as money supply (for inflation) and GDP per capita (for unemployment), are included to isolate specific transmission mechanisms and ensure consistency with the theoretical perspective presented earlier.

### **3.3 Data and Variables Description**

In general, the information regarding the SoOP-macroeconomic indicators nexus which made this work possible was obtained from a variety of resources including books, journals, articles, reports, and reliable websites. Apart from this, as a secondary-type study, this study uses secondary data spanning from 1991 to 2023, and which were mainly collected from the International Monetary Fund (IMF) database and The World Bank database (TWB). The originality of data was based on official Yemeni government statistics through its bodies including the central bank and ministry of finance.

The choice of this period as this study's sample can be justified by the fact that the unity of south and north Yemen has taken place in 1990 and there where official records of macroeconomic indicators popped up. In other words, 1991 marks the start of reliable and consistent time-series data from international databases such as the World Bank and the IMF,

following key economic reforms and improved statistical reporting mechanisms in the country after unification in 1990. In turn, 2023 marks the most recent year of full and reliable data at the time of the study. Another reason, and as stated earlier, this period has witnessed most of the oil price shocks identified by economists and researchers, among of which are the ones related to geopolitical events that took place in the region.

As an explanatory study, this study uses the shocks of oil price (SoOP) as the explanatory variable and the key macroeconomic indicators of gross domestic product (hereafter, GDPY), inflation rate (hereafter, INFLRY), exchange rate (hereafter, EXCHRY) and unemployment rate (hereafter, UNEMPRY) of Yemen as the explained or responsive variables. The selection of the explanatory variable (oil price shocks) is justified by the critical role it plays in shaping the economy of an oil-exporting country like Yemen. Given its dominance as the main source of export earnings, government revenue, and foreign exchange. Shocks in global oil prices directly influence economic growth, inflation, unemployment, and the exchange rate. Further, this selection was grounded theoretically, which explains how oil price shocks affect the economy through different channels, particularly supply-side and money supply channels, making oil price shocks a suitable and relevant factor for analyzing Yemen's macroeconomic changes. A brief description of these variables is summarized in Table 3.1.

**Table 3.1:** Study's Variables Definitions and Measurement

| Variable of interest                                          | Description (*1)                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gross domestic product of Yemen<br><br>(GDPY)                 | The sum of value added by all producers in the economy within the country. Depreciated assets, natural resources depletion and degradation are not neglected when GDP is calculated. Measured in constant LCU (*2) by dividing nominal GDP by GDP deflator.      |
| Yemen's Inflation rate<br><br>(INFLRY)                        | Inflation as measured by the consumer price index reflects the annual % change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, (e.g., yearly). The Laspeyres index is used. |
| Yemen's Unemployment rate<br><br>(UNEMPRY)                    | The share of the labor force with no jobs yet available for and looking for jobs. % of labor force.                                                                                                                                                              |
| Yemen's Exchange rate<br><br>(EXCHRY)                         | The Yemeni rial against the US dollar, calculated as the annual average set by domestic authorities.                                                                                                                                                             |
| Oil price shocks<br><br>(SoOP)                                | Oil price is measured in US\$ / Barrel and represented by the average benchmark prices of Dubai, West Texas Intermediate (WTI), and Brent crude.                                                                                                                 |
| Yemen's gross domestic product per capita<br><br>(GDPcY) (*3) | The gross domestic product divided by population                                                                                                                                                                                                                 |
| Broad money<br><br>(BM2) (*3)                                 | The total amount of money outside banks, demand deposits, savings, foreign currency deposits, banks' checks, travelers' checks, and some other securities and commercial paper certificates.                                                                     |

*\*1 Variables definitions and measurements are taken from the data sources (WB & IMF) / \*2 constant gdp more accurate economy measure as it takes into account the impact of inflation / \*3 CVs*

Source: Author's Construct based on data sources, IMF (2023), TWB (2023)

### 3.4 The Measures of Oil Price Shocks

The interest of studying asymmetries in the macroeconomic influence of shocks in the world's oil price dates back to the late 1980s and particularly as a consequence of the 1986 oil price drops as there was no boom witnessed in response to that drop (Kilian, 2008). Thus, the focus on the nexus's re-establishment between shocks of oils' price and the countries' macroeconomy started. To this end, pioneers including Mork (1989) in the late 1980's., Lee et al. (1995), Hamilton (1996) in the mid to late 1990s have proposed some specifications for measuring oil prices shocks namely asymmetric, scaled and net specifications, respectively, which can spot the asymmetry in the effect transmitted from shocks of price of oil to macroeconomic indicators considering the rise-fall of oil price. Quite recently, other measures for the asymmetric “response” to shocks of oil price were proposed including the partial sum decomposition by Schorderet (2003) which was later extended by Shin et al. (2014), the extend net specifications by Hamilton (2003, 2011) and the SVAR framework by (Kilian, 2008).

As for the pioneering studies, to spot the asymmetry in shocks of oil price's impact on the economy of U.S. Mork's specification (1989) considered the oil price in its real term where positive (i.e., increase) and negative (i.e., decrease) of the OP in real term were treated as two separate variables. Mork tested each variable significance in six-variable VAR model finding an insignificant impact for shocks specified by oil price decrease corresponding to a significant one for shocks specified by oil price rise. As stated by Kose and Baimaganbetov (2015), Mork's asymmetric specification separates real oil price into its positive and negative form as follows:

$$ROP_t^+ = \begin{cases} \Delta ROP_t, & \text{if } \Delta ROP_t > 0 \\ 0, & \text{otherwise} \end{cases} \quad \text{Equation (3.1)}$$

$$ROP_t^- = \begin{cases} \Delta ROP_t, & \text{if } \Delta ROP_t < 0 \\ 0, & \text{otherwise} \end{cases} \quad \text{Equation (3.2)}$$

where  $ROP_t^+$ ,  $ROP_t^-$  are the positive and negative rate of changes in real price of oil in time  $t$ , respectively.  $\Delta ROP_t$  is the change rate in real oil price in time  $t$ .

The asymmetric specification of Mork as noticed by Lee et al. (1995) covered the period where key shocks of the oil price are the result of OP increases rather than decreases particularly in the period between 1948 and 1986. According to Lee et al. (1995), the period between 1986-1992 witnessed substantial changes in the prices of oil between increase and decrease as compared to the period before 1986. Hamilton (1996) also suggested that post 1986, there are larger decline of OP in comparison to OP rise which make Mork's specification is not satisfactory as OP shock measure.

Differently, Hamilton (1996) in his oil price shock specification measure considered the net upward in the prices of oil on the basis of a year window. Hence, the OP shock is specified if the increase in OP in a specific month surpassed the maximum value over the preceding one year (4 quarters). Hamilton's net specifications are represented as follows:

$$NETOP_t^+ = \max[0, ((NETOP_t) - \max(NETOP_{t-1}, \dots, NETOP_{t-4}))] \quad \text{Equation (3.3)}$$

$NETOP_t^+$  represents the net OP increase in time "t" that is spotted through the difference in between the rise in the current net OP ( $NETOP_t$ ) in quarter "t" and the highest (i.e., maximum) rise in the net OP along the preceding Four quarters and zero otherwise (i.e., 0 in a quarter "t" when the OP in the current period is found to be lower than the value at any point in the preceding four quarters). However, only OP shocks caused by increase in

price of oil are captured by Hamilton's net specification while OP shocks out of oil price decline are ignored (Kose and Baimaganbetov, 2015).

Following these oil price shocks measures (i.e. asymmetric, scaled and net specifications) proposed by these pioneers, the asymmetric macroeconomic impact of oil price shocks has been investigated by great number of studies including, among others Mory (1993), Cunado and Gracia (2005) on the basis of Mork's asymmetric specification measure, Iwayemi and Fowowe (2011), Kose and Baimaganbetov (2015) on the scaled specification measure, Balk et al. (2002), Donayre and Wilmot (2016) on the measure of Hamilton's net specifications and Aliyu (2011) following both mark asymmetric specifications and Hamilton's net specification measures, Rodríguez and Sánchez (2004) and Asab (2017) emulating the three specifications measures of the asymmetric, net and scaled.

In regard to recent studies, Schorderet (2003) argued that when macroeconomics' indicators interact with each other, the possibility of prospect asymmetric behavior is big. Thus, to account for such asymmetric impact, Schorderet (2003) suggested the time series is to be split into its initial value as well as into its partial sum of both positive and negative shocks as illustrated in Equation (3.4) below.

$$X_t = X_0 + X_t^+ + X_t^- \quad \text{Equation (3.4)}$$

where  $X_0$  is the initial value while  $X_t^+$  and  $X_t^-$  are the partial sum of positive and negative shocks which can be further expressed as:

$$X_t^+ = \sum_{i=0}^{t-1} 1 \{ \Delta X_{t-i} > 0 \} \Delta X_{t-i} \quad \text{Equation (3.5)}$$

$$X_t^- = \sum_{i=0}^{t-1} 1 \{ \Delta X_{t-i} < 0 \} \Delta X_{t-i} \quad \text{Equation (3.6)}$$

where  $\Delta$  stands for the first difference of  $X_t$ . Both  $X_t^+$  and  $X_t^-$  equals to one as the process between the  $\{\}$  in 3.5 and 3.6 occurs and zero, otherwise. Schorderet (2003) to detect asymmetric cointegration considered two integrated “non-stationary” series (i.e.,  $X_{1,t}$  and  $X_{2,t}$ ) defined following 3.5 and 4.6 as  $X_{it}^+$  and  $X_{it}^-$  (i.e., partial positive-negative sums) for  $i = 1, 2$  and by assuming a “stationary” linear combination ( $Z_t$ ) between  $X_{it}^+$  and  $X_{it}^-$  as follows:

$$Z_t = \delta_0 X_{1,t}^+ + \delta_1 X_{1,t}^- + \delta_2 X_{2,t}^+ + \delta_3 X_{2,t}^- \quad \text{Equation (3.7)}$$

If  $Z_t$  is stationary,  $\delta_0 = \delta_1$  and  $\delta_2 = \delta_3$ ,  $\delta \neq 0$ , then  $X_{1,t}$  and  $X_{2,t}$  are said to be asymmetrically co-integrated.

This proposed asymmetric specification was applied by Schorderet (2003) on the exchange rate relationship between some European countries and the asymmetry in the relationship was found. Following this Schorderet’s asymmetric cointegration specification, Shin et al. (2014) developed an innovative model called nonlinear autoregressive distributed lag (NARDL) starting with a simple asymmetric regression framework that allows for asymmetry by decomposing IV into its negative- positive “partial sum” as to be explained further in following section. Similarly, Shin et al. (2014) empirically tested this framework on the nexus between the output of the U.S, Canada, and Japan and the unemployment in these mentioned countries demonstrating the existence of asymmetry in the relationship on both short as well as long run.

In addition, Hamilton (2003, 2011) extended his own net specifications suggested in Hamilton (1996) to allow for asymmetry in the impact of OP shock to be found whenever

an increase of oil price in a specific month surpassed the higher (i.e., maximum) value over the preceding “three” years (i.e., 12 quarters) as represented in Equation (3.8) below.

$$NETOP_t^+ = \max[0, ((NETOP_t) - \max(NETOP_{t-1}, \dots, NETOP_{t-12}))] \quad \text{Equation (3.8)}$$

Thus, if the price at the current month is less than the max value of the past “three” years, there is no shock in oil price is spotted and vice Versa. The difference from his earlier net specifications as seen in (3.3) is just in number of base year (quarters) while the former is based on 1 year window (i.e., 4 quarters), the latter is on the basis of 3 years window (i.e., 12 quarters). This extended net specification was empirically tested on the shocks in oil price-U. S GDP nexus and the asymmetry in the nexus was evidenced supporting his own earlier findings that shocks in oil prices causing a hike in oil price effect economy in a more significant way than shocks reflected by oil price decline (Hamilton, 2003). Similarly, to the earlier version of this net specification, the OP shocks out of OP decline are still neglected.

These recent measures or specifications of asymmetry were adopted by many studies that concern the asymmetric macroeconomic effect of oil price shocks among of which is the study of Shin et al. (2011, 2014) following the partial sum decomposition method proposed by Schorderet (2003), Donayre and Wilmot (2016) and Bachmeier and Keen (2017) on the extended net specification of Hamilton, Atill et al. (2014), Alsamara et al. (2017), Oyelami (2018) and Khan et al. (2019), on the “partial sum” decomposition by Shin et al. (2014).

Noticeably, these measures of oil price shocks have been applied empirically by an ample number of studies on different cases of developing as well as developed countries. However, there are very limited studies that investigated the asymmetric effect transmitted from oil price shocks to indicators of the economy of the least developed countries (LDC)

which is a UN category containing the world's very low-income countries. To this end, the partial sum decomposition developed by Schorderet (2003) and extended by Shin et al. (2014) is to be considered in measuring shocks of oil price asymmetry in the case of Yemen. The flexibility of this measure to capture the difference in the magnitude of both increase and decrease in the price of oil on macroeconomic indicators as compared to other measures has favored it over other measures. In addition, this measure is associated with the proposed model of analysis in comparison to the net, asymmetric, and scaled specifications which are associated with the VAR model.

### **3.5 Specification of The Proposed Model**

Considering the objectives of this study, the model considers three main aspects including the asymmetric reaction of key macroeconomic activities to SoOP, the symmetric pass-through nexus from exchange rate to oil prices and vice versa, and the DDT symptoms.

As for the first aspect, to carry out this study empirically, the autoregressive distributed lag-error correction model (hereafter, ARDL-ECM) and related F-test (bound test) approaches developed by Pesaran and Shin (1989) and Pesaran et al. (2001) were used as the starting point in the choice of appropriate model considering the main objectives and the sample size of this study. ARDL as in Equation (3.9) according to Pesaran et al. (2001) was an attempt to extend the previous co-integration approaches used to test the relationship between variables and were mostly focused on the relationship among variables of  $I(1)$  integration's order. ARDL, however, can be used to test both short-long nexus in levels among variables regardless of its integration order-level whether pure  $I(0)$ , pure  $I(1)$  or of

both orders together. To this end, following the work of Long and Liang (2018), Menegaki (2019) among others, (3.9) below represents the general form of ARDL ( $p, q$ ).

$$\Delta \ln Y_t = a_0 + a_1 \ln Y_{t-1} + a_2 \ln X_{t-1} + \sum_{i=1}^p \delta_i \Delta \ln Y_{t-i} + \sum_{i=0}^q \vartheta_i \Delta \ln X_{t-i} + \varepsilon_t \quad \text{Equation (3.9)}$$

where  $Y_t$  and  $X_t$  indicate the logarithm of the explained variable, and the explanatory variable, respectively.  $\Delta$  is variable difference implying the changes in the explained and explanatory variables from one time period to another.  $i=1, \dots, k$  is the number of variables in the model while  $t$  and  $t-1$  represent the value of the variable at current time and the lagged values of it in the previous time period, respectively.  $p$  and  $q$  are the lag length on the explained variable with  $i=1, \dots, p$  and on explanatory ones with  $i=0, 1, \dots, q$ , respectively, with  $p$  and  $q$  may or may not have the same optimal lag length.  $E_t$  is the error term,  $a_0$  is the constant (i.e., intercept),  $a_1, a_2$  indicate the long run coefficients and  $\delta_i, \vartheta_i$  represent the coefficients of the short run. However, ARDL-ECM as mentioned by Khan et al. (2019) lack distinguishing between the negative and positive impact of the explanatory variable (or IV) on the explained one (or DV). Additionally, Granger and Yoon (2002) introduced what is known as the hidden co-integration framework to explore the probability of unobserved relationships (i.e., relations that are different from linear or symmetric relations previously documented in earlier studies) exist among time series variables. The unobserved co-integrations were identified and considered as an example of the asymmetrical relationship.

Thus, to analyze such asymmetric-alike behavior which is the main objective of study in hand, the asymmetric version of (3.9) known as Nonlinear autoregressive distributed lag-error correction model (hereafter, NARDL-ECM) developed by Shin et al. (2014) was adopted. NARDL and in addition to the advantages of hidden co-integration detection, best

fit for data of small sample size and the neglecting of the assumption stating that the variables should be of the same order of integration, NARDL-ECM is also favored over other ECM based asymmetric-related modeling techniques which are dominant in the literature regarding asymmetries (e.g. threshold-ECM, Markov-switching model, and smooth transition regression model “STR”) through its ability to jointly model and analysis the dynamics of cointegration and asymmetries within the ECM context (Katrakilidis and Trachanas, 2012). Moreover, NARDL is simple and flexible in modeling complex phenomena such as the one found and argued widely in the literature which claims that in the short-term, the impact of positive shocks is larger while the impact of negative shocks is larger in the long-term or the other way around indicating the possibility of asymmetries’ direction to be switched between short-long-terms (Shin et al., 2014).

Within the development process of NARDL, the Author starts with the introduction of a simple regression as in (3.10) that account for the asymmetric long-run co-integration through decomposing the explanatory variable into negative and positive sub-variables following the specification of Schorderet (2003) shown previously in (3.4) in what’s so-called “partial sum decomposition” as follows:

$$Y_t = \beta^+ X_t^+ + \beta^- X_t^- + u_t \quad \text{Equation (3.10)}$$

where  $Y_t$  is the explained variable, while  $X_t$  is the explanatory variable of that is decomposed into its positive partial sum  $X_t^+$  and negative-partial sum  $X_t^-$  as in Equation (3.4). This process of partial sum can be further defined as below.

$$X_t^+ = \sum_{i=1}^t \Delta X_i^+ = \sum_{i=1}^t \max(\Delta X_i, 0) \quad \text{Equation (3.11)}$$

$$X_t^- = \sum_{i=1}^t \Delta X_i^- = \sum_{i=1}^t \min(\Delta X_i, 0) \quad \text{Equation (3.12)}$$

where  $X_t^+$  = the greater of the changes in  $X_i$ , or 0, otherwise, and  $X_t^-$  = the lower of the changes in  $X_i$ , or 0, otherwise. Hence and considering study's explanatory variable (i.e., SoOP) where  $X_t^+ = SoOP_t^+$  and  $X_t^- = SoOP_t^-$ , both (3.11 to 3.12) can be rewritten as:

$$Y_t = \beta^+ SoOP_t^+ + \beta^- SoOP_t^- + u_t \quad \text{Equation (3.13)}$$

$$SoOP_t^+ = \sum_{i=1}^t \Delta SoOP_t^+ = \sum_{i=1}^t \max(\Delta SoOP_i, 0) \quad \text{Equation (3.14)}$$

$$SoOP_t^- = \sum_{i=1}^t \Delta SoOP_t^- = \sum_{i=1}^t \min(\Delta SoOP_i, 0) \quad \text{Equation (3.15)}$$

where  $\beta^{+/-}$  are the associated parameters in the long run with positive and negative changes in *SoOP*, respectively.

According to Shin et al. (2014), the symmetric ARDL-ECM in (3.9) with taken into consideration steps shown in (3.13-3.15) can be modified to explain the asymmetric effect an explanatory variable may have on explained ones resulting in an asymmetric ARDL (NARDL-ECM) as follows:

$$\begin{aligned} \Delta \ln Y_t = & a_0 + a_1 \ln Y_{t-1} + a_2^+ \ln SoOP_{t-1}^+ + a_2^- \ln SoOP_{t-1}^- + \sum_{i=1}^p \delta_i \Delta \ln Y_{t-i} + \\ & \sum_{i=0}^q (\vartheta_i^+ \Delta \ln SoOP_{t-i}^+ + \vartheta_i^- \Delta \ln SoOP_{t-i}^-) + \varepsilon_t \end{aligned} \quad \text{Equation (3.16)}$$

Equation (3.16) is NARDL-ECM jointly model short-long run asymmetries within NARDL, and it is an extension of (3.9). With most of the terms in (3.16) already defined in (3.9) above,  $SoOP_t^+$  and  $SoOP_t^-$  represent the explanatory variable of positive and negative shock of oil

price, respectively. The explained variables denoted by  $Y_t$  includes GDPY, INFLRY, EXCHRY, and UNEMPRY. The variables are expressed in logarithms for the purpose of minimizing the issue of heteroscedasticity and ensuring normality.  $a_1, a_2^{+/-}$  and  $\vartheta_i^{+/-}$  Represent the long run and short run asymmetric coefficients, respectively. Hence, the associated parameters in the long run  $\beta^{+/-}$  presented in Equation (3.13) are estimated as follow considering Equation (3.16).

$$\beta^+ = \frac{-a_2^+}{a_1} \quad \text{Equation (3.17)}$$

$$\beta^- = \frac{-a_2^-}{a_1} \quad \text{Equation (3.18)}$$

where  $\beta^{+/-}$  are long-run associated parameters used to calculate the long-run coefficients,  $a_2^{+/-}$ , which will enable findings asymmetries in the long run through Wald test.

Thus, taking into consideration the study's independent variables or explained variables, Equation (3.16) yields the following NARDL models of each variable namely GDPY-model, INFLRY-model, EXCHRY-model and UNEMPLRY-model represented by Equation(3.19-3.22) respectively.

$$\Delta \ln \text{GDPY}_t = a_0 + a_1 \ln \text{GDPY}_{t-1} + a_2^+ \ln \text{SoOP}_{t-1}^+ + a_2^- \ln \text{SoOP}_{t-1}^- + \sum_{i=1}^p \delta_i \Delta \ln \text{GDPY}_{t-i} + \sum_{i=0}^q (\vartheta_i^+ \Delta \ln \text{SoOP}_{t-i}^+ + \vartheta_i^- \Delta \ln \text{SoOP}_{t-i}^-) + \varepsilon_t \quad \text{Equation (3.19)}$$

$$\Delta \ln \text{INFLRY}_t = a_0 + a_1 \ln \text{INFLRY}_{t-1} + a_2^+ \ln \text{SoOP}_{t-1}^+ + a_2^- \ln \text{SoOP}_{t-1}^- + a_3 \ln \text{Bm2}_{t-1} + \sum_{i=1}^p \delta_i \Delta \ln \text{INFLRY}_{t-i} + \sum_{i=0}^q b_i \Delta \ln \text{Bm2}_{t-i} + \sum_{i=0}^q (\vartheta_i^+ \Delta \ln \text{SoOP}_{t-i}^+ + \vartheta_i^- \Delta \ln \text{SoOP}_{t-i}^-) + \varepsilon_t \quad \text{Equation (3.20)}$$

$$\begin{aligned} \ln EXCHRY_t &= a_0 + a_1 \ln EXCHRY_{t-1} + a_2^+ \ln SoOP_{t-1}^+ + a_2^- \ln SoOP_{t-1}^- + \\ \sum_{i=1}^p \delta_i \Delta \ln EXCHRY_{t-i} &+ \sum_{i=0}^q (\theta_i^+ \Delta \ln SoOP_{t-i}^+ + \theta_i^- \Delta \ln SoOP_{t-i}^-) + \varepsilon_t \end{aligned} \quad \text{Equation (3.21)}$$

$$\begin{aligned} \Delta \ln UNEMPRY_t &= a_0 + a_1 \ln UNEMPRY_{t-1} + a_2^+ \ln SoOP_{t-1}^+ + a_2^- \ln SoOP_{t-1}^- + \\ a_3 \ln GDPcY_{t-1} &+ \sum_{i=1}^p \delta_i \Delta \ln UNEMPRY_{t-i} + \sum_{i=0}^q b_i \Delta \ln GDPcY_{t-i} + \\ \sum_{i=0}^q (\theta_i^+ \Delta \ln SoOP_{t-i}^+ &+ \theta_i^- \Delta \ln SoOP_{t-i}^-) + \varepsilon_t \end{aligned} \quad \text{Equation (3.22)}$$

Some controlling variables (CVs) including broad money (Bm2) and GDP per capita (GDPcY) were incorporated into (3.19) to (3.22) (see, Jammazi et al., 2015; Bala and Chin, 2018; Niran et al., 2018; Lacheheb and Sirag, 2019; Cheratian et al., 2019; and Suliman and Abid, 2020).

Hence, to empirically implement NARDL models in Equation (3.19) up to Equation (3.22) and as stated by Ibrahim. (2015) and Alsamara et al. (2017) the following steps are to be considered (Appendix 4.1 for flowchart).

- STEP1: Establishing the orders' integration for variables through unit root tests to ensure there is no variable of I (2). This can be called “stationarity analysis” stage.
- STEP2: Estimating of (3.19) to (3.22) through the standard ordinary least square (OLS) to check the availability of cointegration between explained variables and explanatory one of ( $SoOP_t^+$  and  $SoOP_t^-$ ). The selection of optimal lag structure is to be considered in advance to testing for co-integration. The co-integration between variables is null hypothesized as no co-integration (*i.e.*  $a_1 = a_2^+ = a_2^- = a_3 = 0$ ). This step can be called “co-integration analysis” stage.

- STEP3: If the “null” hypothesis of no cointegration is rejected, the model is valid, and the test of both asymmetric long-short run relationships is carried out. Null hypothesis for a symmetric long-term (SLT, hereafter) is  $a_2^+ = a_2^-$  and for a symmetric short-term (SST, hereafter) is  $\vartheta_i^+ = \vartheta_i^-$  ( $i=1, 2, \dots, q$ ). This stage can be called “the asymmetric response analysis”.
- STEP4: Evaluating the asymmetric impact of the dynamic multipliers ( $dm_h^+$  and  $dm_h^-$ ) of changes in ( $SoOP_t^+$ ) and ( $SoOP_t^-$ ) as follow:

$$dm_h^+ = \sum_{i=0}^h \frac{\vartheta y_{t+i}}{\vartheta SoOP_t^+}, \quad h = 0.1.2 \dots \rightarrow \infty \quad \text{Equation(3.23)}$$

$$dm_h^- = \sum_{i=0}^h \frac{\vartheta y_{t+i}}{\vartheta SoOP_t^-}, \quad h = 0.1.2 \dots \rightarrow \infty \quad \text{Equation (3.24)}$$

where  $dm_h^+$  and  $dm_h^-$  are the positive-negative cumulative dynamic multipliers (CDM, hereafter) of positive-negative changes in  $SoOP_t^+$  and  $SoOP_t^-$ , respectively.

Worth mentioning that, NARDL as stated by Shin et al. (2014) is a model of importance because it is not only superb in distinguishing between asymmetries in LR and SR as widely understood but it is in fact and generally accounts for three different types of asymmetries through its outcomes. Asymmetry in the LR (also called reaction asymmetry) that is related to the coefficients of the asymmetric long run-in level (i.e.,  $\beta^+ = \beta^-$ ), the asymmetry of the “impact” related to coefficients of both long-short run at first difference, and lastly the asymmetry detected through CDM which is called the asymmetry of “adjustment” (i.e., detected through the movement from an initial to new equilibrium).

As for the second aspect, which is the analysis of asymmetric pass-through nexus from exchange rate to OP. Equation (3.21), for instance, can capture a one-way effect (i.e., unidirectional) that would be imposed on the exchange rate in response to oil price shocks.

But there is a possibility of two-way relation (i.e., bidirectional) or there might be a pass-through effect that can be transmitted from the fluctuation of the exchange rate to oil prices. Hence, to satisfy this possibility, Equation (3.21) can be rewritten as follows:

$$\Delta \ln \text{SoOP} = a_0 + a_1 \ln \text{SoOP}_{t-1} + a_2^+ \ln \text{EXCHRY}_{t-1}^+ + a_2^- \ln \text{EXCHRY}_{t-1}^- + \sum_{i=1}^p \delta_i \Delta \ln \text{SoOP}_{t-i} + \sum_{i=0}^q (\vartheta_i^+ \Delta \ln \text{EXCHRY}_{t-i}^+ + \vartheta_i^- \Delta \ln \text{EXCHRY}_{t-i}^-) + \varepsilon_t \quad \text{Equation (3.25)}$$

In Equation (3.25), SoOP is the explained/dependent variable and the exchange rate (EXCHRY) is the explanatory/independent one,  $\text{EXCHRY}_{t-1}^+$  and  $\text{EXCHRY}_{t-1}^-$  are the positive and negative partial sum of the IV or explanatory variable while  $a_1, a_2^{+/-}$  and  $\vartheta_i^{+/-}$  indicates the long run and short run asymmetric coefficients, respectively. Once the asymmetric effect in nexus is found whether in SR, LR or in both, the asymmetric effect that might be transmitted to oil price from exchange rate can be found as follows:

$$dm_h^+ = \sum_{i=0}^h \frac{\partial \text{SoOP}_{t+i}}{\partial \text{EXCHRY}_t^+}, h = 0.1.2 \dots \rightarrow \infty \quad \text{Equation (3.26)}$$

$$dm_h^- = \sum_{i=0}^h \frac{\partial \text{SoOP}_{t+i}}{\partial \text{EXCHRY}_t^-}, h = 0.1.2 \dots \rightarrow \infty \quad \text{Equation (3.27)}$$

where  $dm_h^+$  and  $dm_h^-$  are the positive-negative dynamic multipliers of positive-negative changes in  $\text{EXCHRY}_t^+$  and  $\text{EXCHRY}_t^-$ .

In relation to the third aspect that is the diagnosis of DDT. The symptoms of Dutch disease related to macroeconomic indicators (i.e., unemployment, inflation and exchange rate) are to be diagnosed based on the results of NARDL. However, given the fact that the symptoms of DDT are beyond just those related to macroeconomic indicators (i.e., some symptoms are related to the non-oil sectors), an extra analysis using the regression of

ordinary least square (OLS) adapting Rudd (1996) is to be carried out to test the DDT hypothesis.

$$DDT_s = a + bSoOP + cGDPcY + dB_{m2} + e_t \quad \text{Equation (3.28)}$$

where  $DDT_s$  is the symptoms of DD (here is the decline in non-oil sector including manufacturing, agricultural sectors and service sectors) as the DV and the SoOP is the oil price shock as the IV while broad money ( $B_{m2}$ ) and the GDP per capita (GDPcY) are the control variables. Thus, (3.28) yields the following equations:

$$DDT_{AGRIY} = a + bSoOP + cGDPcY + dB_{m2} + e_t \quad \text{Equation (3.29)}$$

$$DDT_{MANY} = a + bSoOP + cGDPcY + dB_{m2} + e_t \quad \text{Equation (3.30)}$$

$$DDT_{SERVY} = a + bSoOP + cGDPcY + dB_{m2} + e_t \quad \text{Equation (3.31)}$$

where  $DDT_{AGRIY}$ ,  $DDT_{MANY}$  and  $DDT_{SERVY}$  represents the symptom of DD on the agricultural, the manufacturing and service sectors, respectively.

### 3.6 Data Analysis Techniques

As stated above, the implementation of study models represented by Equation (3.19-3.22) goes through different steps and each step is implemented through different methods and tests. To this end, the following are the tests and methods to be utilized.

#### 3.6.1 Unit Roots Analysis

This is the first step in the process of performing NARDL and it is done through different unit-roots tests for better and robust results. Choi (2015) mentioned some reasons for which Unit root tests have become of wider use and of greater importance not only in the

discipline of economics but also in others including social sciences and statistics. Firstly, plenty of economic assumptions' validity relies upon whether there are unit-roots exist or not (e.g., no unit root should exist for the real exchange rate to hold for the relative PPP). Secondly, whether variables in use are stationary or not is a key requirement of most regressions and VARs models (i.e., stationarity of variables in use is a must to use those models while the existence of non-stationary ones may yield some issues such as spuriousity in regression).

Moreover, as empirically found by Granger and Newbold (1974), misleading results may attain when the variables of time series exhibit a nonstationary behavior. Hence, to avoid such econometric issues (i.e., fake regression) among others and which results from the use of variables of different integration orders when running regression and VARs models, the identification of each variable's correct order of integration is a must which can be done through the use of different unit roots tests (Maddala and Kim, 1998, 2007). These unit root tests can be basic/traditional including but not limited to the Augmented Dickey-Fuller (ADF), Phillips-Perron Test (PP), Kwiatkowski-Phillips-Schmidt-Shin (KPSS) or unit roots tests that allow for breakpoints or structural changes to be detected including but not limited to Lee and Strazicish test(LS) and Bai- Perron(BP) test.

As so, to accomplish the first step of NARDL model process which is the confirmation of variables stationarity, a unit root test is carried out. The purposed unit root tests to be carried out here are mixture of traditional and breakpoint type tests in order to ensure the assumption of variables integration order is perfectly met. In addition, whether a differencing to bring the variable into the desired order of integration is required or not will be clear. The use of structural changes of unit root tests as mentioned by Glynn et al. (2007)

benefit the researchers to spot the structural changes in the data set even if such breaks are unknown which makes the results of the traditional type of unit root tests biased if such breaks were found. To this end, ADF-test and PP-test along with BP test are to be considered in this study at hand.

### 3.6.1.1 The Augmented Dickey-Fuller (ADF)

This test is one of the two traditional tests to be used. This test was developed by Dickey and Fuller (1979) to accommodate multiple variable autoregressive process AR(q) to augment the Earlier DF test which was pure AR (1) process. The ADF test is represented according to Ryan, and Giles (1999), Paparoditis and Politis (2016), by the following regression test:

$$\Delta X_t = \beta X_{t-1} + \sum_{i=1}^q \partial_i \Delta X_{t-i} + \omega_t \quad \text{Equation (3.32)}$$

where  $X_t$  is the time series of interest as random walk (no intercept, no trend) and  $\Delta$  is the first difference of  $X_t$  (i.e.,  $\Delta X_t = X_t - X_{t-1}$ ).  $\omega_t$  is the error term that of possibility containing serial correlation/ heteroskedasticity while  $q$  is lag order of which its value is set to accounts for autocorrelation in  $\omega_t$  with  $i=1, 2, \dots, q$ . The regression model (3.32) is “random walk” model with no constant (i.e., intercept) or trend (i.e., deterministic trend) and it can be rewritten to accommodate for the constant and trend as follows:

$$\Delta X_t = \alpha + \beta X_{t-1} + \sum_{i=1}^q \partial_i \Delta X_{t-i} + \omega_t \quad \text{Equation (3.33)}$$

$$\Delta X_t = \alpha + \gamma t + \beta X_{t-1} + \sum_{i=1}^q \partial_i \Delta X_{t-i} + \omega_t \quad \text{Equation (3.34)}$$

where  $X_t$  in Equation (3.33) is the time series estimation with intercept  $\alpha$  and in Equation (3.34) with intercept and trend  $\alpha$  and  $\gamma$ ,  $\alpha$  is constant,  $\gamma$  is trend. Hence, the underlying hypotheses of ADF are:

$$H_0: \beta = 0 \quad \text{Equation (3.35)}$$

$$H_1: \beta < 0 \quad \text{Equation (3.36)}$$

The rejection of the  $H_0$  in (3.35) indicate the stationarity (i.e., no unit roots) of the time series  $X_t$  with “zero” mean (i.e., no constant no trend) or with “nonzero” mean (i.e., with constant) or with “deterministic trend” (i.e., with constant and time trend) (Ijomah and Enegesele, 2017). However, and since ADF is a parametric type test where specification of lag order  $q$  is needed, the serial correlation might be developed in case  $q$  was small or the test power deteriorated in the case where  $q$  was big (Arltová and Fedorová, 2016). Thus, to account for such issues and to produce robust unit root test results, the nonparametric type test of Phillips and Perron (PP test) is to be taken into consideration as well.

### 3.6.1.2 The Phillips-Perron (PP)

This test is of the traditional type of unit root test as well (i.e., breakpoints in the time series data are neglected). The lag difference in (3.32) may develop a serial correlation in the residual term  $\omega_t$  which in turn leads to regression’s equation change. Therefore, a test that is robust to issues of autocorrelation, and heteroscedasticity is vital to account for such issues. Hence, as an alternative test of the ADF- test with consideration of the constant case and Constant and trend case in the regression test, a non-parametric unit root test of Phillips and Perron (1988) (i.e., PP test) is developed. Allowing for the inclusion of constant and trend in the PP test is of importance as most of the time series particularly economic ones

commonly contain "nonzero" mean and in many cases time trend. This PP test ignores the lag difference in ADF regression test (3.32) yielding the following PP regression test:

$$\Delta Y_t = \alpha_{Dt} + \beta Y_{t-1} + \omega_t \quad \text{Equation (3.37)}$$

where,  $Y_t$  is the time series of interest,  $\omega_t = I(0)$  or the error term with “zero” mean and  $D_t$  deterministic term (constant or trend). The lag difference is ignored because PP is a non-parametric test type (i.e., it requires no prior specification for the lagged "parameters" and the model in the regression). Thus, (3.37) can be rewritten to accommodate for the constant (i.e., intercept) and trend as follows:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \omega_t \quad \text{Equation (3.38)}$$

$$\begin{aligned} \Delta Y_t = \alpha + \gamma t + \beta Y_{t-1} \\ + \omega_t \end{aligned} \quad \text{Equation (3.39)}$$

where  $Y_t$  in (3.38) is the time series estimation with intercept  $\alpha$  and in (3.39) with intercept and trend  $\alpha$  and  $\gamma$ . Hence, the hypothesis under PP test as follow:

$$H_0: \beta = 0 \quad \text{Equation (3.40)}$$

$$H_1: \beta < 0 \quad \text{Equation (3.41)}$$

Equations (3.40) and (3.41) test the null ( $H_0$ ) of unit root test versus the alternative ( $H_1$ ) of there is no unit root (Lee and Shie, 2004) (Afriyie et al., 2020). The rejection of the null hypothesis,  $H_0$  suggests stationarity (i.e., no unit roots) in the time series  $Y_t$  with “constant” or with “deterministic trend” (i.e., with constant and time trend). The similarity of the hypotheses to be tested under ADF and PP is due to the fact that both tests use the same regression specifications with the exception of how they specify the dependent variable

where it is in level in PP regression and in the first difference in the ADF estimation (Wang and Tomek, 2007). The process of correcting the serial correlations by PP test is done through changing the statistics of ADF test to yield two modified statistics but having the same “asymptotic distribution” of ADF as in (MacKinnon, 1996).

In short and in addition to the stated fact which is its strength in dealing with heteroscedasticity that can be developed through the ADF test lag order specification. The PP test also was found by Arltová and Fedorová. (2016) to be more powerful when dealing with small sample time series such as  $N=25$ ,  $N=50$  and comes second after ADF in series bigger than  $N=50$ . Such reasons are to be considered when comparing the results of the proposed unit root tests to decide which test results are favored.

The question, however, is now which estimation form is to be considered first when testing for stationarity, is it the estimation in (3.32 and 3.37) with none, (3.33 and 3.38) with intercept only, or (3.34 and 3.39) with intercept and trend? According to enders (1995), enders (2010), the most appropriate way to estimate the regression whether to include a random walk (no trend, no intercept), intercept or intercept with the trend is being debated. Thus, the best and more reasonable unit root testing strategy to test for  $H_0$  of  $\beta = 0$  is to start by considering the general form of the regression model as in (3.34) and (3.39) (i.e., with constant and trend) followed by testing the significance of trend and then the significance of constant to lastly the random walk form of regression. The process of such unit root testing strategy as suggested by Doldado et al. (1990), Pfaff (2008), and Enders (2010) comes in the following steps:

- **Step1: Estimation of the regression model with the inclusion of intercept and trend.** Under this estimation, the rejection of  $H_0: \beta = 0$  concluded the

stationarity of the time series model and no further test is required. However, in case the null was failed to be rejected, the significance of trend term  $\gamma_t$  (i.e.,  $\gamma_t = 0$ ), is to be tested under the null of  $\beta = 0$ . Hence, if the trend was found to be significant and  $H_0: \beta = 0$  is rejected, then no more tests are required, and the model is said to be stationary with intercept and significant trend. However, if the trend term was found to be insignificant, the trend term is then excluded from the model and model is said to have unit roots which require further testing.

- **Step 2: Estimation of the regression model with the inclusion of intercept only.** In this step, models are estimated without trend and only with intercept. The rejection of  $H_0: \beta = 0$  concluded the stationarity of the time series model and no further estimation is required. In the case, however, the  $H_0$  of  $\beta = 0$  was not rejected, the significance of the intercept or constant term (i.e.,  $\alpha = 0$ ) in the model is to be tested under the null of  $\beta = 0$ . The decision to reject the null with significant constant concluded that the model is stationary with intercept, otherwise, the insignificant intercept implies the model is to be estimated further for stationarity without intercept as in step 3.
- **Step 3: Estimation of the regression model neither with intercept nor trend.** Here the model is estimated without including trend and constant and the rejection of the null of  $\beta = 0$  implies to no further test is required and the model is said to be stationary without trend or intercept. However, the failure to reject the null of  $\beta = 0$  suggests the series contains unit roots and further testing is required.

However, as mentioned by Pfaff (2008), the non-rejection of the null of  $\beta = 0$  may implies that the series is of higher order than zero (i.e.,  $I(0)$ ) which require testing the series for Stationarity in higher orders in a process called “bottom-up” starting from first difference all the way up into higher orders as needed and as the series still contains unit root. This means following the same steps seated, once the stationarity is confirmed for instance under the first difference either with trend and intercept , intercept only or none, there is no further test under higher order is required.

Worth mentioning that, any time series is vulnerable to structural changes at any point of time along the period and if found, misleading outcomes are generated. To this end, a consideration of a unit root test that detects such structural changes is vital given that traditional tests of stationarity including but not limited to ADF and PP tests cannot account for such breakpoints in the time series and may produce incorrect conclusions (Perron, 1989).

### **3.6.1.3 Bai-Perron (BP) Multiple Breakpoints Test.**

According to Perron (1988), there is a bias in the support of the traditional ADF and PP tests null hypothesis in (3.34) in the case of a breakpoint (i.e., structural break) existence in the time series. This breakpoint may refer to changes occurred in time series prior or post an event. Thus, structural changes related unit root test came into effect with many tests including but not limited to Perron (1988) test on known date single structural change, Zivot and Andrews (1992) test on unknown date single structural change, Lee and Strazicich (2003) test on two known structural changes (Levendis, 2018). To this end, Bai and Perron (2003a) developed it is breakpoints unit root test to allow for the detection of multiple breaks in the series rather than one known single break as addressed by most unit roots structural changes

tests. The BP test considers a multiple regression model contains " $m$ " breaks (i.e.,  $m + 1$  regimes) as below:

$$y_t = x_t'\delta + z_t'\beta_i + \omega_t \quad ; t = T_m + 1, \dots, T ; \quad \text{Equation (3.42)}$$

where  $y_t$  is the dependent variable at time  $t$ ,  $T_1, \dots, T_m$  are unknown breaks in the series,  $\omega_t$  is the error term.  $\delta$  and  $\beta_i$  are the coefficients' corresponding vectors of the covariate's vectors of  $x_t'$  and  $z_t'$  with  $i = 1, \dots, m + 1$ . Thus, this test aims at finding those unknown break dates (i.e.,  $T_1, \dots, T_m$ ) and regressors coefficients (i.e.,  $\delta, \beta_i$ ) when a number of observations  $T$  are there on the covariates vectors (i.e.,  $y_t, x_t', z_t'$ ).

Based on Equation (3.42) three tests namely SUP F type test; double max test and sequential test were proposed to detect how many breaks in the time series under the BP test (Bai and Perron, 2003a) and (Antoshin et al., 2008).

- The SUP F test assumes no structural changes (i.e., zero breaks) versus a known number  $K$  of breakpoints in the time series. In other words, this test can be defined as follows:

$$\sup F = (0, m) \quad \text{Equation(3.43)}$$

Hence, the null versus alternative hypotheses under this test are:

$$H_0: \text{There is no breakpoint ; } m = 0 \quad \text{Equation (3.44)}$$

$$H_1: \text{There is a } K \text{ of known breakpoint ; } m = k \quad \text{Equation (3.45)}$$

However, this test is not applicable with the assumption of unknown break points. For this reason, the second test (i.e., double max test) under BP was developed as a variation of  $\sup F = (0, m)$  test.

- The double max test ( $D_{max}$ ) assumes no breaks versus the existence of unknown number of breakpoints in the time series. Thus, the test can be represented as follows:

$$D_{max} = \max_{n=1, \dots, m} (\alpha_n \sup F(0, n)) \quad \text{Equation (3.46)}$$

where  $\alpha_n$  is the weight for which  $n = 1, \dots, m$  generate the unweighted/equal weighted double max test " $UD_{max}$ " or the weighted double max test " $WD_{max}$ ".

Thus, the hypotheses under this test are:

$$H_0: \text{There is no breakpoint} \quad \text{Equation (3.47)}$$

$$H_1: \text{There is an unknown number of } m \text{ breaks ; } m$$

$$= 1, 2, \dots, 5 \quad \text{Equation (3.48)}$$

where  $m = 5$  implies that maximum of five break dates is mostly sufficient for any empirical application. This test as stated by Perron (2005) is considered very useful if not the most useful tests of its kind to detect the presence of break dates in the time series. The rejection of  $H_0$  as the maximum value of the F-statistics of both  $UD_{max}$  and " $WD_{max}$ " is found to be greater than the critical values of Bai and Perron (2003b) would imply the presence of breaks in the time series but not to the number of breaks that actually there. Hence, the third test (i.e., sequential test) under BP is developed for that purpose.

- The sequential test (also called  $\sup F(L+1|L)$ ) assumes "L" breakpoints versus "L+1" breakpoint. Thus, this test depends on the analysis of the previous test where it can be used once the null hypothesis of the test is rejected which indicates the existence of at least one single breakpoint. The test then can be

used to determine the number of breakpoints in the time series and the dates of these breaks as compared to the double max test which is good to just detect the existence of breakpoint in the series (Wu et al., 2019). The hypotheses under this test are:

$$H_0: \text{There is } (L) \text{ breakpoint} \quad ; L = 0, 1, \dots, \quad \text{Equation (3.49)}$$

$$H_1: \text{There is } (L + 1) \text{ breakpoints} \quad \text{Equation (3.50)}$$

Hence, to find the first break date, the test concluded in favor of  $H_0$  as the F-statistics of  $F(L+1|L)$  is found to be greater than certain critical values of Bai and Perron (2003b). To find more breaks, the same process is sequentially repeated. In other words, and stated by Enders (2014), This sequential process to detect breaks suggests the start of testing the null of “no breakpoint versus the alternative of a single breakpoint. As such the rejection of the null of “no breakpoint “ in favor of “single break”, the process continues to test for the null of “single break” versus the alternative of “two breaks” and as long as the null is rejected, the process continues on the same manner until the PP sequential test fail to reject the null. Hence, the strategy of applying BP test is that using the double max test at first to detect the presence of break point in the time series and then determining the number of break dates through the application of sequential test (Bai and Perron, 2003a).

In short, besides the fact that BP can detect multiple and unknown breaks in comparison to many other breakpoint tests stated, the procedure of the BP test allows for heteroscedasticity and serial correlation to be dealt with in comparison to other breakpoints detecting criteria such as IBC and Schwarz which is an added advantage that favors the use

of BP test (Antoshin et al., 2008). Below is Table 3.2 summarizing the hypotheses under these proposed unit root tests.

**Table 3.2:** Summary of the Underlying Hypotheses of Proposed Unit Roots Test

|                      | <b>The Phillips-Perron (PP)</b> | <b>Bai-Perron (BP) breakpoints test</b>  |                                          |                            |
|----------------------|---------------------------------|------------------------------------------|------------------------------------------|----------------------------|
| <b>Hypotheses</b>    |                                 | <b>Sup F test</b>                        | <b>double max test</b>                   | <b>Sequential test</b>     |
| <b>H<sub>0</sub></b> | There is unit root              | There is no breakpoint                   | There is no breakpoint                   | There is “L” breakpoint    |
| <b>H<sub>1</sub></b> | There is no unit root           | There is a k number of known breakpoints | There is an unknown number of “m” breaks | There is “L+1” breakpoints |

Source: Author’s construct based on above discussion

### 3.6.2 Cointegration Analysis

Once the stationarity test in the first stage confirms the existence of stationarity either at level, first difference or mixture of both orders, the second stage of the NARDL process which is the cointegration test can be carried out. According to Nkoro and Uko (2016), from a theoretical prospect, econometrics suggests that variables under study establishes long run nexus. This long-run nexus is what is conceived as cointegration which emulates such a long-run nexus among time series. Thus, to ensure the model used empirically shows a meaningful relationship, in the long run, the test of cointegration is inevitable and vital.

As for this study in hand, two cointegration tests were carried out. First test is the test of cointegration introduced by Pesaran et al. (2001) that is called F-bound test or simply F-test. This test has been widely adopted by studies since the introduction of ARDL model and later the extension of it (i.e., NARDL) to test for the cointegration among variables. The

second test is the novel bootstrap ARDL test by McNown et al. (2017) with consideration of NARDL rather than ARDL ((BNARDL-Test, hereafter).

The “F-test” is applicable to all independent and dependent variables at their lagged level (F-test on the lagged level of all DV and IV). In other words, the f-test is sometimes referred to as joint F-test as it tests the joint significance of the coefficients of all lagged dependent and independent variables in the model. Thus, in(3.19) up to (3.22), where the GDPY, INFLRY, EXCHRY, and UNEMPRY are the “dependent variables” in each, respectively, and the SoOP is the “independent variable” in each, the hypothesis of null ( $H_0$ ) is tested versus the alternative ( $H_1$ ) taken into account all lagged variables in each equation.

$$H_0: a_1 = a_2^+ = a_2^- = 0 \text{ , (i.e. there is no cointegration)} \quad \text{Equation (3.51)}$$

$$H_1: a_1 \neq a_2^+ \neq a_2^- \neq 0 \text{ , (i.e. there is a cointegration )} \quad \text{Equation (3.52)}$$

To decide for the existence of cointegration, The F-test value is compared with the critical values of upper and lower bounds (hereafter, CVUB and CVLB) introduced by Nayaran (2004) (Appendix 4.3) which fits better in the case of small sample size studies with less than 80 observations as compared to Pesaran et al. (2001) critical values (Nkoro and Uko, 2016). The decision is made as in Table 3.3.

**Table 3.3:** Possible Cases for the Decision of Cointegration Based on F-Test

| Case                             | Decision                                       |
|----------------------------------|------------------------------------------------|
| F-test value > CVUB <sup>a</sup> | ( $H_0$ ) is rejected, cointegration exist     |
| F-test value < CVLB <sup>b</sup> | ( $H_0$ ) is supported, no cointegration exist |
| CVUP > F-test value > CVLB       | indecisive                                     |

Notes:

<sup>a</sup> : Upper bound critical values (CVUB);

<sup>b</sup> : Lower bound critical values (CVLB).

Source: Adopted from Nkoro and Uko (2016).

Thus, the decision to reject ( $H_0$ ) suggests a cointegration among the variables in the mentioned equations. However, The F-test is best when explanatory variables (i.e., IVs) in the equations are integrated in level I (0) or at first difference I (1) or mixed out and the explained ones (i.e., DVs) only at first difference I (1) (Pesaran et al., 2001). Hence, it is not clear the source of significance, whether from the lagged level of DVs or IVs. Thus, the decision of cointegration made on F-test is not robust. The reason according to McNown et al. (2017) is that the shortcoming of unit roots test of having low power may falsely lead the researcher to assume the DV is of order I (1), thereby, getting a significant T-test value on the lagged DV indicates the DV is of order I (0). Therefore, to overcome such issue, the novel bootstrap ARDL test (BARDL-test) of cointegration is introduced.

The second suggested test is the BNARDL-test by McNown et al. (2017) which ignores the previous test assumption of having the explained variables (DVs) of the first order only allowing the significance level test applicable on the lagged level of the explanatory/independent variable. This test is an added test of the cointegration relationship among variables considering the significance of lagged level independent variable coefficient (BNARDL-test on the lagged level of IV). A researcher may obtain a better and genuine insight to decide on the model cointegration as compared to the previous test of cointegration (i.e., overall F-test) (McNown et al., 2017). The test though indicates cointegration related to ARDL (linear ARDL) but is applicable to the nonlinear form of it (i.e., NARDL) as it is an extension of the basic ARDL. Thus, the test is applied on the study NARDL proposed model considering the new created variables from the partial sum (the negative and positive changes in the independent variable).

Since BNARDL test considers the IV lagged level, the Explanatory variables or IVs in (3.19) to (3.22) are the positive and negative (SoOP), thus, the hypothesis of null ( $H_0$ ) is tested versus alternative ( $H_1$ ) as follows:

$$H_0 = a_2^+ = a_2^- = 0 \text{ , (i. e. there is no cointegration)} \quad \text{Equation (3.53)}$$

$$H_1 = a_2^+ \neq a_2^- \neq 0 \text{ , (i. e. there is a cointegration )} \quad \text{Equation (3.54)}$$

To decide for the cointegration, the results of this test are compared with CVUB and CVLB developed by Sam et al. (2018) (Appendix 4.4). The reason for using these critical values is because they are good for a small sample size and most importantly, they were developed particularly for BNARDL-test of cointegration which was implemented previously using the bootstrap procedures. The possible cases of the decision are as shown in Table 3.4.

**Table 3.4:** Possible Cases for the Decision of Cointegration Based on BNARDL-Test

| Case                                  | Decision                                       |
|---------------------------------------|------------------------------------------------|
| BNARDL-test value > CVUB <sup>a</sup> | ( $H_0$ ) is rejected, cointegration exist     |
| BNARDL-test < CVLB <sup>b</sup>       | ( $H_0$ ) is supported, no cointegration exist |
| CVUB > BNARDL-test > CVLB             | indecisive                                     |

Notes:

<sup>a</sup> : Upper bound critical values (CVUB);

<sup>b</sup> : Lower bound critical values (CVLB)

Source: Adopted from Sam et al. (2018)

The rejection of the null hypotheses of F-test (3.51) and BNARDL-test (3.53) evidencing the significance level of these tests which in turn implies the existence of

cointegration (i.e., long-run relationship) among variables included in the model. The two tests together provide a robust decision of the NARDL's cointegration test. Table below summarizes the possible outcomes of conducting both tests of cointegration.

**Table 3.5:** Possible Decisions Based on Both Cointegrations' Tests

| Possible outcomes | Joint F-test                         | BNARDL-test                          | Decision                              |
|-------------------|--------------------------------------|--------------------------------------|---------------------------------------|
| <b>1</b>          | <b>H<sub>0</sub></b> is Not rejected | <b>H<sub>0</sub></b> is Not Rejected | No cointegration <sup>a</sup>         |
| <b>2</b>          | <b>H<sub>0</sub></b> is Rejected     | <b>H<sub>0</sub></b> is Not Rejected | Non-robust cointegration <sup>b</sup> |
| <b>3</b>          | <b>H<sub>0</sub></b> is Not rejected | <b>H<sub>0</sub></b> is Rejected     | Non-robust cointegration              |
| <b>4</b>          | <b>H<sub>0</sub></b> is Rejected     | <b>H<sub>0</sub></b> is Rejected     | Robust cointegration <sup>c</sup>     |

Notes :

<sup>a</sup> : both tests failed to confirm the cointegration;

<sup>b</sup> : one test only confirmed the cointegration ;

<sup>c</sup> :both tests confirmed the cointegration.

Source: Author's construct based on above discussed

The first test (i.e., joint F-test) was used widely along with the application of ARDL and NARDL but the usage of both tests together, including the novel test (i.e., BNARDL-test) to find the cointegration of ARDL is still rare and even less used in the case of using them to test the cointegration of NARDL. Hence, the novel test of BNARDL is applied to the NARDL model of this study. Worth mentioning, other tests such as Johansen test and angel-granger test for cointegration for instance cannot be of use in case of mix integration order variables in the model unlike these two approaches associated with NARDL (Shrestha and Bhatta, 2018). Furthermore, these tests associated with NARDL can detect cointegration in cases where another test such as angel-granger test might unsuccessfully detect it (Allen and McAleer, 2021).

### 3.6.3 The Asymmetric Response Analysis

Post ensuring the stationarity of variables at level, first difference or in both orders as assumed by NARDL-ECM model at the first step and confirming co-integration through the two proposed tests at the second step, the third step which is the test of long-short term nexus among variables in (3.19) to (3.22) is carried out. This test allows for the potential impact of asymmetry to be spotted.

The Wald-test suggested by Shin et al. (2014) is used to detect the asymmetric response in the long term as well as in the short term for (3.19) to (3.22) hypothesizing the following:

- For asymmetric short-term response (SST), the hypothesis of null ( $H_0$ ) is tested versus the alternative ( $H_1$ ) as follows:

$$H_0 = \vartheta_i^+ = \vartheta_i^- = 0 \quad (\text{i.e. no asymmetric response}) \quad \text{Equation (3.55)}$$

$$H_1 = \vartheta_i^+ \neq \vartheta_i^- \neq 0 \quad (\text{i.e. there is asymmetric response}) \quad \text{Equation (3.56)}$$

- For asymmetric long-term response (SLT), the hypothesis of null ( $H_0$ ) is tested versus the alternative ( $H_1$ ) as follows:

$$H_0 = a_2^+ = a_2^- \quad (\text{i.e. no asymmetric response}) \quad \text{Equation (3.57)}$$

$$H_1 = a_2^+ \neq a_2^- \quad (\text{i.e. there is asymmetric response}) \quad \text{Equation (3.58)}$$

The possible decisions of asymmetries based on the Wald -test are in Table 3.6.

**Table 3.6:** Possible Decisions of Asymmetries In Response Based on Wald-Test.

| Null hypotheses                          | Decision       | Conclusion                                               |
|------------------------------------------|----------------|----------------------------------------------------------|
| <b>H<sub>0</sub></b> of SST <sup>a</sup> | - Rejected     | - The asymmetric response in the short term is confirmed |
|                                          | - Not rejected | - No asymmetric response is detected                     |
| <b>H<sub>0</sub></b> of SLT <sup>b</sup> | - Rejected     | - The asymmetric response in the long term is confirmed  |
|                                          | - Not rejected | - No asymmetric response is detected                     |

Notes:

<sup>a</sup> : Short-term asymmetry(SST);

<sup>b</sup> : Long-term asymmetry (SLT).

Source: Author's construct

### 3.6.4 NARDL with Breakpoints Analysis

As the nature of the study is investigating oil shocks and the asymmetric response to them, there are potential breakpoints in the period under study which if neglected, biased outcomes may attain. Thus, in the case of detecting breakpoints dates in the series through Bai- Perron (BP) multiple breakpoints test as explained in the above under stationarity analysis section, a dummy variable is to be added to the NARDL models represented in (3.19) to (3.22) yielding the following NARDL models with dummy breaks:

$$\Delta \ln \text{GDYPY}_t = a_0 + a_1 \ln \text{GDYPY}_{t-1} + a_2^+ \ln \text{SoOP}_{t-1}^+ + a_2^- \ln \text{SoOP}_{t-1}^- + a_3 D + \sum_{i=1}^p \delta_i \Delta \ln \text{GDYPY}_{t-i} + \sum_{i=0}^q (\theta_i^+ \Delta \ln \text{SoOP}_{t-i}^+ + \theta_i^- \Delta \ln \text{SoOP}_{t-i}^-) + \varepsilon_t \quad \text{Equation (3.59)}$$

$$\Delta \ln \text{INFLRY}_t = a_0 + a_1 \ln \text{INFLRY}_{t-1} + a_2^+ \ln \text{SoOP}_{t-1}^+ + a_2^- \ln \text{SoOP}_{t-1}^- + a_3 \ln \text{Bm2}_{t-1} + a_4 D + \sum_{i=1}^p \delta_i \Delta \ln \text{INFLRY}_{t-i} + \sum_{i=0}^q b_i \Delta \ln \text{Bm2}_{t-i} + \sum_{i=0}^q (\theta_i^+ \Delta \ln \text{SoOP}_{t-i}^+ + \theta_i^- \Delta \ln \text{SoOP}_{t-i}^-) + \varepsilon_t \quad \text{Equation (3.60)}$$

$$\Delta \ln \text{EXCHRY}_t = a_0 + a_1 \ln \text{EXCHRY}_{t-1} + a_2^+ \ln \text{SoOP}_{t-1}^+ + a_2^- \ln \text{SoOP}_{t-1}^- + a_3 D + \sum_{i=1}^p \delta_i \Delta \ln \text{EXCHRY}_{t-i} + \sum_{i=0}^q (\theta_i^+ \Delta \ln \text{SoOP}_{t-i}^+ + \theta_i^- \Delta \ln \text{SoOP}_{t-i}^-) + \varepsilon_t \quad \text{Equation (3.61)}$$

$$\begin{aligned} \Delta \ln \text{UNEMP}Y_t = & a_0 + a_1 \ln \text{UNEMP}Y_{t-1} + a_2^+ \ln \text{SoOP}_{t-1}^+ + a_2^- \ln \text{SoOP}_{t-1}^- + \\ & a_3 \ln \text{GDP}cY_{t-1} + a_4 D + \sum_{i=1}^p \delta_i \Delta \ln \text{UNEMP}Y_{t-i} + \sum_{i=0}^q b_i \Delta \ln \text{GDP}cY_{t-i} + \\ & \sum_{i=0}^q (\vartheta_i^+ \Delta \ln \text{SoOP}_{t-i}^+ + \vartheta_i^- \Delta \ln \text{SoOP}_{t-i}^-) + \varepsilon_t \end{aligned} \quad \text{Equation (3.62)}$$

In (3.59) to (3.62),  $D$  is a dummy variable for the possibility of detecting breakpoints (i.e., structural break) across the observed period under consideration where it is assumed (1) right after the identified breakpoints up to the end of it in the series and (0) otherwise (at and before the BP) as expressed in (3.61) (see among others, Cunado and Gracia, 2005; and Basher et al., 2012).

$$D = \begin{cases} 1, & \text{if } t > \text{BP} \\ 0, & \text{if } t \leq \text{BP} \end{cases} \quad \text{Equation (3.63)}$$

where  $D$  is the dummy variable ( $D=1, 2, \dots, 5$ ); ( $t$ ) time trend and (BP) is the occurrence of breakpoint

### 3.6.5 Model's Misspecifications and Stability Check

Lately, it has become common for any empirical study to carry out a misspecification check (i.e., Diagnostic check) to ensure the efficacy of the used econometric model whether it is time series, panel, or cross-section model. There are two key benefits for such tests as suggested by Godfrey (1996) which are the destructive benefit and the constructive benefit. The first value is reflected in the capability of misspecification tests to distinguish between the inadequacy of the model from its adequacy while the later value is reflected in their ability to spot violated assumptions, isolate them and thereby assisting in the model's reformulation or suggesting a better estimator for the model based on these tests' results.

To conclude, NARDL's model goodness of fit, coefficients' stability, and error terms (i.e., residual) are to be checked to ensure unbiased results and a robust model. As for how well the model fit, the  $R^2$  value is considered.  $R^2$  according to Chicco et al. (2021) is called "the determination confident" that was developed in 1921 by Wright to determine the percentage of DV's variance that can be predicted or explained by the IV and it takes the value of between "-1 and +1". In comparison to other measures of regression's model goodness of fit,  $R^2$  is far more informative and reliable. However, regardless of some researchers who criticized the use of  $R^2$  to assess model-goodness of fit, there is no clear justification for such criticism, and the use of this measure remains acceptable (Stare, 1995).

For checking the model error term, Lagrange multiplier (LM) statics is employed to ensure model's residuals are not serially correlated. Due to its ability to test autocorrelation in AR models of a higher order than one, the LM test is favored over The Durbin-Watson statistic (DW) which is limited to testing the autocorrelation of the AR model of order one only or AR (1) (EViews, 2020).

Moreover, autoregressive conditional heteroskedasticity (ARCH) test for heteroskedasticity (i.e., ensuring models residuals are homoscedastic). The ARCH test was favored over other heteroskedasticity tests such as Breusch-Pagan-Godfrey (BPG), white test, Harvey, and others as it is the most suitable to our model which is an autoregressive model. The ARCH as stated by Engle (1982) also examines autoregressive heteroskedasticity in model residual (i.e., the variance changes over time where variance today is predictable by the variance in the past). In addition, useful test in diagnosing models and judging their misspecification particularly due to some variables being omitted or the presence of breakpoints in the series due to its power in detecting such effects.

Lastly, the stability of the model's long-short term coefficients is to be checked through the employment of cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) of Brown et al. (1975). It surpasses some other instability tests including the test of Chow (1960) as it can be used in the case where the breakpoint in the time series is not unknown. Thus, whether the breakpoint is to be found in the "constant" where "CUSUM" does better, or in the coefficient or error variance where "CUSUMQ" does better, these tests together ensure the detection of such a breakpoint that could cause instability in the model (Turner, 2010). Table 3.7 summarizes the misspecifications' check tests.

**Table 3.7: Model's Proposed Diagnostics Tests**

| <b>Misspecification's test</b>    | <b>Functionality</b>                                    |
|-----------------------------------|---------------------------------------------------------|
| <b>R<sup>2</sup></b>              | Checking the "goodness of NARDL's fit"                  |
| <b>LM test <sup>*1</sup></b>      | Ensuring NARDL is autocorrelation-free                  |
| <b>ARCH-LM test <sup>*1</sup></b> | Ensuring the "homoscedasticity" of NARDL                |
| <b>CUSUM and CUSUMQ</b>           | Checking NARDL's short-long term coefficients stability |

Notes:

<sup>\*1</sup>:H<sub>0</sub> of there is no serial correlation/heteroskedasticity up to lag order p

Source: Author's construct based on the discussed-above

## **CHAPTER 4**

### **RESULTS AND ANALYSIS**

#### **4.1 Chapter's Introduction**

In the previous chapters, a variety of theoretical studies have been reviewed as well as the methods used to empirically analyze them. Therefore, from what has been discussed and stated in the previous chapters, there is no such identical effect for the shocks of oil prices on the cases being studied due to a variety of reasons. Thus, several methods and tests have been proposed in the methodology chapter to be carried out to analyze the case at hand. Therefore, and since these proposed tests are based on different assumptions and hypotheses, the need for empirical analysis is vital in order to reach the findings that best suit the case of this study at hand. Hence, this chapter is basically an empirical application of the purposed methods and tests mentioned in the previous chapter. It examines and discusses the objectives and questions related to this study thoroughly. It does that through the outputs of these tests (i.e., the stationary analysis, co-integration analysis, symptoms of Dutch disease analysis, and asymmetry analysis of the shocks on several macroeconomic indicators of this study case).

#### **4.2 Unit Root Tests Results**

To implement “NARDL”, the variables forming the time series need to be of the integration order of  $I(0)$  or  $I(1)$  or of both orders together. Hence, the stationarity analysis (i.e., unit root analysis) is carried out to check the variables' integration order.

#### 4.2.1 The Phillips-Perron (PP) Unit Root Test Results

The PP test is conducted to check the existence of unit roots in the study time series. The null hypothesis under the PP test as in (3.40) suggests that "a variable has a unit root". To this end, Table 4.1 represents the results of the conducted PP unit root test.

**Table 4.1: PP Unit Root Test Overall Results**

| Variables <sup>b</sup>                                  | PP test <sup>a</sup> |                     |           |                       |           | Decision |
|---------------------------------------------------------|----------------------|---------------------|-----------|-----------------------|-----------|----------|
|                                                         | Level                |                     |           | 1st difference        |           |          |
|                                                         | Trend & intercept    | Intercept           | None      | Trend & intercept     | Intercept |          |
| <b>Gdpy</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>     | (0.9430)<br>-1.8301  | (0.4679)<br>1.5855  | (0.6631)  | (0.0025)*<br>-1.8154  | -         | I (1)    |
| <b>Inflry</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>   | (0.6646)<br>-0.2535  | (0.3627)<br>1.2284  | (0.1180)  | (0.0006)*<br>0.6377   | -         | I(1)     |
| <b>Exchry</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>   | (1.0000)<br>0.3702   | (1.0000)<br>-0.9309 | (1.0000)  | ( 0.0187)**<br>2.2244 | -         | I(1)     |
| <b>Unemplry</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup> | (0.9292)<br>-0.1068  | (0.2258)<br>2.8794  | ( 0.9894) | (0.0394)**<br>-2.0223 | -         | I(1)     |
| <b>SoOP</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>     | (0.5500)<br>1.4497   | ( 0.6077)<br>1.6205 | (0.7422)  | ( 0.0008)*<br>-0.8237 | -         | I(1)     |
| <b>GDPcY</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>    | (0.9322)<br>-2.7845  | (0.9787)<br>-0.8624 | (0.3169)  | (0.0012)*<br>-2.1850  | -         | I(1)     |
| <b>BM2</b><br>T <sup>d</sup><br>C <sup>e</sup>          | (0.0010)*<br>-2.6180 | -                   | -         | -                     | -         | I(0)     |

Notes:

<sup>a</sup> : The Phillips-Perron test tests the null versus the alternative hypothesis as in (3.41) & (3.41);

\*, \*\*, \*\*\* :  $H_0$  in (3.40) is rejected at 1 %, 5 % & 10 % significance level, respectively; values in () are the p-values while others are the t-statistics; Probability based on MacKinnon (1996);

<sup>b</sup> : Yemen's gross domestic product "Gdpy", Yemen's inflation rate "Inflry", Yemen's exchange rate "Exchry", Yemen's unemployment rate "Unemplry", GDP per capita "GDPcY, money supply" BM2";

<sup>d</sup> : Trend (T) significance, trend is significant when t-stats > critical values of Mackinnon (1996) in appendix (5.2);

<sup>e</sup> : constant (C) significance, constant is significant when t-stats > critical values of Mackinnon (1996) in appendix (5.2);

(-) : proceed no further with other deterministic as "stationarity " is already achieved.

Source: Author's construct based on EViews results

Following the unit roots procedure steps earlier, the results of the PP test are shown in Table 4.1 above. Firstly, the results concerning the significance of trend (T) term indicated that trend found to be significant for all variables making the consideration of testing for variable stationarity under trend and intercept form as in (4.39) prioritized. This is because the t-statistics of trend in level as well as in 1st difference for all variables appeared to be greater than the critical values of Mackinnon (1996) provided in the Appendix 5.2 . To this end, the overall results of stationarity with trend and intercept indicated the absence of stationarity in level for all variables (Gdpy, Inflry, Exchry, SoOP, GDPcY) except for (BM2) which was found to be stationary. Thus, BM2 required no further test and can be concluded to have no unit root test due to the rejection of the null of 4.40 at the 1 % significance level ( $0.0010 < 0.01$ ). The remaining variables (i.e., Gdpy, Inflry, Exchry, SoOP, GDPcY) were further tested in the first difference following the same steps. All variables were found to achieve stationarity in the first difference with trend and intercept. More specifically and given the significance of the trend term, Gdpy achieved stationery in the first difference due to the null of 4.40 being rejected at the 1 % significance level given the p-value of (0.0025). Similarly, the Inflry, SoOP, and GDPcY rejected the null hypothesis at the 1 % significance level with p-values of (0.0006),(0.0008) and (0.0012), respectively. Thus, these variables are said to be stationary in the first difference with trend and intercept. As for Exchry and Unemplry variable, the stationarity was as well in the first difference with trend and intercept due to the rejection of the null hypothesis at a 5 % significance level with p-values of (0.0187) and (0.0394), respectively.

Therefore, Since the stationarity of all variables is achieved, there is no further test under “none” deterministic is required. From this, it can be concluded that all null hypotheses

of there are unit root in the first difference are rejected which indicates the absence of any I (2) variable in the model (IHSEViews., 2022).

In brief, since the trend terms were found to be significant in both level and first difference, all variables were tested for stationarity at the level with trend and intercept as suggested by the steps mentioned earlier. The null hypothesis of "a variable has unit root" failed to be rejected for all variables in the level except for one variable (i.e., BM2). This acquired further stationarity testing under the first difference for all remaining variables which successfully rejected the null hypothesis and achieved stationary at first difference with trend and intercept. For further confirmation, the stationarity was tested under "intercept", and "none" terms at level, and all variables were found to fail rejecting the null of "a variable has unit root test".

#### **4.2.2 The Augmented Dicky-Fuller (ADF) Test Results**

To double check the PP results illustrated in Table 4.1 above, another widely used traditional unit root test was checked. The results are shown in Table 4.2 below.

Similarly, to the steps of performing unit root tests such PP test, the results shown in Table 4.2 above represent the stationarity results through ADF. In general, the results were more or less similar to the results through the PP test in Table 4.1. In other words , all variables except BM2 are of first order of integration I(1). To conclude , all variables based on both tests are clearly stationary in the I (1) integration order with this study's main variables, and particularly the explanatory regressors are of I (1) integration order. Hence, from the PP and ADF overall results, it can be concluded that the conditions for applying

NARDL such as the variables to be of any order of integration whether I (0) or/and I (1), and the explanatory to be of I (1) are met.

**Table 4.2: ADF Unit Root Test Overall Results**

| Variables <sup>b</sup>                                  | ADF test <sup>a</sup> |                     |          |                       |           | Decision |
|---------------------------------------------------------|-----------------------|---------------------|----------|-----------------------|-----------|----------|
|                                                         | Level                 |                     |          | 1st difference        |           |          |
|                                                         | Trend & intercept     | Intercept           | None     | Trend & intercept     | Intercept |          |
| <b>Gdpy</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>     | (0.9286)<br>-2.4964   | (0.3787)<br>1.7759  | (0.8353) | ( 0.0038)*<br>-2.1336 | -         | I (1)    |
| <b>Inflry</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>   | (0.1855)<br>-0.0661   | (0.1727)<br>2.7897  | (0.3031) | (0.0021)*<br>1.1772   | -         | I(1)     |
| <b>Exchry</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>   | (0.6228)<br>1.4831    | (0.5861)<br>-1.3031 | (0.9875) | (0.0083)*<br>1.8478   | -         | I(1)     |
| <b>Unemplry</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup> | (0.9538)<br>-0.1068   | (0.1585)<br>2.8794  | (0.9986) | (0.0265)**<br>-2.4027 | -         | I(1)     |
| <b>SoOP</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>     | (0.6571)<br>3.0896    | (0.6588)<br>1.3313  | (0.8657) | (0.0008)*<br>-0.6138  | -         | I(1)     |
| <b>GDPcY</b><br>(T) <sup>d</sup><br>(C) <sup>e</sup>    | (0.9785)<br>-2.9042   | (0.9988)<br>-1.5118 | (0.1049) | (0.0021)*<br>-2.6172  | -         | I(1)     |
| <b>BM2</b><br>T <sup>d</sup><br>C <sup>e</sup>          | (0.0004)*<br>-2.3370  | -                   | -        | -                     | -         | I(0)     |

Notes:

<sup>a</sup> : The [ADF](#) incorporates the null versus the alternative hypothesis as in (3.35) & (3.36);

\*, \*\*, \*\*\* :  $H_0$  in (3.40) is rejected at 1 %, 5 % & 10 % significance level, respectively; values in () are the p-values according to which  $H_0$  is tested & values “not” in parentheses are the t-statistics; Probability based on MacKinnon (1996) one-sided p-values.

<sup>b</sup> : Yemen’s gross domestic product “Gdpy”, Yemen’s inflation rate “Inflry”, Yemen’s exchange rate “Exchry”, Yemen’s unemployment rate “Unemplry”, GDP per capita “GDPcY, money supply” BM2”;

<sup>d</sup> : Trend (T) significance, trend is significant when t-stats > critical values of Mackinnon (1996) in appendix (5.2);

<sup>e</sup> : constant (C) is significant when t-stats > critical values of Mackinnon (1996) in appendix (5.2);

(-) : proceed no further with other deterministic as “stationarity “ is already achieved.

Source: Author’s construct based on EViews results

Worth mentioning, while the ADF and PP tests have determined the stationarity of the data, the KPSS test was not emphasized in the main analysis because its null hypothesis

differs, focusing on stationarity rather than a unit root. Since the aim was to test for unit roots, ADF and PP were deemed sufficient. However, KPSS was also conducted for robustness, and its results reported in Appendix 4.2 were largely consistent with ADF and PP test. It was also acknowledged that incorporating the KPSS test could enhance robustness by providing complementary evidence, and this is suggested as an avenue for future research.

#### **4.2.3 Bai-Perron (BP) Breakpoints Unit Root Test Results**

There is a possibility of the presence of one or more breakpoints at different times along the variables' time series and standard unit root tests like PP test are not effective in detecting such breakpoints. Thus, this test was conducted to spot if there are any structural changes in the time series of the different variables. It was favored over other unit root tests that allow breakpoint detection as it can detect multiple breakpoints at different timings in the series.

As stated, there are three tests that can be conducted under the BP breakpoint unit root test for the purpose of detecting structural breaks in the study time series. The first test (i.e., SUB F test) is conducted when the breakpoint is known as stated in the hypothesis under it shown (3.33). Thus, the requirement of breakpoint date prior knowledge in the case of SUB F test makes it unfit to be in use when the breakpoint dates are uncertain (Bellamy and Blackstone, 2015). Therefore, this test is to be neglected for the detection of breakpoints dates in the time series of study variables. Therefore, the second BP test of double max is needed to detect the existence of breakpoints in the time series, and once it did so, the third BP test of the sequential test is required to determine the number of breakpoints dates in the series.

According to Bai and Perron (2003a) the appropriate way is detecting at least one break point in the series using double max test while the decision of how many breakpoints in the series is determined by the sequential test.

The second BP double max test hypothesized that of no breakpoints versus unknown breakpoints in the time series (3.47) and (3.48). The rejection of the null hypothesis indicates the availability of breakpoints in the time series. The results of this test are as tabled in Table 4.3.

**Table 4.3: BP Double Max Test Results**

| Variables <sup>a</sup> | BP double max test |                    | Critical values |         |
|------------------------|--------------------|--------------------|-----------------|---------|
|                        | UDMax <sup>b</sup> | WDMax <sup>c</sup> | UDMax           | WDMax   |
| Gdpy                   | (113.3728*)        | (212.1990*)        | 11.70**         | 12.81** |
| Inflry                 | (65.05967*)        | (99.26813*)        | 11.70**         | 12.81** |
| Exchry                 | (242.8269*)        | (300.1797*)        | 11.70**         | 12.81** |
| Unemplry               | (98.6558*)         | (121.5422*)        | 11.70**         | 12.81** |

Notes:

\* : Significant at the 0.05 (5 %) level;

\*\* : Bai-Perron (2003b) critical values of unweighted & weighted double max test;

<sup>a</sup>: Variables as previously prescribed in Table 4.1;

<sup>b</sup>: The unweighted double max where values in (parentheses) indicate the maximized values of scaled F-statistics for UDMax ( $H_0$  of no break is rejected as the maximized F-statics > CVs of UDMax);

<sup>c</sup>: The weighted double max where values in (parentheses) indicate the maximized values of weighted F-statistics for WDMax ( $H_0$  of no break is rejected as the maximized weighted F-statics > CVs of WDMax).

Source: Author's construct based on EViews results

The results shown in Table 4.3 of the PB of the double max test were obtained by estimating the least square equation at first followed by performing the multiple breakpoints test of BP. The estimation was done through regressing each of the dependents' variables (Gdpy, Inflry, Exchry and Unemplry) on the independent variable (SoOP) and the constant (C).

As clearly seen from Table 4.3, both unweighted double max (hereafter, UDMax), as well as the weighted double max (hereafter, WDMax) values of all variables, are significant at the 5 % significance level indicating the presence of a breakpoint in the time series of variables. Moreover, it can be seen that the maximized values of both (UDMax) and (WDMax) are greater than the critical values provided by Bai and Perron (2003b) indicating the rejection of the test null hypothesis that there are no breakpoints. Hence, the double max test ascertained the presence of unknown breakpoints in the time series. However, to determine the dates and the numbers of these unknown breakpoints, the sequential test ( $\sup F_T(L+1/L)$ ) is needed which is the best strategy as suggested by Bai and Perron (2003a).

The sequential test is used to determine the breakpoints which were found to be present in the time series of variables through the double max test. The testing of the null hypothesis of (L) breakpoints vs the alternative hypothesis of there is (L+1) breakpoints (i.e., additional breakpoints) is the main consideration of the sequential test. Thus, Following the same process of performing the double max, the sequential test was conducted, and the results are shown in the following Table 4.4.

As seen from Table 4.4, the alternative breakpoints (1 and 2) for the null breakpoints (0 and 1) for all dependents variables (i.e., GDPY, INLFRY, EXCHRY, UNEMPLRY) are significant at 5 % level with their scaled F- tests values greater than the critical values provided by pai and perron (2003b). This indicates the rejection of the null hypotheses of the breakpoints (0 ) and (1) in favor of the alternative hypotheses of the breakpoints (1) and (2) while the null of breakpoint (2) is not rejected in the favor of the alternative test (3). Hence, break dates that are corresponding to the significant alternative break tests (1 and 2)

for GDPY, INFLRY, EXCHRY and UNEMPLRY were determined. More specifically, two break dates were detected for all models of GDPY, INFLRY, EXCHRY and UNEMPLRY.

**Table 4.4: BP Sequential Test Results**

| Variables <sup>a</sup> | Break tests <sup>b</sup> | Sequential test |                    |             |
|------------------------|--------------------------|-----------------|--------------------|-------------|
|                        |                          | Scaled F-test   | Critical values ** | Break dates |
| Gdpy                   | 0 vs. 1 *                | 59.3009         | 11.47              | 1996        |
|                        | 1 vs. 2 *                | 56.3356         | 12.95              | 2016        |
|                        | 2 vs. 3                  | 6.73028         | 14.03              | -           |
| Inflry                 | 0 vs. 1 *                | 62.0153         | 11.47              | 1997        |
|                        | 1 vs. 2 *                | 23.0625         | 12.95              | 2015        |
|                        | 2 vs. 3                  | 12.2159         | 14.03              | -           |
| Exchry                 | 0 vs. 1 *                | 43.6179         | 11.47              | 1995        |
|                        | 1 vs. 2 *                | 177.728         | 12.95              | 2019        |
|                        | 2 vs. 3                  | 10.8855         | 14.03              | -           |
| Unemplry               | 0 vs. 1 *                | 40.6505         | 11.47              | 1997        |
|                        | 1 vs. 2 *                | 22.5934         | 12.95              | 2015        |
|                        | 2 vs. 3                  | 5.39523         | 14.03              | -           |

Notes:

<sup>a</sup> : Variables as previously prescribed in Table 4.1

<sup>b</sup> : The break test of  $H_0$  of L vs  $H_1$  of L+1 where for all models “0 vs. 1” means the null of “0” break is rejected in favor of “1” break and for “1 vs. 2” the null of 1 break is rejected in favor of “2” breaks both at 5 % level implies “2” breaks in the regressor of “SoOP.”

\* :Significant at the 0.05 (5 %) level.

\*\* : Bai-Perron (2003b) critical values of sequential test.

Source: Author’s construct based on EViews results

This test as the name implies detects the breaks in a sequential manner. For instance, in the break test of 0 vs. 1, the test rejected the null of the “0” break in favor of the “1” break at a 5 % significance level indicating the detection of one breakpoint. Sequentially, the break tests 1 vs. 2 means the null of "0" break is replaced with the null of "1" break, and the alternative becomes "2" breaks, and the rejection of the null of "1" in favor of the alternative "2" breaks indicates the detection of two breakpoints and so on until the null is rejected and the final number of breakpoints are determined. pertaining to this, the BP test failed to reject

the null of "2" breaks in favor of "3" breaks in the break test of 2 vs.3 concluding only two break dates were detected in all models.

The found break dates in the variables' time series are captured through adding dummy variable into NARDL model of each variable shown in (3.54) to (3.57) as ignoring them may lead to biased outcomes. As so, with the results of BP multiple breakpoint test, the first step in the process of performing NARDL is completed.

Worth mentioning that, the detected breaks shown in the table above coincide with some events. For instance, 1995, 1996, and 1997 are right after the civil war between North and South in the middle to late 1994, and which followed by several economic reforms. These reforms include, but are not limited to, the major economic reform program supported by the IMF and World Bank involving fiscal consolidation, exchange rate unification, and trade liberalization. etc. (Engers et al., 2002). 2015 reflects the escalation of the political unrest that started late 2014. 2016 and 2019 are the escalation of conflict results, which led to institutional fragmentation, including the relocation of the central bank to another city out of rebel control.

Surprisingly, there was no breakpoint detected in the variables during the COVID-19 period. Such absence of a breakpoint relevant to such an event is most likely because the economy has been in a prolonged state of structural deterioration before the pandemic, due to the prolonged political instability and economic collapse, causing it to operate in a persistent crisis regime. Hence, this pre-existing collapse due to prolonged instability meant that new shock related to the COVID-19 event did not cause a new structural break, but rather a continuation and intensification of ongoing economic distress. Such a phenomenon, where a new structural change effect may be absorbed by an existing dominant impact, is

not unique to the case of Yemen. For instance, and as noted in the IMF (2004) Staff Report on Chile, structural break tests may not detect a new breakpoint when recent economic fluctuations are relatively mild compared to ongoing or past shocks. Thus, such insight supports the claim that Yemen's pre-existing crisis was so profound, causing the following shock, such as COVID-19, to be taken as a continuation of negative trends in the economy, but not a standalone breakpoint.

### **4.3 Cointegration Analysis Results**

Checking for the availability of cointegration (i.e., the long form association) between explained variables and explanatory ones in the study model is the second step in the process of conducting NARDL. As stated earlier, this study considers beside the common and widely used tests of cointegration (i.e., joint F-test), the bootstrap NARDL test (BNARDL test) in the non-linear form to genuinely decide on the cointegration among variables. However, the selection of optimal lag structure is vital prior to cointegration test.

Out of many criteria of the optimal lag length such as Akaike's information criterion (AIC), Schwarz information criterion (SIC), Hannan-Quinn criterion (HQC), etc. The Akaike's information criterion (AIC) is set for the selection of lag length of study's model variable. The AIC criterion performs better in the case of small sample studies (<60 observations) and is recommended for the lag length selection of autoregressive models (Liew, 2004) and (Asghar and Abid, 2007). Different lag length can be selected for study variables considering the fact that there is no unputdownable evidence from an economic theory stating that the lag length has to be the same for all variables under investigation

(Ozcicek and McMillin, 1999). The results of optimal lag selections (Appendix 5.1) have finalized the appropriate lag length for each model as summarized in the Table below.

**Table 4.5: Optimal Lag Selection**

| <b>Variable<sup>a</sup></b> | <b>Number of lags selected <sup>b</sup></b> |
|-----------------------------|---------------------------------------------|
| <b>Gdpy</b>                 | 2                                           |
| <b>Inflry</b>               | 1                                           |
| <b>Exchry</b>               | 2                                           |
| <b>Unemplry</b>             | 1                                           |

Notes:

<sup>a</sup>: As previously prescribed in Table 4.1;

<sup>b</sup>: selection based on The Akaike's information criterion (AIC).

Source: Author's construct based on EViews results

Worth mentioning, the issue of serial correlation is to be considered where the selected lag length may be changed accordingly (Pesaran et al., 2001). So as the optimal lags of all variables have been determined, the test of cointegration is inevitably important to empirically ensure the variables of the suggested model exhibit some sort of association in the long run. The results of both tests as well as the summary of corresponding critical values to be compared with are illustrated in Table 4.6.

Table 4.6 shows the results of cointegration through the two proposed tests, namely the Joint F-test and the BNARDL test. As stated earlier, the use of BNARDL is to genuinely augment the results of the joint F-test and to account for any hidden issue in the unit root test regarding the assumption that all explained variables need to be of first order only as this test ignores such an assumption.

**Table 4.6: Summary of Cointegration Tests' Results**

| <b>Cointegration tests</b>       |                                 |                     |                     |                                |                     |                     |
|----------------------------------|---------------------------------|---------------------|---------------------|--------------------------------|---------------------|---------------------|
| <b>Variables<sup>a</sup></b>     | <b>Joint F-test<sup>b</sup></b> |                     |                     | <b>BNARDL-test<sup>c</sup></b> |                     |                     |
| <b>Gdpy</b>                      | 6.6952                          |                     |                     | 7.4230                         |                     |                     |
| <b>Inflry</b>                    | 30.0310                         |                     |                     | 27.0468                        |                     |                     |
| <b>Exchry</b>                    | 7.7162                          |                     |                     | 8.4681                         |                     |                     |
| <b>Unemplry</b>                  | 3.6869                          |                     |                     | 4.1264                         |                     |                     |
| <b>Significance level</b>        | 10 %                            |                     | 5 %                 |                                | 1 %                 |                     |
| <b>CVLB and CVUB<sup>d</sup></b> | <b><i>I</i> (0)</b>             | <b><i>I</i> (1)</b> | <b><i>I</i> (0)</b> | <b><i>I</i> (1)</b>            | <b><i>I</i> (0)</b> | <b><i>I</i> (1)</b> |
| <b>Joint F-test *</b>            | 2.75                            | 3.99                | 3.35                | 4.77                           | 4.76                | 6.67                |
| <b>BNARDL test **</b>            | 2.22                            | 3.84                | 2.80                | 4.70                           | 4.15                | 6.83                |

Notes:

<sup>a</sup>: Variables as previously prescribed in Table 4.1

<sup>b</sup>: cointegration is confirmed through F-bound test (joint F-test) as the null in 3.51 is rejected given upper bound(CVUB) and lower bound (CVLB) critical values of Nayaran (2004) in either 1 %, 5 % or 10 % significance level;

<sup>c</sup>: robust cointegration is confirmed through Bootstrap NARDL (BNARDL) as the null in 3.53 is rejected given upper bound(CVUB) and lower bound (CVLB) critical values of Sam et al. (2018) in either 1 %, 5 % or 10 % significance level;

<sup>d</sup>: Lower bound critical values, *I* (0) and Upper bound critical values, *I* (1);

\*: Critical values taken from Nayaran (2004) >> [case 3, N=30, K=4 ] as in appendix (4.2);

\*\*: Critical values taken from Sam et al. (2018)>> [case 3, N=30, K=4] as in appendix (4.3);

Source: Author's construct based on results of EViews.

As for the joint F-test related results, in general, the results of all models suggested the rejection of the null hypothesis in 3.51 confirming the existence of cointegration between the “explained variables” namely Gdpy, Inflry, Exchry and Unemplry and the “explanatory variable” of SoOP. More specifically, the F-test value for the Gdpy-model (6.6952) is above the upper bound critical values (6.67, 4.77 and 3.99) at 1 %, 5 % and 10 % significance level, respectively. This result confirmed the presence of cointegration according to conditions of cointegration in comparison with critical values of Nayaran (2004) summarized in Table 4.3. Similar to Gdpy-model, the Exchry and Inflry models with F-test values of (30.0310) and (7.7162) appear to be greater than the upper bound critical values (6.67, 4.77 and 3.99) at all significance levels. These result as well indicate the presence of cointegration between both Exchry and Inflry and SoOP. Lastly, the Unemplry-model with its joint F-test value of (3.69) indicates to a weak cointegration with SoOP at the 10 % significance level. Hence, based on

the results of the joint F-test, the cointegration is confirmed yet not robust due to the reasons mentioned earlier. To this end, BNARDL is conducted as well for cointegration's robustness.

As for the BNARDL test, in general, and similarly to the previous test, the results of all models suggested the rejection of the null hypothesis in 3.53 indicating the presence of cointegration between the “explained variables” namely Gdpy, Inflry, Exchry, and Unemplry, and the “explanatory variable” of SoOP. Given the conditions of cointegration summarized in Table 3.4 taking into consideration the critical values of Samet al. (2018) that are provided in full in Appendix 4.4, it can be said all models have met the condition for a robust cointegration. More specifically, the BNARDL value of (7.4230) exceeds the upper bound critical values of (6.83) at the 1 % level , (4.70) at the 5 % level and (3.84) at the 10 % level. According to this result, the cointegration between Gdpy and SoOP is robust. For Inflry and Exchry models, BNARDL values of (27.0468) and (8.4681) exceeded the upper bound critical values of (6.83), (4.70), and (3.84) at 1 %, 5 %, and 10 % significance levels, respectively. These results also implied a robust cointegration among variables in these models. lastly, for the Unemplry-model, the rejection of the null was found only at the 10 % significance level at where BNARDL value of (4.1264) exceeded the upper critical value of (3.84). Thus, for this model, an augmented cointegration among variables is evidenced as well.

The cointegration results of this study align with established literature across multiple economies of different categories, including but not limited to Bass (2019) on Russian GDP, Lacheheb and Sirag (2019) on Algerian inflation, Suliman and Abid (2020) on Saudi Arabia’s exchange rate, and Kocaarslan et al.(2020) on unemployment. These similarities arise from the common fact shared by these economies, as well as other

economies to be mentioned in a later chapter, which is the high dependency on oil, in addition to the limited diversification of external revenues in the case of Yemen. Such a high reliance leads to unavoidable exposure to external shocks, which drives such a consistent long-run association.

To conclude, referring to the possible outcomes summarized in Table 3.5 of conducting both tests together to genuinely detect the cointegration among variables, the fourth outcome (i.e., robust cointegration exists) was dominant for all models.

#### **4.4 The Asymmetric Response Analysis Results**

The third step in performing NARDL is to detect the asymmetry in both short as well as long run and this is the main objective of this study. Differently from the previous two analyses where NARDL was considered in its normal form, NARDL-ECM or error correction model of NARDL is to be considered for the purpose of detecting the asymmetries in the short run through Wald test.

Equations (3.19) to (3.22) represent the NARDL-ECM of all variables' models and Wald-test suggested by Shin et al. (2014) is used to detect the asymmetric response in these models. The Wald test according to Shin et al. (2014) entails the p-values of the  $X^2$  statistic distributions to be less than a predetermined significance level for the rejection of the null hypotheses of no asymmetry in the long term ( $a_2^+ = a_2^-$ ) and in the short term ( $\vartheta_i^+ = \vartheta_i^- = 0$ ). The results of NARDL-ECM and Wald-test for all models are illustrated in the following subsections with each model results tabulated and elaborated

#### 4.4.1 GDPY-SoOP Asymmetric Response Analysis

Here is the NARDL analysis related to the Gdpy- SoOP model where the Asymmetric response of Gdpy to both positive-negative shocks of oil price is tested in both short-long runs. Table 4.7 showed the results obtained.

**Table 4.7: Asymmetry Response Test for GDPY-SoOP Model**

| <b>Output A: NARDL-ECM</b>                                        |                                     |              |                                   |                     |              |
|-------------------------------------------------------------------|-------------------------------------|--------------|-----------------------------------|---------------------|--------------|
| <b>Variables</b>                                                  | <b>Coefficients</b>                 | <b>Prob.</b> | <b>Variables</b>                  | <b>Coefficients</b> | <b>Prob.</b> |
| <b>Long run (LR)<sup>a</sup></b>                                  |                                     |              | <b>Short run (SR)<sup>b</sup></b> |                     |              |
| INGDPY (-1)                                                       | -0.6528                             | 0.0010*      | D(INSOOP_POS)                     | 0.2777              | 0.7142       |
| INSOOP_POS (-1)                                                   | 0.2433                              | 0.0015*      | D(INSOOP_NEG)                     | 0.0299              | 0.0000*      |
| INSOOP_NEG(-1)                                                    | 0.4919                              | 0.0006*      | D(INSOOP_NEG(-1))                 | 0.4024              | 0.0180*      |
| DUM1_GDPY(-1)                                                     | 0.2222                              | 0.0018*      | D(DUM1_GDPY)                      | -0.2690             | *            |
| DUM2_GDPY(-1)                                                     | 0.0286                              | 0.7622       | D(DUM1_GDPY(-1))                  | 0.0709              | 0.3265       |
|                                                                   |                                     |              | D(DUM2_GDPY)                      | -0.1599             | 0.0188*      |
|                                                                   |                                     |              |                                   |                     | *            |
|                                                                   |                                     |              |                                   |                     | 0.2570       |
| <b>Output B: Long run (level equation) <sup>c</sup></b>           |                                     |              |                                   |                     |              |
| INSOOP_POS                                                        | 0.3728                              | 0.0000*      |                                   |                     |              |
| INSOOP_NEG                                                        | 0.7535                              | 0.0004*      |                                   |                     |              |
| DUM1_GDPY                                                         | 0.3403                              | 0.0003*      |                                   |                     |              |
| DUM2_GDPY                                                         | 0.0438                              | 0.7716       |                                   |                     |              |
| <b>Output C: Wald test (asymmetric response test)<sup>d</sup></b> |                                     |              |                                   |                     |              |
| <b>Wald-test</b>                                                  | <b>Coefficients(ch<sup>2</sup>)</b> | <b>Prob.</b> | <b>Decision</b>                   |                     |              |
| W <sub>SLT</sub>                                                  | 19.4754                             | 0.0000*      | Asymmetric                        |                     |              |
| W <sub>SST</sub>                                                  | 37.7398                             | 0.0000*      | Asymmetric                        |                     |              |

Notes:

<sup>a</sup>: The dependent variable(GDPY) and the regressors of “positive shocks of oil prices (SOOP\_POS) and negative shocks (SOOP\_NEG) in logarithms(IN);

<sup>b</sup>: The variables in difference (D) of their logarithms;

<sup>c</sup>: The results of LR coefficients in output C are computed as in (3.17) and (3.18);

<sup>d</sup>: Wald test for the Asymmetric short-term response (W<sub>SST</sub>) tests the null of 3.55 ((H<sub>0</sub>=no asymmetric response in the SR) and Wald test for the Asymmetric long-term response (W<sub>LSL</sub>) tests the null of 3.57 (H<sub>0</sub>=no asymmetric response in the LR);

\*, \*\*, \*\*\* : 1 %, 5 % & 10 % significance level, respectively;

(-1): Denotes the variable at its past period while the dummy variables are denoted by dum1 & dum2; Prob. is the probability “p-values”.

Source: Author’s construct based on results of EViews.

According to the results presented in Table 4.7 above, output (A) represents the results of the asymmetric error correction model containing both long-short runs coefficients

in different periods. The impact asymmetry is to be detected through this output. Considering the long-run effect, both positive and negative SoOP seem to positively and significantly affect the GDPY with negative ones taking the lead with (0.492) versus (0.243) for positive ones. The structural break that happened in the year 1996 also had some positive effect in the past period to the break on the LR but negative effect on the SR while the 2016 break imposed no effect at all and the effect solely comes from the positive and negative oil price shocks. As for the other part of the output which concerns the short-run effect, it has been noticeable that the significant negative effect on the GDPY in the past period (-0.281) has turned to positive and significant impact on the current period (0.388) in response to the negative SoOP only while there is no sign for any effect in response to positive SoOP.

The output(B) represents the long-run asymmetric coefficients at level which are the results of dividing long-run coefficients in output (A) on the coefficient of the lagged DV. In other words, this output detects the “reaction” asymmetry associated with LR parameters as stated earlier. GDPY increases by 0.37 % in response to one unit of increase in the (positive SoOP) and decreases by about 0.75 % in response to one unit of decrease in the (negative SoOP). Thus, it can be said that GDP reacts positively to both positive and negative SoOP(given the positive sign of both LR coefficients). However, the magnitude of these impacts whether asymmetric or symmetric is found through the Wald test (output C).

The output (C) provided the results of the Wald test which detects the short-long run asymmetries in the model by determining whether the difference between the coefficients of Positive SoOP and negative SoOP is statistically significant or not. Thus, when found to be significant, the response of GDPY to both shocks are said to be asymmetric. Hence, the results of the Wald test in both long- -term ( $W_{SLT}$ , 0.000) and short-term ( $W_{SST}$ ,

0.0000) suggested asymmetries as both are statistically significant at 1 % level implying the rejection of the ( $H_0$ ) stating “no asymmetric response in the long-short terms).

The results aligned with those of Lard and Mignon (2008) and Alsamara et al. (2017) on the Saudi economy. In terms of asymmetry. However, the magnitude of positive shocks was found to be greater than that of negative ones, which is the opposite of what was observed in Yemen, where negative shocks are more pronounced. This is not surprising as Yemen, in terms of export, is not comparable to Saudi for instance, which would make a greater return out of positive shocks. However, with conflict still going on either internally or in the region, the results might be altered in the future. More to be discussed in a later chapter.

#### **4.4.2 INFLRY-SoOP Asymmetric Response Analysis**

In similar way to pervious model, the NARDL analysis related to Inflry- SoOP model is performed to test the Asymmetric response of Gdpy to both positive-negative shocks of oil price in both short-long runs. Table 4.8 summarizes the results of this test.

Table 4.8 shows the results for inflation rate of Yemen response and relationship to and with SoOP in their negative and positive form. Referring to Output (A) with Consideration of the long-run effect, both negative and positive long-run SoOP whether in current or past periods indicate an absence of any significant effect which means both structural breaks happened along the period has changed the way Inflry has been impacted by these shocks. This is clearly seen from the insignificant p-values for both shocks (0.5939 and 0.5007) in comparison to those of the structural changes represented by dummies (dum1\_inflry and dum2\_inflry). On the contrary, the negative SoOP with a coefficient value

of (1.6933) is significantly ( $0.0039 < 1\%$ ) and positively and intermediately affect the Infly in the short run. The intermediate effect indicates the absence of any lagged effect in the previous period.

**Table 4.8: Asymmetry Response Test Results for INFLRY-SoOP Model**

| <b>Output A: NARDL-ECM</b>                                        |                                     |              |                                   |                     |              |
|-------------------------------------------------------------------|-------------------------------------|--------------|-----------------------------------|---------------------|--------------|
| <b>Variables</b>                                                  | <b>Coefficients</b>                 | <b>Prob.</b> | <b>Variables</b>                  | <b>Coefficients</b> | <b>Prob.</b> |
| <b>Long run (LR)<sup>a</sup></b>                                  |                                     |              | <b>Short run (SR)<sup>b</sup></b> |                     |              |
| ININFLRY(-1)                                                      | -1.4998                             | 0.0000*      | D(INSOOP_NEG)                     | 1.6933              | 0.0039*      |
| INSOOP_POS                                                        | 0.0863                              | 0.5939       | INBM2                             | -0.0172             | 0.7266       |
| INSOOP_NEG(-1)                                                    | 0.2899                              | 0.5007       |                                   |                     |              |
| DUM1_INFLRY                                                       | -2.5901                             | 0.0000*      |                                   |                     |              |
| DUM2_INFLRY                                                       | 1.5207                              | 0.0008*      |                                   |                     |              |
| <b>Output B: Long run (level equation) <sup>c</sup></b>           |                                     |              |                                   |                     |              |
| INSOOP_POS                                                        | 0.0575                              | 0.5950       |                                   |                     |              |
| INSOOP_NEG                                                        | 0.1932                              | 0.5010       |                                   |                     |              |
| DUM1_INFLRY                                                       | -1.7268                             | 0.0000*      |                                   |                     |              |
| DUM2_INFLRY                                                       | 1.0139                              | 0.0005*      |                                   |                     |              |
| <b>Output C: Wald test (asymmetric response test)<sup>d</sup></b> |                                     |              |                                   |                     |              |
| <b>Wald-test</b>                                                  | <b>Coefficients(ch<sup>2</sup>)</b> | <b>Prob.</b> | <b>Decision</b>                   |                     |              |
| W <sub>SLT</sub>                                                  | 0.3632                              | 0.5467       | Non-Asymmetric                    |                     |              |
| W <sub>SST</sub>                                                  | 10.5839                             | 0.0011*      | Asymmetric                        |                     |              |

Notes:

<sup>a</sup> : The dependent variable(INFLRY) and the regressors of “positive shocks of oil prices (SOOP\_POS) and negative shocks (SOOP\_NEG) in logarithms(IN);

<sup>b</sup> : The variables in difference (D) of their logarithms;

<sup>c</sup> : The results of LR coefficients in output C are computed as ( 3.17) and (3.18);

<sup>d</sup> : Wald test for the Asymmetric short-term response (W<sub>SST</sub>) tests the null of 3.55 ((H<sub>0</sub>=no asymmetric response in the SR) and Wald test for the Asymmetric long-term response (W<sub>SLT</sub>) tests the null of 3.57 (H<sub>0</sub>=no asymmetric response in the LR);

\*, \*\*, \*\*\* : 1 %, 5 % & 10 % significance level, respectively;

(-1): Denotes the variable at its past period while the dummy variables are denoted by dum1 & dum2; Prob. is the probability “p-values”.

Source: Author’s construct based on results of EViews.

Results incorporated in the output (B) which are the coefficients of LR at level show that negative SoOP causes the Infly to decline by 0.19 % corresponding to a 1 % unit decrease as compared to a 0.1 % increase corresponding to a 1 % of a unit increase in the

positive SoOP. However, though negative SoOP seems to have the bigger effect, both effects are insignificant in the long run at a level similar to the long-run effect in past periods.

The output (C) shows the results of asymmetry test using Wald test. The results clearly indicate the absence of asymmetry in the long run ( $0.5467 > 5\%$ ) while evidencing the asymmetry in the short run only. Thus, rejecting the null hypothesis of no asymmetric response in the short term ( $0.0011 < 5\%$ ) suggests asymmetric response of INFLRY to the SoOP. Hence, the response of Inflry to the negative SoOP is asymmetric.

Recapping the overall empirical studies reviewed earlier, it would be fair to say the results were controversial. Such mixed conclusions are not of surprise due to the differences in country contexts. However, these results are in line with, but not limited to, Cunado and Gracia (2005), who found inflation responded asymmetrically to oil shocks in the short run. In the Yemen case, the existence of such an asymmetric short-term effect may have been driven by the conflict instability, higher oil reliance, and most importantly, the absence of a short-run adjustment mechanism. However, on the long run, the cumulative effects of positive and negative shocks tend to even out.

#### **4.4.3 EXCHRY-SoOP Asymmetric Response Analysis**

Here the Inflry- SoOP NARDL model is conducted to test whether Inflry responds asymmetrically to SoOP or not in both short run and long run . summary of main results is tabulated below in Table 4.9.

**Table 4.9: Asymmetry Response Test Results for EXCHRY-SoOP Model**

| Output A: NARDL-ECM                                                                                                                                                                                                                                                                                               |                                |          |                             |              |           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------|-----------------------------|--------------|-----------|
| Variables                                                                                                                                                                                                                                                                                                         | Coefficients                   | Prob.    | Variables                   | Coefficients | Prob.     |
| Long run (LR) <sup>a</sup>                                                                                                                                                                                                                                                                                        |                                |          | Short run (SR) <sup>b</sup> |              |           |
| INEXCHRY(-1)                                                                                                                                                                                                                                                                                                      | -0.3625                        | 0.0337** | D(INEXCHRY(-1)              | -0.1265      | 0.2044    |
| INSOOP_POS(-1)                                                                                                                                                                                                                                                                                                    | 0.0739                         | 0.1295   | D(INSOOP_POS)               | -0.0838      | 0.5383    |
| INSOOP_NEG(-1)                                                                                                                                                                                                                                                                                                    | 0.0946                         | 0.2449   | D(INSOOP_POS(-1)            | 0.1946       | 0.1380    |
| DUM1_EXCHRY(-1)                                                                                                                                                                                                                                                                                                   | 0.9956                         | 0.0182** | D(INSOOP_NEG)               | -0.1310      | 0.2770    |
| DUM2_EXCHRY(-1)                                                                                                                                                                                                                                                                                                   | 0.8248                         | 0.0004*  | D(INSOOP_NEG(-1)            | -0.4053      | 0.0059*   |
|                                                                                                                                                                                                                                                                                                                   |                                |          | D(DUM1_EXCHRY)              | 1.6234       | 0.0000*   |
|                                                                                                                                                                                                                                                                                                                   |                                |          | D(DUM1_EXCHRY(-1)           | 0.6422       | 0.0097*   |
|                                                                                                                                                                                                                                                                                                                   |                                |          | D(DUM2_EXCHRY)              | 1.0538       | 0.0000*   |
|                                                                                                                                                                                                                                                                                                                   |                                |          | D(DUM2_EXCHRY(-1)           | -0.2404      | 0.0855*** |
| Output B: Long run (level equation) <sup>c</sup>                                                                                                                                                                                                                                                                  |                                |          |                             |              |           |
| INSOOP_POS                                                                                                                                                                                                                                                                                                        | 0.2039                         | 0.0565** |                             |              |           |
| INSOOP_NEG                                                                                                                                                                                                                                                                                                        | 0.2611                         | 0.4167   |                             |              |           |
| DUM1_EXCHRY                                                                                                                                                                                                                                                                                                       | 2.7464                         | 0.0000*  |                             |              |           |
| DUM2_EXCHRY                                                                                                                                                                                                                                                                                                       | 2.2754                         | 0.0012*  |                             |              |           |
| Output C: Wald test (asymmetric response test) <sup>d</sup>                                                                                                                                                                                                                                                       |                                |          |                             |              |           |
| Wald-test                                                                                                                                                                                                                                                                                                         | Coefficients(ch <sup>2</sup> ) | Prob.    | Decision                    |              |           |
| W <sub>SLT</sub>                                                                                                                                                                                                                                                                                                  | 6.5275                         | 0.0382** | Asymmetric                  |              |           |
| W <sub>SST</sub>                                                                                                                                                                                                                                                                                                  | 7.1574                         | 0.0075*  | Asymmetric                  |              |           |
| Notes:                                                                                                                                                                                                                                                                                                            |                                |          |                             |              |           |
| <sup>a</sup> : The dependent variable(EXCHRY) and the regressors of “positive shocks of oil prices (SOOP_POS) and negative shocks (SOOP_NEG) in logarithms (IN);                                                                                                                                                  |                                |          |                             |              |           |
| <sup>b</sup> : The variables in difference (D) of their logarithms;                                                                                                                                                                                                                                               |                                |          |                             |              |           |
| <sup>c</sup> : The results of LR coefficients in output C are computed as (3.17) and (3.18);                                                                                                                                                                                                                      |                                |          |                             |              |           |
| <sup>d</sup> : Wald test for the Asymmetric short-term response (W <sub>SST</sub> ) tests the null of 3.55 ((H <sub>0</sub> =no asymmetric response in the SR) and Wald test for the Asymmetric long-term response (W <sub>LSL</sub> ) tests the null of 3.57 (H <sub>0</sub> =no asymmetric response in the LR); |                                |          |                             |              |           |
| *, **, *** : 1 %, 5 % & 10 % significance level, respectively;                                                                                                                                                                                                                                                    |                                |          |                             |              |           |
| (-1): Denotes the variable at its past period while the dummy variables are denoted by dum1 & dum2; Prob. is the probability “p-values”.                                                                                                                                                                          |                                |          |                             |              |           |
| Source: Author’s construct based on results of EViews.                                                                                                                                                                                                                                                            |                                |          |                             |              |           |

Source: Author’s construct based on results of EViews.

Referring to output (A) in Table above, In the long run, positive SoOP in past period positively but insignificantly ( $0.1295 > 5\%$ ) impact the exchange rate while negative SoOP in the same past period negatively and insignificantly impacted it as well ( $0.2449 > 5\%$ ). As for the short-run side, only the negative SoOP in the past period were found to be significant in 1 % level ( $0.0059 < 1\%$ ) implying the positive response of Exchry to this negative SoOP. In other words, the Exchry appreciates by about 0.40 % in response to the negative oil price shock. Results also implied to the significant role played by the structural breaks throughout the period in determining the effect of oil price shocks on the Exchry in both long-short runs.

Hence, alongside the negative oil price shock effect as stated, the significance of short- and long-run effects associated with the 2019 structural break, for instance, may reflect multiple factors, including the intensified domestic instability, and external shocks such as the COVID-19 pandemic, which disrupted global oil prices and financial flows. These disruptions likely contributed to sharp exchange rate adjustments in the post-2019 period.

Output (B), which represent the long-run only coefficients at level indicate the positive and significant impact of positive SoOP on the Exchry and the absence of this effect in the case of Negative SoOP. In other words, it is found that Exchry may appreciate by about 0.20 % in response to 1 % increase in the positive SoOP at significance level of 5 %.

The Wald test results in the outcome(C) suggest the rejection of  $H_0$  in the short run and the long run suggesting the asymmetric response of EXHCRY to both positive and negative shocks of oil. This asymmetric response is significant at the 5 % level with  $(0.0382 < 5 \%)$  in the long run and at 1 % significance level in the short run  $(0.0075 < 1 \%)$ .

Agreeing with some studies, such as Abed et al.(2016), who suggested exchange rate reacts asymmetrically to both short and long runs. Such an effect is of no surprise, taking the high oil dependency in addition to the fragile financial system, which has been worsened after the transfer of the central bank to another city.

#### **4.4.4 UNEMPLRY-SoOP Asymmetric Response Analysis**

Here is the NARDL analysis related to the Unemplry- SoOP model where the Asymmetric response of Gdpy to both positive-negative shocks of oil price is tested in both short-long runs. Table 4.10 showed the main results.

**Table 4.10:** Asymmetry Response Test Results for UNEMPLRY-SoOP Model

| <b>Output A: NARDL-ECM</b>                                        |                                     |              |                                   |                     |              |
|-------------------------------------------------------------------|-------------------------------------|--------------|-----------------------------------|---------------------|--------------|
| <b>Variables</b>                                                  | <b>Coefficients</b>                 | <b>Prob.</b> | <b>Variables</b>                  | <b>Coefficients</b> | <b>Prob.</b> |
| <b>Long run (LR)<sup>a</sup></b>                                  |                                     |              | <b>Short run (SR)<sup>b</sup></b> |                     |              |
| INUNEMPLRY(-1)                                                    | -0.3995                             | 0.0157**     | D(INSOOP_POS)                     | 0.0302              | 0.3630       |
| INSOOP_POS(-1)                                                    | -0.0102                             | 0.5674       | INGDPCY                           | 0.1313              | .0331**      |
| INSOOP_NEG                                                        | -0.0859                             | 0.0420**     |                                   |                     |              |
| DUM1_UNEMPLRY                                                     | 0.0300                              | 0.1015       |                                   |                     |              |
| DUM2_UNEMPLRY                                                     | 0.0590                              | 0.0605***    |                                   |                     |              |
| <b>Output B: long run (level equation) <sup>c</sup></b>           |                                     |              |                                   |                     |              |
| INSOOP_POS                                                        | -0.0257                             | 0.6166       |                                   |                     |              |
| INSOOP_NEG                                                        | -0.2151                             | 0.0463**     |                                   |                     |              |
| DUM1_UNEMPLRY                                                     | 0.0752                              | 0.1246       |                                   |                     |              |
| DUM2_UNEMPLRY                                                     | 0.1478                              | 0.0047*      |                                   |                     |              |
| <b>Output C: Wald test (asymmetric response test)<sup>d</sup></b> |                                     |              |                                   |                     |              |
| <b>Wald-test</b>                                                  | <b>Coefficients(ch<sup>2</sup>)</b> | <b>Prob.</b> | <b>Decision</b>                   |                     |              |
| W <sub>SLT</sub>                                                  | 4.3227                              | 0.0376**     | Asymmetric                        |                     |              |
| W <sub>SST</sub>                                                  | 0.8630                              | 0.3529       | Non- Asymmetric                   |                     |              |

Notes:

<sup>a</sup> : The dependent variable(UNEMPLRY) and the regressors of “positive shocks of oil prices (SOOP\_POS) and negative shocks (SOOP\_NEG) in logarithms (IN);

<sup>b</sup> : The variables in difference (D) of their logarithms;

<sup>c</sup> : The results of LR coefficients in output C are computed as in (3.17) and (3.18);

<sup>d</sup> : Wald test for the Asymmetric short-term response (W<sub>SST</sub>) tests the null of 3.55 ((H<sub>0</sub>=no asymmetric response in the SR) and Wald test for the Asymmetric long-term response (W<sub>LST</sub>) tests the null of 3.57 (H<sub>0</sub>=no asymmetric response in the LR);

\*, \*\*, \*\*\* : 1 %, 5 % & 10 % significance level, respectively;

(-1): Denotes the variable at its past period while the dummy variables are denoted by dum1 & dum2; Prob. is the probability “p-values”.

Source: Author’s construct based on results of EViews.

The results represented in the output (A) shown in the Table above suggested that Unemplry is affected insignificantly and negatively responding to positive SoOP in the past period where it could decline by about 0.01 % in the 10 % significance level (00.567< 5 %). differently, the negative SoOP is found to effect Unemplry positively with an increase of bout (0.09 %) in the 5 % level of significance which is a bigger effect as compared to positive SoOP. As for the short-run, only Positive SoOP effect the Unemplry but insignificantly. In addition, and Similar to Exchry, Results also implied to the significant role played by the structural breaks along the period in determine the effect of oil price shocks on the Unemplry

but only on the long run. Moreover, it has been noticed that gross domestic product per capita (GDPcY) were found to impose some significant impact on the Unemplry in the short run.

Output (B), however, implied to the % of change in the long run coefficient at level responding to both positive-negative SoOP. More specifically, in response to negative SoOP (i.e., when there is 1 % decrease in SoOP), the Unemplry significantly increase by about 0.2 % while when there is 1 % increase in SoOP, it declines by 0.02 % which is not significant at any significance level.

The test of asymmetry through Wald test as in output (C) suggested the rejection of  $H_0$  at 1 % level of significance ( $0.0376 < 5\%$ ) in the case of long run evidencing the asymmetric response of UNEMRY to SoOP. However, in the short run, there is no evidence of any short-run asymmetry between Unemplry and SoOP with insignificant p-value of 0.352. These results indicate an alignment with some other studies, including, for instance, Rahma et al. (2016), who found long-run asymmetry reaction of unemployment rate towards oil shocks, particularly negative ones. Oil-dependent countries like Yemen tend to reduce government spending on employing economic sectors, which eventually affects negatively the unemployment rate in the country.

#### **4.5 The Asymmetric Dynamic Multiplier Response**

Since the asymmetric association was checked between the DV and IV as explained above, Shin et al. (2014) suggested deriving the asymmetric response of the dynamic multiplier to keep track of how DVs are being adjusted from their initial equilibrium to a new one over time following a unit change in  $(SoOP_t^+)$  and  $(SoOP_t^-)$ . Figure 4.1 below

illustrates the CDM response of DVs (Gdpy, Inflry, Exchry and Unemply) to a unit change in  $(SoOP_t^+)$  and  $(SoOP_t^-)$ .

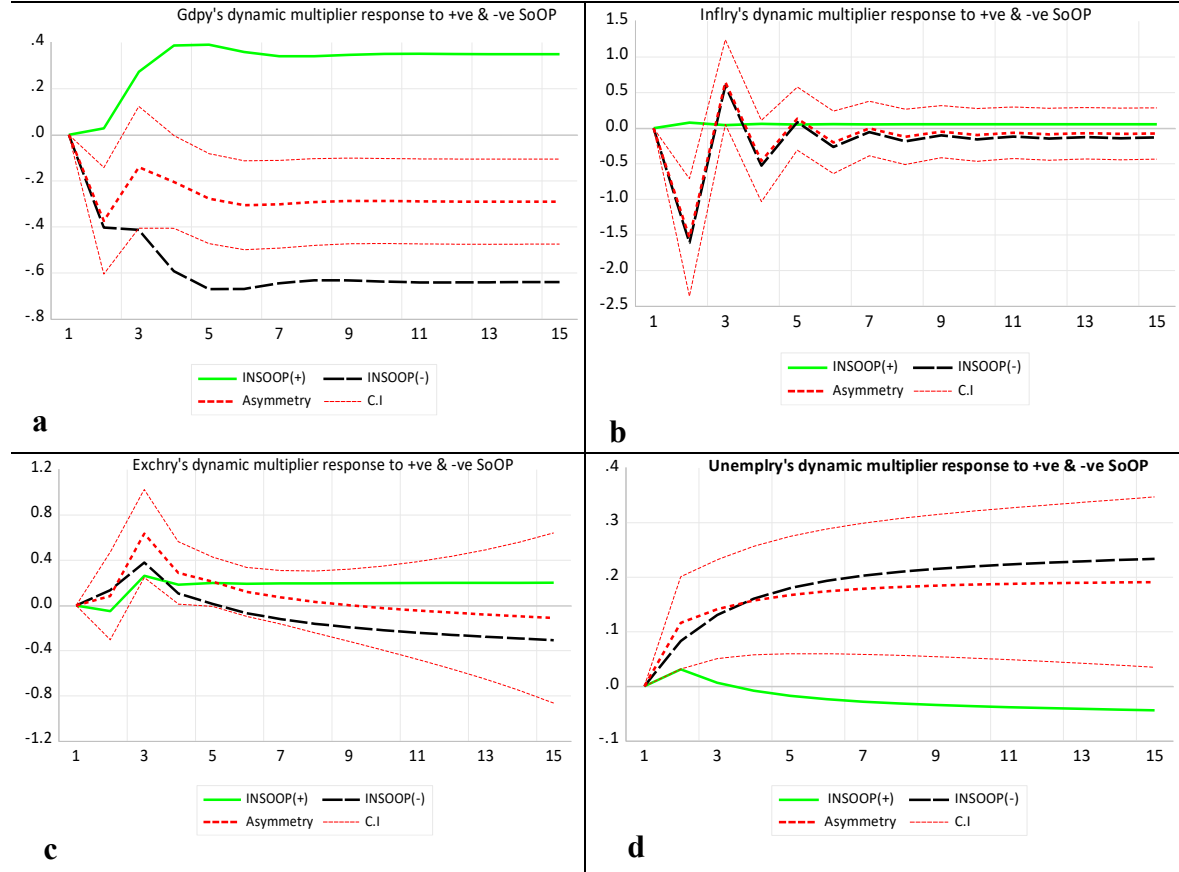


**Figure 4.1: Cumulative Dynamic Multiplier (CDM) for All Models**

Source: Author's construct based on (EViews output)

Figure 4.1 (a, b, c and d) above shows the results of the asymmetric CDM which according to Shin et al. (2014) can still detect the possible asymmetries which may be found along the path of adjustments even if there was no evidence of asymmetries in both runs were detected through modeling the ECM. Moreover, asymmetry is confirmed when the general rule stating that “upper” and “lower” boundaries of the critical intervals “C.I” do not contain any of the “zero” line within is met (Almalki et al., 2022).

For the Gdpy-model presented by Figure 4.1(a), the general observations included that the asymmetric multiplier effect graph for the model clearly depicts the presence of asymmetry in the response of Gdpy to SoOP due to the deviation of the (0) line out from within the boundaries of the upper-down bands of the critical intervals (C.I) at some point. Moreover, it is also clear that GDP responds positively to (SoOP+) and negatively to (SoOP-) with the response in long run is being more pronounced as compared to the response in the short run. However, in the long run, the magnitude of the decrease following negative shocks which is (-0.64) is greater than the magnitude of the increase following the positive shock (0.35). Hence these results are more or less similar to those found through earlier test above.

Furthermore, following the starting change in a unit of SoOP+, GDPY was slightly increased in the short term by (0.03 %) in the second period before it increased even further to reach its maximum level in the fourth period reaching (0.39 %) all the way up to the sixth period where it started stabilizing (i.e., reaches stable level) at (0.36 %) all the way up to the fifteenth period in the long run. Similarly, and responding to an initial fall down in a unit of negative SoOP, the GDPY sharply declined in the short run by (0.38 %) in the same period of increase (i.e., the second period) up to the fifth period where it started declining even further reaching its high of (0.69 %) before it adjusted to a stable level at the sixth period all the way up to the last period. Hence, it can be said that Gdpy takes approximately 5 to 6 years to reach an equilibrium state on both sides. However, the difference in the impact (red dashed line) recorded its greatest at the third period with (0.14 %) in response to the negative SoOP indicating a bigger magnitude for negative shocks in comparison to the positive ones on the Gdpy.

For the Inflry-model presented in Figure 4.1(b), evidence of asymmetry is clearly depicted by the asymmetric dynamic multiplier graph, particularly on the short-run where the (0) line diverged from within the critical intervals' upper-lower bands. In regard to the overall response of Inflry to SoOP, it showed a positive response to positive shocks and a positive response at the initial periods (i.e., 3rd period) and a negative response in the remaining periods to negative shocks with the magnitude of decrease (-0.44 %) resulting from negative SoOP was greater than the corresponding magnitude of increase (0.05 %) following positive shocks.

As for the response to one unit change in  $\text{SoOP}^+$ , Inflry rapidly started adjusting to a new equilibrium state in the second period to finally achieve a stable adjustment in the fourth period onwards which indicated that it required the Inflry up to 4 years to move into an equilibrium level in response to  $\text{SoOP}^+$ . On the contrary, in response to a unit change in negative SoOP, it took the Inflry up to 8-9 years in the process of transferring into an equilibrium level. before these periods, the Inflry suffered from swinging up and down marking its highest decrease (-1.61 %) in the initial period (i.e., second year) before bouncing up to 0.60 % two years after. However, the difference in the impact (red dashed line) was stronger in response to negative SoOP with (-1.54) compared to (0.60) responding to positive ones. The results of this dynamic multiplier are also more or less in line with pervious results stated earlier.

As for the general observations that can be drawn from the Exchry-model presented in Figure 4.1(c), the upper-lower bands of the critical intervals (C.I) don't contain the (0) line at some point indicating the asymmetric behavior of Exchry towards SoOP. In addition, the Inflry seems to respond positively in response to positive SoOP except in the initial

period (i.e., 2nd period) where it showed some weak negative response while responding positively to negative SoOP in the initial stages or short-run and negatively to negative SoOP on the long run. However, the difference in the impact represented in the graph by the dashed red line appears to be at its greatest level 2-3 years post its occurrence indicating that Exchry appreciates responding to both shocks but with the negative ones being stronger in the magnitude than positive shocks.

Furthermore, following the starting change in a unit of positive SoOP, Exchry recorded its highest in the third period with (0.26 %) before it finally started stabilizing into an equilibrium state in the fourth period. This means it takes 4-5 years for the Exchry to be adjusted to an equilibrium level in response to positive SoOP. On the contrary, since its highest of (0.38 %) in the third period as well, it continued declining along the remaining period until it was finally stabilized in the fourteenth period. This means, Exchry needed about 14 to 15 years to be in an equilibrium state in response to negative shocks.

Referring to Figure 4.1(d) which shows the Unemplry-model asymmetric multiplier graph, the asymmetry is clearly evidenced as both C. I upper-lower bands don't contain the (0) line and even in the short run there is a sign of weak asymmetry which was not detected through previous analysis. Interestingly and differently from previous variables, Here the Unemplry responds negatively to the positive SoOP except in the second period and positively to negative SoOP along all the periods. In addition, the difference in the impact (i.e., asymmetry) recorded its high with (0.19) in the tenth period before it continued stabilizing at the same level along the remaining period indicating to the stronger magnitude of negative SoOP (0.23) in comparison to positive ones (-0.04).

Furthermore, following one unit increase in positive SoOP, the Unemplry started declining from its positive response in the second period into its negative responses along the remaining periods up to the eleventh period where it started stabilizing and adjusting to an equilibrium state. Thus, it required the Unemplry 11-12 years to move into an equilibrium level. Similarly, and following the same one-unit change in negative SoOP, about 12 years for the Unemplry was taken to adjust into an equilibrium state. Results are more or less same as in previous analysis but with detecting a weak asymmetry in the short-run which is possible for dynamic multiplier to do that as claimed by Shin et al. (2014).

#### **4.6 Asymmetric Pass-Through From Exchry to SoOP Analysis**

In the previous section, the asymmetric effect to both positive and negative SoOP on EXCHRY was evidenced indicating to one-way pass-through effect. However, there is a possibility of two-way pass-through. In other words, depreciation or appreciation of Exchry might pass an effect to the prices of oil as well. NARDL-ECM was applied in similar way to the steps stated earlier to detect whether there is an effect transmitted to price of oil in the country in response to increase or decrease in the exchange rate market. Table 4.11 illustrates the results obtained.

As can be seen from the table which illustrates the results of the asymmetric pass-through from positive and negative Exchry to OP. cointegration output results of F-test (1.5753) and BNARDL-test (1.7250) evidenced the absence of cointegration as both values were found to be less than the lower-bound critical values of (6.18, 4.26, 3.43) and (5.46, 3.36, 2.53) in all significance levels (i.e., 1 %, 5 %, and 10 %), respectively. Moreover, NARDL-ECM output also indicates the absence of any significant passthrough effect that

can be transmitted from either positive or negative Exchry to SoOP either in the short run or in the long run.

**Table 4.11:** Asymmetry Passthrough Nexus Exchry-→ SoOP Results

| Output                     | Exchry-→SoOP                                                                                                                                                                                                                                                                                                                   |              |        |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------|
| Cointegration <sup>a</sup> | Joint F-test                                                                                                                                                                                                                                                                                                                   | BNARDL-test  |        |
|                            | 1.5753                                                                                                                                                                                                                                                                                                                         | 1.7250       |        |
| NARDL-ECM                  | Variables                                                                                                                                                                                                                                                                                                                      | coefficients | Prob.  |
| Long-run                   | INSOOP (-1)                                                                                                                                                                                                                                                                                                                    | -0.1737      | 0.0630 |
|                            | INEXCHRY_POS                                                                                                                                                                                                                                                                                                                   | 0.0872       | 0.1337 |
|                            | INEXCHRY_NEG                                                                                                                                                                                                                                                                                                                   | 0.0574       | 0.8863 |
| Short-run                  | -                                                                                                                                                                                                                                                                                                                              | -            | -      |
| Wald-test <sup>b</sup>     | Decision                                                                                                                                                                                                                                                                                                                       | Coefficients | Prob.  |
| W <sub>SLT</sub>           | No asymmetry                                                                                                                                                                                                                                                                                                                   | 0.0065       | 0.9353 |
| W <sub>SST</sub>           | No asymmetry                                                                                                                                                                                                                                                                                                                   | -            | -      |
| Dynamic multiplier         | <p style="text-align: center;">SoOP dynamic response to +ve &amp; -ve Exchry</p> <p style="text-align: center;"> <span style="color: green;">—</span> INEXCHRY(+)    <span style="color: black;">—</span> INEXCHRY(-)<br/> <span style="color: red;">- - -</span> Asymmetry    <span style="color: red;">. . .</span> C.I </p> |              |        |

Notes:

<sup>a</sup>: Critical values taken from Nayaran (2004) & Sam et al. (2018) >> [case 3, N=30, K=2] as in appendices (4.2) & (4.3)

<sup>b</sup>: Wald test for asymmetric passthrough response in the short-term (W<sub>SST</sub>) & the long-term (W<sub>SLT</sub>).

The number in parentheses(-1) represents the variable at its past period; Prob. is the probability “p-values”; C.I is the critical interval

Source: Author’s construct based on (EViews output).

Furthermore, Wald test results detected no asymmetric passthrough response from oil prices to either exchange rate appreciation or depreciation in both the short-long terms. The prob value of (0.9353) which is greater than the 5 % significance level failed to reject

the null hypothesis stating there is an asymmetric response from SoOP to both negative (i.e., depreciation) and positive (i.e., appreciation) exchange rate. These results were clearly confirmed through the multiplier effect graph which indicated the total absence of any asymmetric pass-through as the “zero” line lies within the boundaries of the critical intervals(C.I). Hence, the overall results found no effect can be imposed on oil prices through the appreciation or deprecation of the local currency versus the USD whereas the only pass-through effect can be passed from positive and negative SoOP to the exchange rate of the country as found earlier. Similar results were found by other studies, including but not limited to Suliman and Abid (2020), who found a unidirectional and non-causal effect runs from exchange rate to oil prices in Saudi Arabia. However, the results are opposite to those of Chen et al. (2024), who found bidirectional relations. This reflects the fact that Yemen's currency is not an oil-based currency, which does not affect oil prices.

#### **4.7 Dutch Disease Symptoms Analysis**

This analysis as stated is carried out to see whether the Yemen economy suffers from the phenomena called “Dutch disease” post the discovery of oil and being a heavily dependent oil country. The default hypothesis for DDT is that non-oil tradable sectors of an exporting oil economy are negatively reacting towards positive oil shocks and positively reacting to negative shocks. On one hand, The NARDL model results indicated the intermediary impact that could be transmitted to non-oil sectors such as manufacturing and agricultural through key economic indicators (i.e., INFLRY, EXCHRY, UNEMPLRY) responses to positive and negative oil shocks. As stated earlier, one of the symptoms of DDT is the appreciation of exchange rate responding to positive oil price shocks (i.e., oil price rise). In relation to this, the EXCHRY was found to appreciate in response to positive SoOP

on the long run which indicate implying the presence of the DD effect. Moreover, the increase in Unemployment rate is another symptom of DDT which is found to be true in the case of Yemen as the UNEMPLRY increases in response to positive SoOP in the long run.

However, these results are not sufficient to say that Yemen economy has been suffered from “DD” phenomena because these indicators along with some others might just play as a medium to transfer the impact to the non-oil sectors. for instance, spike in the unemployment rate might be the reason for employees to migrate from such sectors to the booming oil sector leading to a contraction in these sectors. Similarly, the appreciation of local currency might affect the demand for the exported goods of non-oil tradable sectors, driving them into a contraction. Thus, it is vital to examine the impact of DD on these sectors directly and with consideration of other control variables that might be another reason beside the DD symptom for the contraction of these non-oil tradable sectors. The following OLS results show the diagnosis of DD symptoms on the main non-oil tradable sectors in the country namely agricultural, service and manufacturing.

According to the results shown in Table 4.12, the regression model shows that around 70 %, 55 % and 85 % of the DVs of (DDTAGRIY, DDTMANY, and DDTSERVY) were explained by the oil price shocks (SoOP) as shown by R<sup>2</sup> values, respectively. Moreover, the IVs (i.e.) SoOP represent the natural resource of oil that the country highly tends to rely on since its discovery showed a significant effect at 1 % level for both agriculture and service sectors while having a little to no significant effect on the manufacturing sectors. The impact was bigger on the service sector followed by the agricultural sector and lastly manufacturing sector but with some little contribution to gross domestic product per capita (GDPcY) in the deterioration of dependency on these sectors.

**Table 4.12:** Dutch Disease Analysis Results

| <b>Variable <sup>a</sup></b> | <b>DDT<sub>IV</sub><sup>c</sup></b> | <b>Coefficients</b> | <b>Prob.</b> | <b>R<sup>2</sup></b> |
|------------------------------|-------------------------------------|---------------------|--------------|----------------------|
| <b>DDT<sub>AGRIY</sub></b>   |                                     |                     |              | 0.7062               |
|                              | SOOP                                | -0.1694             | 0.0000*      |                      |
|                              | BM2 <sup>b</sup>                    | 0.0825              | 0.2350       |                      |
|                              | GDPCY <sup>b</sup>                  | 0.0040              | 0.0355**     |                      |
| <b>DDT<sub>MANY</sub></b>    |                                     |                     |              | 0.5549               |
|                              | SOOP                                | -0.0101             | 0.6173       |                      |
|                              | BM2 <sup>b</sup>                    | 0.0551              | 0.3046       |                      |
|                              | GDPCY <sup>b</sup>                  | 0.0070              | 0.0000*      |                      |
| <b>DDT<sub>SERVY</sub></b>   |                                     |                     |              | 0.8519               |
|                              | SOOP                                | -0.1124             | 0.0000*      |                      |
|                              | BM2 <sup>b</sup>                    | 0.0675              | 0.1125       |                      |
|                              | GDPCY <sup>b</sup>                  | 0.0107              | 0.0000*      |                      |

Notes:

\*, \*\*, \*\*\* :level of significance at 1 %, 5 % & 10 % ;

<sup>a</sup> : Dutch disease DVs of agriculture (DDT<sub>AGRIY</sub>), manufacturing (DDT<sub>MANY</sub>), and service (DDT<sub>SERVY</sub>) sectors of Yemen, respectively;

<sup>c</sup> : Dutch disease independent variables (DDT<sub>IV</sub>);

<sup>b</sup> : Control variable .

Source: Author's construct based on EViews output.

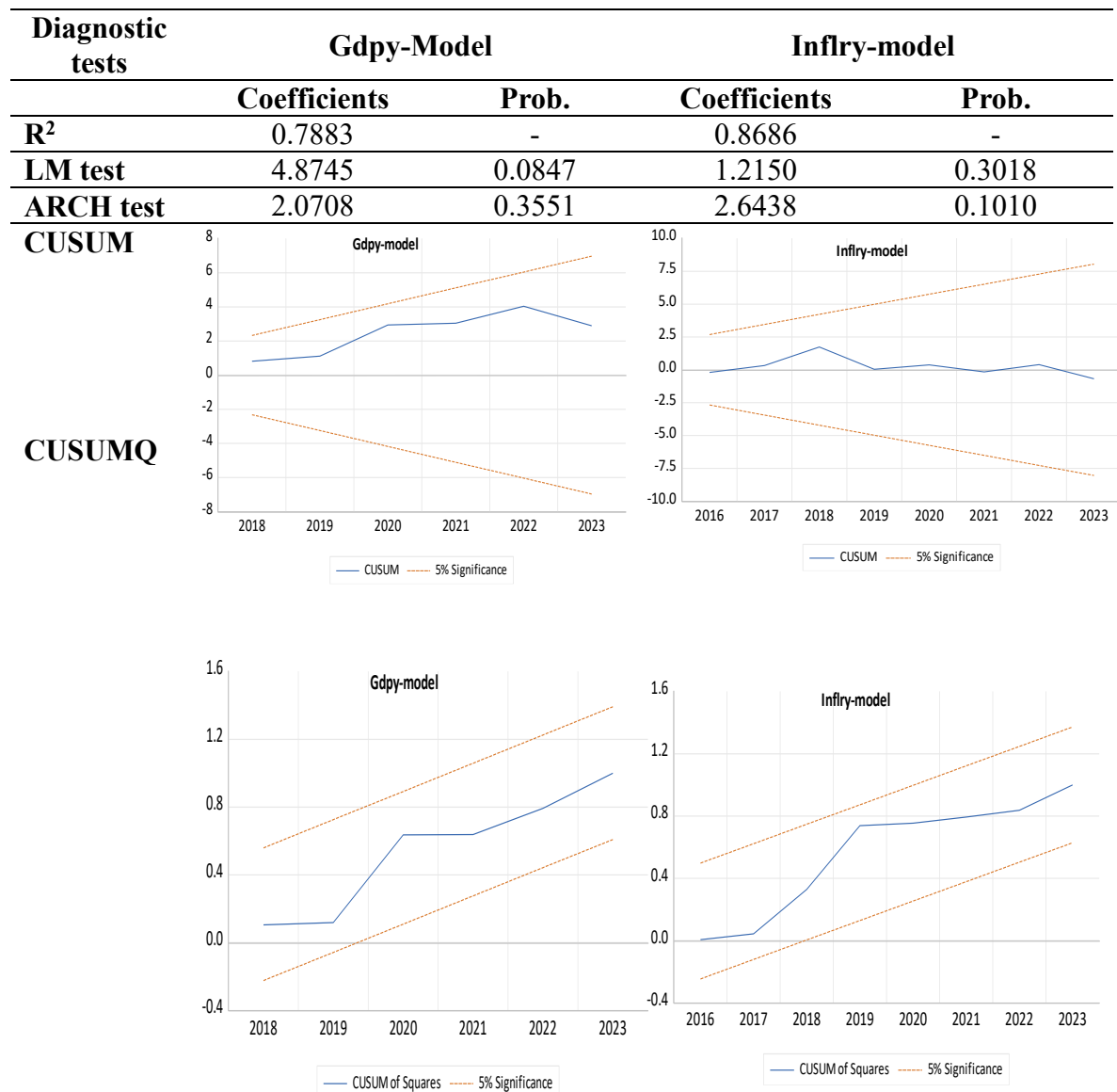
Hence, for the manufacturing sector, the contraction is less in response to SoOP with a 1 % decrease in its share of the country's GDP followed by service sector with 11 %, and lastly, agriculture with about 17 % marking the highest affected sector by the discovery of oil. These results show that the DD is responsible in one way or another for the decline of non-oil tradable sector shares in the country's economic growth.

These results confirm that Yemen's economy is vulnerable to the Dutch disease phenomenon due to its heavy reliance on oil exports. Rising oil revenues create large inflows of foreign exchange. The large inflows of foreign exchange reduce the competitiveness of Yemen's non-oil tradable sectors, including agriculture and manufacturing, which were once the main source of income of the country. The findings more or less in agreement with other studies including but not limited to Rudd (1996).

## 4.8 Misspecifications & Stability Check Results

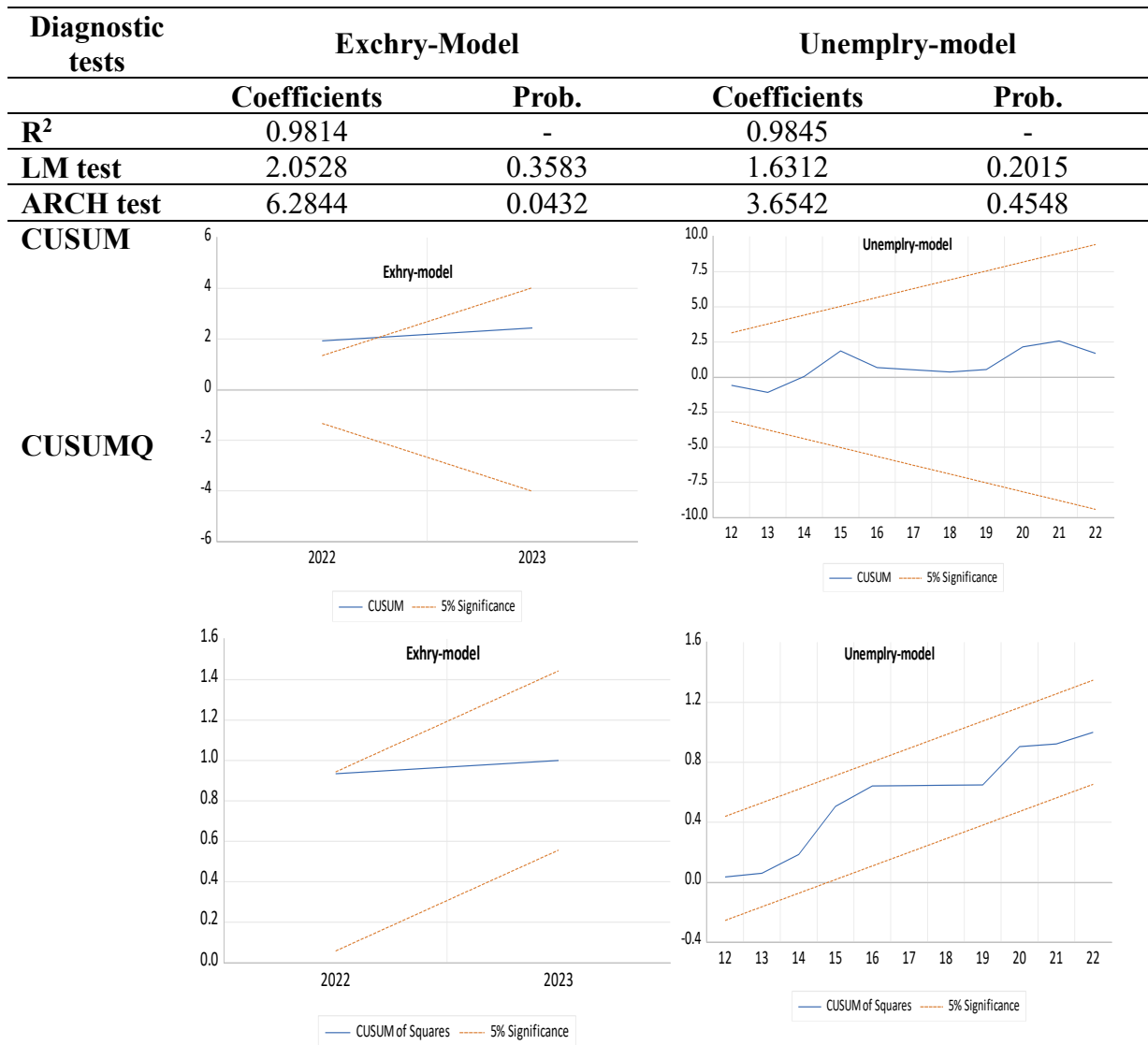
Referring to Table 4.7 shown previously, several misspecification tests (i.e., diagnostic check) were conducted to check how adequate are the models used to analyses objectives of this study. The following Table 4.13 and Table 4.14 illustrate these results.

**Table 4.13:** Diagnostic Tests Results (Gdpy-Inflry-Models)



Source: Author's construct based on EViews output.

**Table 4.14:** Diagnostic Tests Results (Exchry-Unemplry-Models)



Source: Author's construct based on EViews output.

Referring to results presented in Table 4.13 and Table 4.14 above, the goodness of fit tested by  $R^2$  shows that all models with all selected IVs fit well with 79 % for the GDPY, 87 % for the INFLRY, 98 % for the EXCHRY and 98 % for the UNEMPLRY indicating the percentage of changes being explained by the explanatory variable of SoOP. In addition, the four models are found to be autocorrelation-free as indicated by LM test results. P-values of

all variables (0.08, 0.30, 0.35 and 0.20) are greater than the significance level of 5 % suggesting the failure to reject the null hypothesis stating that there is no serial correlation at the specified lag of each model.

Similarly, for the heteroscedastic test (i.e., ARCH test), the p-values of Gdpy, Inflry and Unemply suggested the failure to reject the null hypothesis stating that there is no heteroscedasticity up to the specified lag in the 5 % level implying that the data are more of homoscedastic than heteroscedastic. However, for the Exchry-model, the p-value (0.0432) suggested the rejection of the null hypothesis of no heteroskedasticity in favor of homoscedasticity. However, according to Bessler et al. (2014) and Hayes and Cai (2007) the OLS model parameters are still valid and non-biased when the homoscedasticity condition is violated. Thus, the model can still be estimated as long as the other tests of misspecifications are appropriate.

Finally, CUSUM and CUSUMQ test plots indicate that the coefficients of all models are stable as they fall within the critical bounds of the 5 % significance. However, for Exchry-model, a Potential parameter instability is indicated by the CUSUM plot crossing the critical boundaries, which could be the result of structural changes throughout the sample period. Nonetheless, the CUSUMQ plot staying inside the boundaries shows that the residuals' variance is stable. Thus, while the model's volatility remains controlled as suggested by CUSUMQ plot, the underlying relationships between variables may have changed, reinforcing the importance of including structural break dummies to account for any break point in the series and eventually stabilizing the estimation. In brief, the study's NARDL models of all variables were found to successfully pass all tests of misspecifications and stability.

## 4.9 Conclusion

In this chapter, the proposed methods and tests elaborated in the previous chapter were empirically applied and analyzed accordingly. Through the application of NARDL, the asymmetric LR and SR relations and the impact of OP shocks in their negative as well as positive forms on the proposed models' variables were analyzed. The findings through NARDL suggested cointegration or the long-run relationship between variables and OP shocks. In general, the asymmetric response of some key macroeconomic indicators of the country towards these shocks. The magnitude impact of negative shocks was found to be greater than the positive ones as suggested by the multiplier effect results within NARDL. Furthermore, the analysis continued to explore whether there is any reverse effect that can be transmitted from the appreciation or the depreciation of exchange rate to oil price shocks in general. The results found that there are no sign of any reverse impact and the impact stayed through one way, which is from shocks of oil prices to the exchange rate. Moreover, since this study concerned oil prices shocks and as a natural resource that has been becoming since its discovery the main source of the country's export revenue, it was important to analyze if there was any relation to what is known economically by "Dutch disease" and the obtained results taking into consideration key sectors of the economy alongside the oil sector. It was suggested through the results that the economy of the country was cursed by this phenomenon to some degree, particularly in the main sectors (i.e., agriculture, services and manufacturing). Lastly, the results were diagnosed for any misspecification that could affect the credibility of the findings. The results indicated the well-specifications of the models, the freedom of models from any serial correlation and heteroscedasticity issues and were found to be well-stabled. To conclude, recalling the words of the famous statistician George Box "All models are wrong, but some are useful".

## **CHAPTER 5**

### **DISCUSSION AND CONCLUSION**

#### **5.1 Summary of Empirical Evidence**

A period spanning from 1990 to 2023, which is the period where both parts of separated Yemen have become one and the discovery of Oil took place and has been becoming a major player in the overall economy of the new united YEMEN. Thus, considering the importance of this key new player in the country's economy, this study objectives revolving around the response of major economic indicators to any negative or positive shocks in the price of oil are analyzed and investigated empirically through a time series analysis using the asymmetric ARDL method (i.e., NARDL). The analysis takes place in stages to ensure all NARDL conditions are met, and the selected method is good to adopt for analysis throughout this study. Starting from the stationary analysis stage followed by the cointegration analysis stage and ending with the asymmetric response analysis stage both in the short and long term.

As for the stationary analysis stage, the traditional Phillips-Perron (PP) test is used along with the Bai-Perron (BP) breakpoint test to account for potential structural changes in the series. The cointegration analysis is carried out using the common method of the bound test (f-test) plus the newly augmented ARDL approach in its nonlinear form (i.e., BNARDL). The Wald test is used in the stage of analyzing the short-long run asymmetric response of key economic activities to positive and negative shocks of oil prices followed by evaluating these asymmetric responses' multiplier effects. Lastly, several diagnostic tests are used including adjusted  $R^2$  to check the goodness of models, LM test and ARCH test to ensure

models are serial correlation-free and heteroskedasticity-free and CUSUM test to check the stability of models.

In addition, the same analysis is done to check the existence of a passthrough relation between shocks of oil prices and the exchange rate in the country. Furthermore, due to the heavy dependence on oil after its discovery, there was a possibility of the economy suffering from Dutch disease (DD) which acquired a diagnostic analysis for the symptoms of this phenomenon. To this end, the findings through NARDL were considered to diagnose these symptoms plus the use of the OLS method to investigate further on the presence of DD due to the effect of the positive and negative shocks in oil on the major non-oil sectors including manufacturing, service and agriculture.

## **5.2 Discussion on Findings**

Considering this study's objectives, the analysis was carried out in a way that allows for achieving them and eventually draw a conclusion and suggest suitable recommendations for the better of the country's economy.

Major findings of this study, in general, included evidence for the presence of an augmented cointegration among variables of interest as suggested by both proposed cointegration test results. moreover, it was found that key macroeconomic variables have a short and long asymmetric response to/and nexus with positive and negative oil price shocks. gross domestic product and exchange rate of the country (Gdpy and Exchry) and Exchry, for instance, were found to react asymmetrically in response to both shocks while the inflation rate (Inflry) asymmetric response to these shocks was found to be only in the short-run and for the unemployment rate (Unemplry) only in the long- run. Furthermore, it was found that

there is no asymmetric impact pass-through from the exchange rate decrease or increase to the prices of oil, and the Yemen economy, in general, suffered from the symptoms of Dutch disease post the discovery of Oil and the heavy dependence on it. The tendency of the government to rely on oil as the main source of revenue in replacement of other economic sectors such as manufacturing, agricultural, and service sectors was found to be the reason for the diagnosis of Yemen's economy with Dutch disease.

More specifically, in terms of the study's objective achievements, the first and second objectives are to investigate and examine the presence of asymmetric short-long run relationships between explained variables and explanatory variables as well as the asymmetric responses of explained ones to explanatory ones. unit-root test results were necessary to ensure that the model is suitable for testing the achievement of these objectives. Thus, the results of stationary analysis suggested the selected method is fit to use for further analysis as it was found the variables of interest are of  $I(0)$  and  $I(1)$  integration order. The significance of the variables including  $Gdpy$ ,  $Inflry$ ,  $Unemplry$  in both intercept and intercept with trend indicates the variable is exhibiting both stable mean and consistent or systemic trend in its changes over time. Such pattern of stationarity is valuable in providing meaningful insight into both the short-term dynamics and the long-term trend of the variable. However, when the significance is found in both levels and the first difference, such as  $BM2$ , it can be concluded that the stationarity is achieved in the variable original form (i.e., at level). The results are similar to studies such as Saraswat and Saraswat (2023) who concluded the stock return variable is stationary at level after exhibiting stationarity in both level and first difference. Other studies include among others Jiranyakul (2015), Malik (2016), Taşar (2017).

However, the unit root test to account for optional breakpoints in the series (i.e., Bai-Perron (BP) breakpoint test) found the presence of structural changes at different timing in all models including GDPY-SoOP, INFLRY-SoOP, EXCHRY-SoOP and UNEMPLRY-SoOP. Hence, the NARDL models considered the adding of dummies breaks (i.e., dummies variables) into each model corresponding to the year of break by assigning “0” value before and up to the break point and assigning “1” value for the remaining years from the year of change in the series.

The long-run relationship between “dependent variable” of all models with the “independent variable” was evidenced as presented in Table 5.6 through the results of cointegration using F-test and the augmented BNARDL test. These results are in line with studies that suggested cointegration between shocks of oil prices in both negative and positive forms and the GDP including but not limited to Lardic and Mignon (2008) study on the US and euro area countries, Aliyu (2009) study on Nigeria, Sidra and Qayyum (2014) study on Pakistan economy and Bass (2019) on Russian economy. Moreover, the results are also similar to these obtained regarding Inflation and oil prices shocks including but not limited to studies by Chou and Lin (2013) on Taiwan, Long and Liang (2018) on China and Lacheheb and Sirang (2019) on Algeria. In addition, the results of EXCHRY-SoOP cointegration came to same conclusion with studies including the study on the exchange rates of 18 major currencies by Jammazi et al. (2015), the study on Saudi Arabia by Suliman and Abid (2020). Similarly, this study results confirming the cointegration between exchange rate and shocks in prices of oil were also similar to studies such as Bocklet and Baek (2016), Cuestas and Gil-Alana (2018) and Kocaarslan et al. (2020).

Regarding the short-term relationships and the asymmetric short-long run response of the DVs to IVs. The response of GDPY to both negative and positive SoOP was found to be asymmetric in both short and long term with negative SoOP imposing a bigger effect in terms of magnitude as compared to positive ones. These results came to an agreement with several studies about the presence of asymmetric short-long term response to positive and negative SoOP and slight disagreement with some regarding which shock is more effective including but not limited to Lardic and Mignon (2008), Aziz and Dahalan (2015), Alsamara et al. (2017) and Niran et al. (2018). one noticeable difference is that positive shocks positively impact the GDP of most major exporters been investigated by some studies and positively but in smaller magnitude than negative ones do in the case of minor exporters. As for the effect of detected break dates, the two breaks detected in the series show that only the break in 1996 has some significant contribution on the way oil price shocks effect the GDP. The GDPY was found to be hit negatively during this period of time in the short run before it recovers slowly towards the long run. This break date falls right after the civil war between Yemen's south and Yemen's north which occurred in late 1994 and ended in 1995.

As for the asymmetric long-short response of INFLRY to SoOP, the results found and presented in Table 4.8 suggested the asymmetry in response between variables under investigation in the SR term only while suggesting no asymmetry in the LR term. However, the negative SoOP was found to be imposing bigger positive impact though not significant on INFLRY as compared to positive ones in the LR term and significant positive impact in the SR term. In other words, INFLRY responds positively (i.e., decline) to negative shocks in the short run. These results regarding the positive impact in the LR in line with studies such as Chin and Bala (2018) and in line with Cunado and Gracia (2005) regarding the asymmetry in SR and positive significant impact in the SR as well. Furthermore, INFLRY

was affected negatively by the structural change occurred in accordance with the Asian financial crises in 1997 witnessing a slight drop. This decline may be due to the fact Yemen as western Asian country was not among those countries who was hit direct and hard by the crisis such southeast Asian countries. However, the break detected in 2015 might have to do with the political unrest in the country that has contributed to the inflation rise as well.

The asymmetry in response was found in both SR and LR terms in the case of EXCHRY and negative and positive SoOP. Moreover, in the LR, local currency tends to appreciate responding to positive SoOP and to negative SoOP in the SR. However, the magnitude of negative shocks is greater in comparison to positive ones. Results are more or less in line with studies including but not limited to Kose and Baimaganbetov (2015), Abed et al. (2016), Taşar (2017) among others. Furthermore, two break dates were found to have effect on the EXCHRY alongside oil price shocks, the civil war related event in 1995 and the emergence of a parallel exchange market (i.e., black market) in 2019 due to the ongoing political unrest. two break dates were found, the civil war related in 1995 and the emergence of a parallel exchange market (i.e., black market) in 2019.

As for the UNEMLRY, it was found to asymmetrically respond to SoOP in the LR term but with no asymmetry detected in the SR. Both positive and negative SoOP were found to positively and significantly affect the unemployment rate in the LR. In the SR term, however, the response is positive but insignificant to positive shocks. The results were in line with some other studies including among others, Rahma et al. (2016), Driouchi and Hamrit (2020). Furthermore, UNEMPLRY was affected alongside the shocks in the price of oil by two break dates one in 1997 which might have to do with the slow recovery of the

civil war that ended in 1995 and the Asian financial crisis in 1997. The other one is highly related to the Arab uprising events that occurred in the country in 2011.

From the above discussed, it can be generally concluded that there is a long-short-term asymmetric association between most key indicators of Yemen's economy and the positive and negative oil price shocks with a greater magnitude mostly in response to negative shocks. Additionally, the detected structural changes have contributed in one way or another to the sharp decline/rise in the price of oil and eventually on the economic activities being investigated.

In regard to the third objective which concerns the pass-through nexus between EXCHRY and SoOP. The findings imply the absence of such a relation from EXCHRY to SoOP suggesting a unidirectional nexus from SoOP to exchange rate only. This means the OP shows no response to any changes in the exchange rate market while exchange rate does feel any shocks in the OP. These results came into agreement with the study of Suliman and Abid (2020) who found unidirectional between OP and Saudi exchange rate particularly in the short run and no causal from exchange rate to OP. Other studies include but not limited to Wang and Wu (2012), Bénassy-Quéré et al. (2007). These results confirm that the country currency is non-oil currency and if there is effect on exchange market it could be due to other factors including alongside the shocks of oil prices, the inflation and unemployment rates rise. Hence in the case of YEMEN, it can be concluded that exchange rate plays no significant role in explaining or forecasting the changes and shocks in the oil market which is similar to the overall conclusion found by Beckmann et al. (2020) through their study of reviewing the literature regarding such nexus.

The fourth objective concern the diagnosis of what is so called “Dutch disease” symptoms in the Yemen economy post the discovery of oil in the country and adapting it as the main source of revenue of the country. The results indicated that EXCHRY depreciates significantly in response to negative SoOP but significantly appreciates in response to positive shocks in the LR as well. The symptom of DD suggests an appreciation in response to positive shocks or no effect or the other way around which was found by the results implying the presence of DD effect in regard to exchange rate. Similarly, the results also suggested spike in UNEMPLRY in its reaction towards the positive SoOP which also indicate to the effect of DD.

Considering key non-oil tradable sectors which used to be key part in the revenue of the country prior to oil discovery, the DD impact was clearly noticeable according to the OLS results. Agricultural sector share to the country’s GDP declined by 17 %, service sector by around 11 % and manufacturing sector by 1 % and all in the favor of oil share to the country’s GDP. These results were found to be in line with similar studies investigated the “Dutch disease” phenomena on other countries including but not limited to Rudd (1996), Jahan-Parvar and Mohammadi, (2008) and Cheratian et al. (2019). It can be concluded that, YEMEN heavy reliant on oil as source of revenue has led the country’s economy to suffer from the effect of “Dutch disease” particularly on non-oil tradable sectors.

### **5.3 Theoretical Contribution**

This study, which focuses on Yemen, a unique case as a non-oil exporting country with a fragile economy due to several economic and political reasons, may offer several theoretical contributions to the existing and vast economic literature. It first contributes to

the limited literature on very low-income countries and those classified as least developed, thereby widening the reader's insight into how such effects unfold in these low-income economies.

Bringing the fragility of an economy into theoretical focus is another contribution of this study. Similar to empirical studies, a vast majority of theoretical literature is dominated by stable and institutionalized economies, neglecting, to some extent, unstable and fragile economies such as Yemen's economy. Such a focus on such economies may offer a perspective that is often missing in mainstream macroeconomic theory.

Revisiting Dutch disease theory is another theoretical contribution of this study. Mostly, this theory is applied to the rich and well-stabilized economies such as the Netherlands, the UK, Norway, etc. Hence, targeting the least developed countries to emphasize the need to reconsider it in today's fragile-state settings. Another key contribution is in the application of a nonlinear model such as NARDL. This application encourages the use of such a nonlinear model in the understudied and overlooked economies.

## **5.4 Policy Implication**

In the light of study's findings, some policy implications and recommendations can be suggested for consideration by the policy and decision-makers in the country.

### **5.4.1 Revenue Diversification**

One of the key takeaways from this study is that Yemen's heavy dependence on oil exports has left its economy vulnerable to constant oil shocks. As seen, whenever there is an

oil price swing, so do the key indicators, including GDP, inflation, the exchange rate, and the unemployment rate, as well as other non-oil sectors, which were once the greater source of revenues. Therefore, diversifying revenue sources is a critical priority. To this end, with vast arable land (approx. 24 million hectares), favorable weather, and labor surplus, the Agriculture with policymakers' intervention stands out as the most promising non-oil alternative. Thus, Government investment in infrastructure, training, and financing mechanisms such as loans and subsidies accessible to farmers would enhance the export potential for this sector. This would not only diversify revenue sources and boost growth but also reduce unemployment.

#### **5.4.2 Exchange Rate and Inflation Management**

Another important implication of the findings was regarding the inflationary rate and exchange rate, which were found to be negatively affected particularly by negative shocks. The current policies adopted by the government, including the expanding monetary policy and the passive or floating exchange rate regime, have proven to be ineffective in offsetting or mitigating such impact. Such policies have encouraged an exchange rate black market due to the lack of foreign currency versus the local currency as well as causing inflation to spike up even further. The government, through CBY, is advised to adopt other controlling policies over prices and exchange rate markets including tightening monetary policy. Such policy will, if applied effectively and monitored thoroughly, may reduce the inflation and keep the prices of goods and services stable. As for the exchange rate, the adopted exchange rate regime stated earlier has left the Yemeni rial exposed to oil price shocks, fueling inflation and black-market activity. Hence, a transfer to a fixed exchange rate regime - pegged to a stable currency like the USD - would, in the long run, anchor inflation,

reduce exchange rate volatility, and restore confidence in the economy. However, this requires strong policy discipline and adequate foreign reserves, but in Yemen's fragile context, a fixed regime could serve as a stabilizing bridge while better and more effective reforms take place.

#### **5.4.3 Rebuilding Yemen's Foreign Currency Flow**

The findings suggested that Yemen's currency is not an "oil currency," which means the rial doesn't strengthen even when there is an increase in oil revenue. This makes it crucial to develop other sectors that can help earn foreign currency. Increasing the export of agricultural goods and small-scale industries could reduce the trade deficit and the depreciation of the currency. Furthermore, if the political situation improves, the tourism industry could significantly contribute to foreign currency reserves. What is important now is for policymakers to create a foundation, spend in the sectors that have expansion potential and would help earning foreign currency.

#### **5.5 Limitations of The Study**

As no research without limitation, no matter how comprehensive in scope, this study is no exception. Firstly, this research is country-specific, mainly focusing on Yemen, a low-income and highly oil-dependent country associated with prolonged political instability. This focus may limit the findings of this study to be generalized to reflect the realities of other low-income or least developed countries or other oil-exporting ones. As such, the asymmetric effects observed here might not apply in countries with more stable political systems or diversified economies.

Secondly, another limitation could be the dependence of this study on secondary data. Although it was collected from reliable and recognized sources such as the IMF and the World Bank but in the case of Yemen and due to the reasons mentioned earlier(i.e., ongoing political unrest, institutional fragmentation, etc.), the possibility of gaps or inconsistencies in the time series may exist. This would eventually impact the precision of empirical results.

Thirdly, given the ongoing volatility in the country, the timeframe from 1991 to 2023 may be considered a limitation as it may overlook more recent data and shifts in economic dynamics. This would cause the relevance of long-run findings to no longer mirror the current or future realities. Additionally, the structural break tests failed to capture the impact of COVID-19, overlooking a major recent shock that has been a nightmare for most of the world's economies in recent years. However, given the long-run nature of this study, the omission of COVID-19 might not significantly affect the overall findings due to the dominance of earlier structural changes, which absorbed the COVID-19 effect into it, as stated earlier, but it still leaves out a major recent disruption.

## **5.6 Suggestions for Future Research**

To address the limitation of "findings" may not be applicable to economies of same category as Yemen. To the researcher's best knowledge, researches regarding the countries classified as LDC or low-income are limited. Thus, future research through comparative cross-low-income countries study through applying similar methods which would be for instance Panel NARDL rather than NARDL only. This would assist whether the findings in the case of Yemen are consistent across different countries of same category or are uniquely

shaped by Yemen's internal dynamics. Furthermore, such research would highlight vulnerabilities shared by different countries and inform more universal policy recommendations for Yemen's alike fragile economies.

Given the limitations of secondary data in Yemen's case, incorporating primary data through surveys, interviews, where feasible, or by collaborating with local or international agencies to access more reliable and updated data would be the best approach for future studies. This would ensure improved accuracy for empirical insights.

Considering the third limitation, future research may consider a longer timeframe or shorten the period to focus on recent years, which include major events, including the war in Gaza, the Russian Ukrainian war, and explicitly include COVID-19 as a known structural break. Doing so would enhance the relevance of the results to current economic conditions. incorporating COVID-19 as a known structural break would eliminate any possibility of it not being detected by breakpoint tests that are designed to detect unknown breaks.

Methodologically wise, future research and due to always development in econometric models, using alternative models other than NARDL, such as time-varying parameter models, quantile autoregression, or econometric methods based on machine learning, could offer deeper insights and capture more complex dynamics in the relationship under study. In addition, Further research could consider the use of the KPSS test together with the ADF and PP tests to provide further evidence regarding stationarity, by testing the alternative null hypothesis of trend stationarity or level stationarity

To sum up, as with any study, it's important to acknowledge its limitations. No study is flawless, and shortcomings may arise in terms of methodology, objectives, and other aspects. In econometrics specifically, constant advancements lead to the creation of new

methods. Therefore, future researchers are encouraged to stay abreast of these developments and integrate them into their studies.

## **5.7 Conclusion**

The shocks in the prices of oil can be very effective, either positive or negative to the economy of any country as oil plays an important and major role in the economy of most of the world nations. To this end, this study in hand targeted the LDC of YEMEN to find the asymmetric association and impact between the country's key economic indicators and the shocks of this important commodity particularly oil is the major source of revenue in the country. Additionally, and considering the fact that the heavy dependence on any natural source may cause what is known as "Dutch disease", it was imperative to diagnose the economy of the country for the symptoms of this disease.

This study started with an economic overview of the country's economy to explore the standing of the country in the world economy and how it performed in the chosen period of the study. Following was the view of past literature theoretically and empirically related to the shocks of oil prices and their impact on different world countries' economic activities. In relation to this, this study takes the supply-side mechanism as its main theoretical framework, highlighting how oil price shocks directly raise production costs, reduce output, and increase unemployment and inflation. It is complemented by the monetary policy channel, where keeping money supply unchanged can shape the impact of shocks, and by Dutch Disease theory, which explains how oil price rises directly affect exchange rates in resource-dependent economies like Yemen. Hence to achieve the objectives of this study, this study adopted the methodology of NARDL along with the new test of cointegration (i.e.,

augmented bootstrap ARDL) but in the nonlinear form. Additionally, the outcomes from NARDL alongside the regression model based on OLS were adopted to diagnose the symptoms of Dutch disease in the economy.

The results from the proposed methods and related tests indicated first the presence of cointegration among variables included in the models. Furthermore, the asymmetric response to positive and negative shocks in the oil prices was evidenced in most of the indicators with negative shocks playing a bigger role in such impact compared to positive ones. more specifically, GDP and exchange rate were found to respond asymmetrically to shocks in both long-short runs while inflation responds asymmetrically only in the short run and unemployment rate only in the long run. In keeping with this, the first two objectives can be said to be achieved. It was found the absence of any reverse effect as well transmitted from the exchange rate to oil prices (i.e., no two-ways nexus). This result indicated the achievement of the third objective of this study at hand. Moreover, the heavy reliance on oil was found to be a cause for the suffering somehow from the "Dutch disease" in the economy, particularly in other key sectors such as manufacturing, agriculture and services. Thus, in the light of this, the fourth objective was achieved.

last but not least, the findings were discussed, and in light of these discussed findings, some policy implications suggestions, and recommendations to both policymakers in the country and future researchers were provided.

## REFERENCES

- Abed, R. El, Amor, T. H., Noura, R., & Rault, C. (2016). Asymmetric effect and dynamic relationships between Oil prices shocks and exchange rate volatility: Evidence from some selected MENA countries. *Topics in Middle Eastern and African Economies*, 18(2), 1–25.
- Afriyie, J. K., Twumasi-Ankrah, S., Gyamfi, K. B., Arthur, D., & Pels, W. A. (2020). Evaluating the Performance of Unit Root Tests in Single Time Series Processes. *Mathematics and Statistics*, 8(6), 656–664.
- Ahmad, F. (2013). The Effect of Oil Prices on Unemployment: Evidence from Pakistan. *Business and Economics Research Journal*, 4(1), 43-57.
- Ahmed, S. (2016). The Impact of Oil Prices on the Economic Growth and Development in the MENA countries. *Munich Personal RePEc Archive*, (89073),1-23.
- Ahmed, M. I., Farah, Q. F., & Kishan, R. P. (2023). Oil price uncertainty and unemployment dynamics: Nonlinearities matter. *Energy Economics*, 125, 106806.
- Alfalih, A. A. (2024). The impact of oil prices, foreign direct investment and trade openness on unemployment rates in an oil-exporting country: The case of Saudi Arabia. *Heliyon*, 10(e25094).
- Aliyu, S. (2009). Impact of Oil Price Shock and Exchange Rate Volatility on Economic Growth in Nigeria: An Empirical Investigation. *Research Journal of International Studies*, (11), 4-15.

- Aliyu, S. (2011). Oil price shocks and the macroeconomy of Nigeria: nonlinear approach. *J. For International Business and Entrepreneurship Development*, 5(3), 179.
- Allegret, J.-P., Mignon, V., & Sallenave, A. (2015). Oil price shocks and global imbalances: Lessons from a model with trade and financial interdependencies. *Economic Modelling*, 49, 232–247.
- Allen, D., & McAleer, M. (2021). A nonlinear autoregressive distributed lag (NARDL) analysis of the FTSE and S&P500 indexes. *Risks*, 9(11), 195.
- Almalki, A. M., Hassan, M., & Amin, M. F. B. (2022). The asymmetric relationship between structural oil shocks and food prices: evidence from Saudi Arabia. *Applied Economics*, 54(54), 6216–6233.
- Al-Mawali, N. (2016). Modeling the Impact of the Oil Sector on the Economy of Sultanate of Oman. *International Journal of Energy Economics and Policy*, 6(1), 120-127.
- AMF. (2023). *The Joint Arab Economic Report 2022*. Abu Dhabi : Arab Monetary Fund.
- Arltová, M., & Fedorová, D. (2016). Selection of Unit Root Test on the Basis of Length of the Time Series and Value of AR(1) Parameter. *STATISTIKA*, 96(3), 47–63.
- Isamara, M., Mrabet, Z., Gangopadhyay, P., & Elafif, M. (2017). The asymmetric effects of oil price on economic growth in Turkey and Saudi Arabia: new evidence from nonlinear ARDL approach. *International Journal of Development and Conflict*, 7, 97-118.

- An, L., Jin, X., & Ren, X. (2014). Are the macroeconomic effects of oil price shock symmetric? A Factor-Augmented Vector Autoregressive approach. *Energy Economics*, 45, 217–228.
- Antoshin, S., Berg, A., & Souto, M. (2008). Testing for Structural Breaks in Small Samples. IMF Working Papers.No.75. International Monetary Fund.
- Arltová, M., & Fedorová, D. (2016). Selection of Unit Root Test on the Basis of Length of the Time Series and Value of AR(1) Parameter. *STATISTIKA*, 96(3), 47–64.
- Arnold, R. (2008). *Macroeconomics* (9th ed.). Mason: South-Western Cengage Learning
- Arnold, R. (2018). *Macroeconomics* (13th ed.). Boston: Cengage.
- Asghar, Z., & Abid, I. (2007). Performance of lag length selection criteria in three different situations. *MPRA Paper, No.40042*. Munich Personal RePEc Archive. Retrieved from <https://mpra.ub.uni-muenchen.de/40042/>.
- Atil, A., Lahiani, A., & Nguyen, D. (2014). Asymmetric and nonlinear pass-through of crude oil prices to gasoline and natural gas prices. *Energy Policy*, 65, 567-573.
- Aziz, M., & Dahalan, J. (2015). Oil Price Shocks and Macroeconomic Activities in Asean-5 Countries: A Panel VAR Approach. *Eurasian Journal of Business and Economics*, 8(16), 101-120.
- Bachmeier, L., & Keen, B. (2017). Modeling the Asymmetric Effects of an Oil Price Shock. Researchgate,1-38. Retrieved May 12,2020 from [https://www.researchgate.net/publication/326925791\\_Modeling\\_the\\_Asymmetric\\_Effects\\_of\\_an\\_Oil\\_Price\\_Shock](https://www.researchgate.net/publication/326925791_Modeling_the_Asymmetric_Effects_of_an_Oil_Price_Shock).

- Baek, J. (2021). A new look at the oil price-exchange rate Nexus: Asymmetric evidence from selected OPEC member countries. *Economic Analysis and Policy*, 70, 172-181.
- Bajwa, I., Elahi, M., Rafi, W., & Bajwa, F. (2019). Oil Overdependence and Dutch Disease, KSA Evidence. *Management Studies and Economic Systems (MSES)*, 4(3), 213-223.
- Bai, J., & Perron, P. (2003a). Computation and Analysis of Multiple Structural Change Models. *Journal of Applied Econometrics*, 18, 1-22.
- Bai, J., & Perron, P. (2003b). Critical values for multiple structural change tests. *The Econometrics Journal*, 6(1), 72–78.
- Bal, D. P., & Rath, B. N. (2015). Nonlinear causality between crude oil price and exchange rate: A Comparative Study of China and India. *Energy Economics*, 51, 149-156.
- Balke, N., Brown, S., & Yucel, M. (2002). Oil Price Shocks and the U.S. Economy: Where Does the Asymmetry Originate? *The Energy Journal*, 23(3), 27-52.
- Bamaiyi, G. (2024). Effect of oil price shocks on selected macroeconomic variables in niger ia (1990-2021). *International Journal of Development and Economic Sustainability*, 12(1), 12-25
- Barsky, R., & Kilian, L. (2004). Oil and the macroeconomy since the 1970s. *Journal of Economic Perspectives*, 18(4), 115-134.
- Basher, S. A., Haug, A. A., & Sadorsky, P. (2012). Oil prices, exchange rates and emerging stock markets. *Energy Economics*, 34(1), 227–240.

- Basher, S. A., Haug, A. A., & Sadorsky, P. (2016). The impact of oil shocks on exchange rates: A Markov-switching approach. *Energy Economics*, 54, 11–23.
- Bass, A. (2018). Is Groningen effect still present in Russia: A vector error correction approach. *International Journal of Energy Economics and Policy*, 8(5), 273-280.
- Bass, A. (2019). Do institutional quality and oil prices matter for economic growth in Russia: An empirical study. *International Journal of Energy Economics and Policy*, 9(1), 76–83.
- Baumeister, C. and Kilian, L. (2016). Forty Years of Oil Price Fluctuations: Why the Price of Oil May Still Surprise Us. *Journal of Economic Perspectives*, 30(1), 139-160.
- Baumeister, C., & Peersman, G. (2012). The role of time-varying price elasticities in accounting for volatility changes in the crude oil market. *Journal Of Applied Econometrics*, 28(7), 1087-1109.
- Baumeister, C., & Peersman, G. (2013). Time-Varying Effects of Oil Supply Shocks on the US Economy. *American Economic Journal: Macroeconomics*, 5(4), 1-28.
- Beckmann, J., Czudaj, R. L., & Arora, V. (2020). The relationship between oil prices and exchange rates: Revisiting theory and evidence. *Energy Economics*, 88, 104772.
- Bénassy-Quéré, A., Mignon, V., & Penot, A. (2007). China and the relationship between the oil price and the dollar. *Energy Policy*, 35(11), 5795-5805.
- Benhabib, A., Kamel, S., & Maliki, S. (2014). The relationship between oil price and the Algerian exchange rate. *Topics in Middle Eastern and African Economies*, 16(1), 127-141.

- Benhmad, F. (2012). Modeling nonlinear granger causality between the oil price and U.S. dollar: A wavelet-based approach. *Economic Modelling*, 29(4), 1505-1514.
- Bernanke, B., Gertler, M., & Watson, M. (1997). Systematic monetary policy and the effects of oil price shocks. *Brookings Papers on Economic Activity*, 1, 91-155.
- Bessler, D. A., McCarl, B. A., Wu, X., & Alan Love, H. (2014). Quantitative methods in Agricultural Economics. *Encyclopedia of Agriculture and Food Systems*, 1–10.
- Bhadury, S., Das, S., Ghosh, S., & Gopalakrishnan, P. (2023). Impact of crude prices shock on gdp growth: using a linear, nonlinear and extreme value framework. *Indian Growth and Development Review*, 16(1), 91-103
- Bigerna, S. (2024). Connectedness analysis of oil price shocks, inflation, and exchange rate for the MENA region countries. *Resources Policy*, 88, 104344.
- Bocklet, J., & Baek, J. (2017). Do oil price changes have symmetric or asymmetric effects on the unemployment rate? Empirical evidence from Alaska. *Energy Sources, Part B: Economics, Planning, and Policy*, 12(5).402-407
- Bruno, M., & Sachs, J. (1982). *Input price shocks and the slowdown in economic growth: the case of u.k. manufacturing*. nber working paper series no.815. Massachusetts: National Bureau of Economic Research.
- Brown, S., & Yücel, M. (1999). Oil prices and U.S. aggregate economic activity: a question of neutrality. *Economic and Financial Review*, Federal Reserve Bank of Dallas, Second Quarter: 16–23.

- Brown, S., & Yücel, M. (2002). Energy prices and aggregate economic activity: an interpretative survey. *The Quarterly Review of Economics and Finance*, 42(2), 193-208.
- Brown, S., Yücel, M., & Thompson, J. (2003). *Business cycles: the role of energy prices*. working paper no.0304. Dallas: Federal Reserve Bank of Dallas.
- Buiter, W., & Purvis, D. (1980). *Oil, Disinflation, and Export Competitiveness: A Model of the "Dutch Disease."* nber working paper series no. 592. Massachusetts: National Bureau of Economic Research.
- Cao, H., Khan, F. U., Shaikh, P. A., Khan, F., Zehri, M., & Yousaf, H. (2024). Does Oil Price Shock Drive Inflation? Evidence from G20 Countries. *Journal of the Knowledge Economy*, 16, 904–924. <https://doi.org/10.1007/s13132-024-01877-1>
- CBY. (2022). Monthly report Monetary and Financial Developments-August2022.Aden: The central bank of Yemen
- Chen, S., Chang, B. H., Fu, H., & Xie, S. (2024). Dynamic analysis of the relationship between exchange rates and oil prices: a comparison between oil exporting and oil importing countries. *Humanities & Social Sciences Communications*, 11(801)
- Cheratian, I., Farzanegan, M., & Goltabar, S. (2019). *Oil Price Shocks and Unemployment Rate: New Evidence from the MENA Region*. MAGKS joint discussion paper No. 31-2019. Philipps-University Marburg

- Chicco, D., Warrens, M. J., & Jurman, G. (2021). The coefficient of determination R-squared is more informative than SMAPE, MAE, MAPE, MSE and RMSE in regression analysis evaluation. *PeerJ Computer Science*, 7(5), e623.
- Chin, L., & Bala, U. (2018). Asymmetric Impacts of Oil Price on Inflation: An Empirical Study of African OPEC Member Countries. *Energies*, 11(11), 3017.
- Choi, S., Furceri, D., Loungani, P., Mishra, S., and Poplawski-Ribeiro, M. (2018). Oil prices and inflation dynamics: evidence from advanced and developing economies. *J. Int. Money Financ.* 82, 71–96. doi: 10.1016/j.jimonfin.2017.12.004
- Chou, K., & Lin, P. (2013). Oil price shocks and producer prices in Taiwan: an application of non-linear error-correction models. *Journal of Chinese Economic and Business Studies*, 11(1), 59-72.
- Chuku, C., Effiong, E., & Sam, N. (2010). Oil price distortions and their short-and long-run impacts on the Nigerian economy. *MPR Paper*, 24434, 1-30. Retrieved from <https://mpra.ub.uni-muenchen.de/24434/>.
- CMWG, & ACAPS. (2020). Volatility of the Yemeni rial: Drivers and impact of Yemeni Rial's volatility. The Cash and Market Working Group.
- Coleman, S., Cuestas, J.C., Mourelle, E., Cuestas, J. (2011). *Investigating the oil price exchange nexus: Evidence from Africa*. Sheffield Economic Research Paper no 011015. The University of Sheffield.
- Cogni, A., & Manera, M. (2008). Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries. *Energy Economics*, 30(3), 856-888.

- Corden, W. M., & Neary, J. P. (1982). Booming Sector and Deindustrialization in a Small Open Economy. *The Economic Journal*, 92(368), 825–848.
- Coudert, V., Mignon, V., & Penot, A. (2007). Oil Price and the Dollar. *Energy Studies Review*, 15(2), 1-18.
- Coudert, V., & Mignon, V. (2016). Reassessing the empirical relationship between the oil price and the dollar. *Energy Policy*, 95, 147-157.
- CSO. (2023). *The annual statistics book -2023*. Aden: Central Statistical Organization.
- Cuestas, J., & Gil-Alana, L.(2018). Oil price shocks and unemployment in Central and Eastern Europe. *Economic Systems*, 42(1), 164-173.
- Cunado, J., & Gracia, F. (2005). Oil prices, economic activity and inflation: evidence for some Asian countries. *The Quarterly Review Of Economics And Finance* 45(1), 65-83.
- Czudaj, R., & Beckmann, J. (2013a). Oil prices and effective dollar exchange rates. *International Review of Economics & Finance*, 27(1), 621-636.
- Czudaj, R., & Beckmann, J. (2013b). Is there a homogeneous causality pattern between oil prices and currencies of oil importers and exporters? *Energy Economics*, 40(1), 665-678.
- Deheri, A., & Ramachandran, M. (2023). Does Indian economy asymmetrically respond to oil price shocks? *The Journal of Economic Asymmetries*, 27, 1-10.

- Dickey, D. A., & Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, 49(4), 1057.
- Doğrul, H., & Soytas, U. (2010). Relationship between oil prices, interest rate, and unemployment: Evidence from an emerging market. *Energy Economics*, 32(6), 1523-1528.
- Dolado, J. J., Jenkinson, T., & Sosvilla-Rivero, S. (1990). COINTEGRATION AND UNIT ROOTS. *Journal of Economic Surveys*, 4(3), 249–273.
- Donayre, L., & Wilmot, N. (2016). The Asymmetric Effects of Oil Price Shocks on the Canadian Economy. *International Journal of Energy Economics and Policy*, 6(2), 167-182.
- Driouche, M., & Hamrit, A. (2020). The Asymmetric Impact of Oil Price Shocks on The Evolution of The Unemployment Rate in Algeria: New Evidence Using NARDL Analysis. *Les Cahiers Du CREAD*, 36(2), 27-58.
- EIA. (2020). YEMEN. U.S energy information administration.
- EIA. (2024). *Energy & Financial Markets -Crude oil*. U.S. Energy Information Administration(EIA).Eia.gov.[https://www.eia.gov/finance/markets/crudeoil/spot\\_prices.php](https://www.eia.gov/finance/markets/crudeoil/spot_prices.php)
- ECB. (2024). *Economic Bulletin Issue 7*, 2024. Retrieved from European Central Bank web site: <https://www.ecb.europa.eu/press/economic-bulletin/html/eb202407.en.html>
- Enders, W. (1995). *Applied Econometric Times Series*. New York: John Wiley & Sons.

- Enders, W. (2010). *Applied Econometric Time Series* (3rd ed.). New York: John Wiley & Sons.
- Enders, W. (2014). *Applied Econometric Times Series*(4<sup>th</sup> ed.). New York: Wiley.
- Engers , K., Williams, S., Choueiri, N., Sobolev, Y., & Walliser, J. (2002). Yemen in the 1990s:From Unification to Economic Reform -- IMF Occasional Paper No. 208. Washington, DC.
- Engle, R. F. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica*, 50(4), 987–1007.
- ESCWA. (2024). *Arab Sustainable Development Report 2024*. Beirut: United Nations: ESCWA.
- EViews. (2020). EViews 12 User’s Guide II. CA: IHS Markit.
- Fadare, S. O., Oladipo, O., & Agama, E. (2025). Oil Price Shocks and Economic Growth in Oil Exporting Countries: A Case Study of a Small Open Economy. *International Journal of Energy Economics and Policy*, 15(2), 260-269.
- Farhani, S. (2012). Impact of Oil Price Increases on U.S. Economic Growth: Causality Analysis and Study of the Weakening Effects in Relationship. *International Journal of Energy Economics and Policy*, 2(3), 108-122.
- Ferderer, J. (1996). Oil price volatility and the macroeconomy. *Journal of Macroeconomics*, 18(1), 1-26.

- Fratzscher, M., Schneider, D., & Van Robays, I. (2013). *Oil Prices, Exchange Rates and Asset Prices*. Working paper No.1689. European Central Bank.
- Fueki, T., Higashi, H., Higashio, N., Nakajima, J., Ohyama, S., & Tamanyu, Y. (2018). Identifying oil price shocks and their consequences: the role of expectations in the crude oil market. IBS working paper No 725. Bank for International Settlements.
- Gago, J., & Vale, S. (2025). Oil price swings and inflationary echoes: The impact of oil market shocks on consumer and producer prices in Europe and the U.S. *Resources Policy*, 107, 105667
- Gao, W., Wen, J., Zakaria, M., & Mahmood, H. (2022). Nonlinear and asymmetric impact of oil prices on exchange rates: Evidence from South Asia. *Economics*, 16(1), 243-256.
- Gbatu, A., Wang, Z., Wesseh, J. P., & Tutdel, I. (2017). Asymmetric and Dynamic Effects of Oil Price Shocks and Exchange Rate Fluctuations: Evidence from a Panel of Economic Community of West African States (ECOWAS). *International Journal of Energy Economics and Policy*, 7(3), 1-13.
- Ghosh, S. (2011). Examining crude oil price–Exchange rate nexus for India during the period of extreme oil price volatility. *Applied Energy*, 88(5), 1886-1889.
- Gulaliyev, M., Musayeva, J., Musayeva, F., Jabbarova, A., & Hatamov, F. (2024). Effects of Oil Price Shock on the Exchange Rate of National Currencies in Oil-Rich Countries: In the Case of some Arab Countries and Azerbaijan. *Wseas Transactions on Business and Economics*, 21, 44-50.

- Habib, M., Bützer, S., & Stracca, L. (2016). Global Exchange Rate Configurations: Do Oil Shocks Matter? *IMF Economic Review*, 64(3), 443-470.
- Ha, J., Kose, M. A., Ohnsorge, F., & Yilmazkuday, H. (2023). Understanding the global drivers of inflation: How important are oil prices? (Policy Research Working Paper No. 10283). International monetary fund.
- Hack, K., & Troderman, J. (2022). Crude oil prices rise above \$100 per barrel after Russia's further invasion into Ukraine. Retrieved from: <https://www.eia.gov/todayinenergy/detail.php?id=55020>
- Hajebi, E., & Samadi, S. Y. (2025). Macroeconomics Effect of Oil Price Shocks. *Journal of Finance and Economics*, 13(3), 94–100.
- Hamilton, J. (1983). Oil and the Macroeconomy since World War II. *Journal of Political Economy*, 91(2), 228-248.
- Hamilton, J. (1985). Historical Causes of Postwar Oil Shocks and Recessions. *The Energy Journal*, 6(1).
- Hamilton, J. (1996). This is what happened to the oil price-macroeconomy relationship. *Journal of Monetary Economics*, 38(2), 215-220.
- Hamilton, J. D. (2003). What is an oil shock? *Journal of Econometrics*, 113(2), 363–398.
- Hamilton, J. D. (2011). Nonlinearities and the macroeconomic effects of oil prices. *Macroeconomic Dynamics*, 15(3), 364-378.

- Hayes, A. F., & Cai, L. (2007). Using heteroskedasticity-consistent standard error estimators in OLS regression: An introduction and software implementation. *Behavior Research Methods*, 39(4), 709–722.
- Hidhiir, M., Aziz, M., & Fadzim, W. (2007). Oil price shocks: A comparative study on the impacts of oil price movements in Malaysia and the UK economies. In *International Economic Conference on Trade and Industry (IECTI)* (1-38). Bayview Hotel Georgetown, Penang.
- Hooker, M. (2000). Are Oil Shocks Inflationary? Asymmetric and Nonlinear Specifications versus Changes in Regime. *Journal Of Money, Credit And Banking*, 34(2), 540-561.
- Huang, W., & Chao, M. (2012). The effects of oil prices on the price indices in Taiwan: International or domestic oil prices matter? *Energy Policy*, 45(1), 730-738.
- Humbatova, S. and Hajiyev, N. (2019). Oil Factor in Economic Development. *Energies*, 12(8), 1573.
- Hunt, B., Isard, P., & Laxton, D. (2002). The Macroeconomic Effects of Higher Oil Prices. *National Institute Economic Review*, 179(1), 87-103.
- Ibrahim, Mansor H (2015). Oil and food prices in Malaysia: a nonlinear ARDL analysis. *Agricultural and Food Economics*, 3(1), 2–14
- IHSEviews. (2022). *NARDL in EViews 13: A Study of Bosnia's Tourism Sector*. Retrieved January 3, 2023, from EViews econometric analysis insight blog website: <https://blog.eviews.com/2022/09/nardl-in-eviews-13-study-of-bosnias.html>.

- Ijomah, M. A., & Enegesele, D. (2017). On the Use of Unit Root Test to Differentiate Between Deterministic and Stochastic Trend in Time Series Analysis. *American Scientific Research Journal for Engineering, Technology, and Sciences*, 27(1), 234–246.
- IMF. (2004). Chile: Selected Issues. *IMF Staff Country Reports*, 04(292),44–55.  
<https://doi.org/10.5089/9781451807608.002>
- IMF. (2020). Republic of yemen. International Monetary Fund. Retrieved january 12,2021 from <https://www.imf.org/en/Countries/YEM>.
- IMF. (2023). *World economic Outlook: Navigating Global Divergences. October 2023*. Washington, DC.
- IMF. (2023a). *World economic outlook-2023-population*. Retrieved June 30, 2023, from www.imf.org website: <https://www.imf.org/external/datamapper/LP@WEO/YEM>.
- IMF. (2023b). *World economic outlook-2023-real gdp growth*. Retrieved June 30, 2023 from: [https://www.imf.org/external/datamapper/NGDP\\_RPCH@WEO/YEM](https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/YEM)
- IMF. (2023c). *World Economic Outlook database: April 2023*. International monetary fund.
- IMF. (2023d). Exchange Rates selected indicators, Yemen, Rep. of. Retrieved July 3, 2023, from data.imf.org website: <https://data.imf.org/regular.aspx?key=61545850>.
- Inusah, N. (2018). Toda-Yamamoto Granger no-causality analysis of stock market growth and economic growth in Ghana. *Journal of Accounting, Business and Finance Research*, 3(1),36-46.

- Ito, K. (2017). Dutch disease and Russia. *International Economics*, 151, 66–70.
- Iwayemi, A., & Fowowe, B. (2011). Impact of oil price shocks on selected macroeconomic variables in Nigeria. *Energy Policy*, 39(2), 603-612.
- Jahan, S., Mahmud, A. S., & Papageorgiou, C. (2014). What Is Keynesian Economics? In *Finance and development* (pp.53–54). Washington, DC: IMF.
- Jahan-Parvar, M., & Mohammadi, H. (2011). Oil Prices and Real Exchange Rates in Oil-Exporting Countries: A Bounds Testing Approach. *The Journal of Developing Areas*, 45(1), 3012-322.
- Jammazi, R., Lahiani, A., & Nguyen, D. K. (2015). A wavelet-based nonlinear ARDL model for assessing the exchange rate pass-through to crude oil prices. *Journal of International Financial Markets, Institutions and Money*, 34, 173–187.
- Jiranyakul, K. (2015). Oil Price Shocks and Domestic Inflation in Thailand. *Munich Personal RePEc Archive*, (62797),1-9.
- Jiranyakul, K. (2016). Oil Price Shocks and Domestic Inflation in Thailand. *Munich Personal RePEc Archive*, (71070),1-20.
- Jiranyakul, K. (2018). Oil Price Shocks and Domestic Inflation in Thailand. *Munich Personal RePEc Archive*, (87699), 1-25.
- Kamara, A. M., Sallam, M. A. M., & Ebrahim, E. E. M. (2025). Asymmetric effects of exchange rates and oil prices on inflation in Egypt. *International Journal of Energy Economics and Policy*, 15(3), 486–497.

- Katrakilidis, C., & Trachanas, E. (2012). What drives housing price dynamics in Greece: New evidence from asymmetric ARDL cointegration. *Economic Modelling*, 29(4), 1064–1069.
- Khan, M., Teng, J., & Khan, M. (2019). Asymmetric impact of oil prices on stock returns in Shanghai stock exchange: Evidence from asymmetric ARDL model. *PLOS ONE*, 14(6), 1-14.
- Kilian, L. (2008). The Economic Effects of Energy Price Shocks. *Journal of Economic Literature*, 46(4), 871-909. doi:10.1257/jel.46.4.871.
- Kilian, L., & Zhou, X. (2023). *Oil price shocks and inflation* (Working Paper No. 2312). Federal Reserve Bank of Dallas.
- Kim, J., & Jung, H. (2017). Relationship between oil price and exchange rate by FDA and copula. *Applied Economics*, 50(22), 2486-2499.
- Kocaaslan, O. (2019). Oil price uncertainty and unemployment. *Energy Economics*, 81, 577-583.
- Kocaarslan, B., Soytaş, M., & Soytaş, U. (2020). The Asymmetric Impact of Oil Prices, Interest Rates and Oil Price Uncertainty on Unemployment In US. *Energy Economics*, 86(104625), 1-11.
- Kose, N., & Baimaganbetov, S. (2015). The Asymmetric Impact of Oil Price Shocks on Kazakhstan Macroeconomic Dynamics: A Structural Vector Autoregression Approach. *International Journal Of Energy Economics And Policy*, 5(4), 1058-1064.

- Kriskkumar, K., Naseem, N. A., & Azman-Saini, W. N. (2022). Investigating the asymmetric effect of oil price on the economic growth in Malaysia: Applying augmented ARDL and nonlinear Ardl Techniques. *SAGE Open*, 12(1).
- Lacheheb, M., & Sirag, A. (2019). Oil price and inflation in Algeria: A nonlinear ARDL approach. *The Quarterly Review of Economics and Finance*, 73, 217-222.
- Ianchovichina, E., & Onder, H. (2017). Dutch disease: An economic illness easy to catch, difficult to cure. Retrieved December 12, 2020, from Brookings website: <https://www.brookings.edu/articles/dutch-disease-an-economic-illness-easy-to-catch-difficult-to-cure/>.
- Lardic, S., & Mignon, V. (2008). Oil prices and economic activity: An asymmetric cointegration approach. *Energy Economics*, 30(3), 847–855.
- Lee, K., Ni, S., & Ratti, R. (1995). Oil Shocks and the Macroeconomy: The Role of Price Variability. *The Energy Journal*, 16(4), 1-19.
- Lee, C., & Shie, F.-S. (2004). Fractional Integration and the Phillips-Perron Test. *Academia economic papers*, 32(2), 273–312.
- Liew, V. (2004). Which Lag Length Selection Criteria Should We Employ? *Economics*, 3(33), 1-9.
- Long, S., & Liang, J. (2018). Asymmetric and nonlinear pass-through of global crude oil price to China's PPI and CPI inflation. *Economic Research-Ekonomska Istrazivanja*, 31(1), 240–251.

- Löschel, A., & Oberndorfer, U. (2009). Oil and Unemployment in Germany. *Jahrbücher Für Nationalökonomie Und Statistik*, 229(2-3), 146-162.
- Loungani, P. (1986). Oil Price Shocks and the Dispersion Hypothesis. *The Review of Economics and Statistics*, 68(3), 536-39.
- MacKinnon, J. G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics*, 11(6), 601–618.
- Malik, A. (2016). The Impact of Oil Price Changes on Inflation in Pakistan. *International Journal of Energy Economics and Policy*, 6(4), 727-737.
- Mohammed, D., Afangideh, J., & Ogundele, O. (2019). Oil Price and Exchange Rate Nexus-Evidence from Nigeria. *International Journal of Accounting and Financial Reporting*, 9(1), 298.
- MoPIC. (2016). Yemen socio-economic update 2016. Ministry of Planning & International Cooperation.
- MoPIC. (2017). Yemen socio-economic update 2017. Ministry of Planning & International Cooperation.
- Mork, K. (1989). Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results. *Journal of Political Economy*, 97(3), 740-744.
- Mork, K. (1994). Business Cycles and the Oil Market. *The Energy Journal*, 15(01), 15-38.
- Mory, J. (1993). Oil Prices and Economic Activity: Is the Relationship Symmetric? *The Energy Journal*, 14(4), 151-161.

- Moshiri, S. (2015). Asymmetric effects of oil price shocks in oil-exporting countries: the role of institutions. *OPEC Energy Review*, 39(2), 222-246.
- Moshiri, S., & Arezoo Banihashem. (2012). Asymmetric Effects of Oil Price Shocks on Economic Growth of Oil-Exporting Countries. *SSRN Electronic Journal, USAEE WP No. 12-140*. [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2163306](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2163306).
- Nandi, B. K., Kabir, M. H., & Nandi, M. K. (2024). Crude oil price hikes and exchange rate volatility: A lesson from the Bangladesh economy. *Resources Policy*, 91, 104858–104858. <https://doi.org/10.1016/j.resourpol.2024.104858>
- Neary, J., & Wijnbergen, S. (1985). *Natural resources and the macroeconomy: a theoretical framework*. UCD Centre for Economic Research, WP. No. 36. University College Dublin.
- Niran, A., Fausat, A., & Musa, M. (2018). Empirical Evidence of Oil Price Shocks and Oil Economy Asymmetric Nexus: The Cases of Angola and Nigeria. *Advances in Social Sciences Research Journal*, 5(6), 17-32.
- Nusair, S. A. (2016). The effects of oil price shocks on the economies of the Gulf Cooperation Council countries: Nonlinear analysis. *Energy Policy*, 91, 256–267.
- Nusair, S. A. (2020). The asymmetric effects of oil price changes on unemployment: Evidence from Canada and the U.S. *The Journal of Economic Asymmetries*, 21. doi:10.1016/j.jeca.2019.e00153

- Oyelami, L. (2018). Effects of Oil Price Movement on Nigerian Macroeconomic Variables: Evidence from Linear near and Nonlinear ARDL Modelling. *Iran. Econ. Rev*, 22(4), 908-933.
- OPEC. (2019). OPEC Annual Statistical Bulletin. Vienna: Organization of the Petroleum Exporting Countries.
- Ordóñez, J., Sala, H., & Silva, J. (2011). Oil Price Shocks and Labor Market Fluctuations. *The Energy Journal*, 32(3), 89-118.
- Osman, A., Sebu, J., Iledare, O. O., Eric Amoo Bondzi, & Mubarik Salifu. (2023). Structural Vector Autoregressive Analysis of Crude Oil Price Shocks on Ghana's Economy. *Universal Journal of Finance and Economics*, 3(1), 1–18.
- Ozcicek, O., & McMillin, W. (1999). Lag length selection in vector autoregressive models: symmetric and asymmetric lags. *Applied Economics*, 31(4), 517-524.
- Ozturk, F. (2015), Oil price shocks-macro economy relationship in Turkey. *Asian Economic and Financial Review*, 5(5), 846-857.
- Ritahi, O., & Echaoui, A. (2025). Macroeconomic effects of raising oil prices: Insights from Morocco. *International Journal of Energy Economics and Policy*, 15(2), 380–390
- Park, J. (2007). Oil price shocks and stock market behavior. PHD. University of Missouri-Columbia.
- Paparoditis, E., & Politis, D. N. (2016). The asymptotic size and power of the augmented Dickey–Fuller test for a unit root. *Econometric Reviews*, 37(9), 955–973.

- Peersman, G., & Van Robays, I. (2009). Oil and the Euro area economy. *Economic Policy*, 24(60), 603-651.
- Perron, P. (1989). The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. *Econometrica*, 57(6), 1361.
- Perron, P. (2005). Dealing with Structural Breaks. *RePEc: Research Papers in Economics, WP-017*, 1–91.
- Phillips, P. C. B., & Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika*, 75(2), 335–346.
- Pfaff, B. (2008). *Analysis of Integrated and Cointegrated Time Series with R* (2nd ed.). New York: Springer.
- Rahma, E., Perera, N., & Tan, K. (2016). Oil price shocks and their consequences on sudan's gdp growth and unemployment rates. In 21st International Academic Conference. Miami.
- Rahman, S., & Serletis, A. (2010). The asymmetric effects of oil price and monetary policy shocks: A nonlinear VAR approach. *Energy Economics*, 32(6), 1460–1466.
- Razmi, F., Azali, M., Chin, L., & Shah Habibullah, M. (2016). The role of monetary transmission channels in transmitting oil price shocks to prices in ASEAN-4 countries during pre- and post-global financial crisis. *Energy*, 101, 581-591.
- Ryan, K. F., & Giles, D. E. A. (1999). Testing for unit roots in economic time series with missing observations. In T. B. Fomby & R. C. Hill (Eds.), *Messy Data (Advances in Econometrics, volume 13)* (pp. 203–242). Bingley: Emerald Publishing Limited.

- Riman, H., Akpan, E., & Offiong, A. (2013). Asymmetric Effect of Oil Price Shocks on Exchange Rate Volatility and Domestic Investment in Nigeria. *British Journal of Economics, Management & Trade*, 3(4), 513-532.
- Rodríguez, R., & Sánchez, M. (2004). *Oil price shocks and real GDP growth: empirical evidence for some OECD countries*. ECB working paper no.362. European central bank.
- Rudd, D. (1996). *An Empirical Analysis of Dutch Disease: Developing and Developed Countries*. IWU honors project paper no.42. Illinois Wesleyan University.
- Sa'ad, S., Usman, A. B., Omaye, S. O., & Yau, H. (2023). Asymmetric Pass-through effects of oil price shocks and exchange rates on inflation in Nigeria: Evidence from a nonlinear ARDL model. *European Scientific Journal ESJ*, 1. doi:10.19044/esiprep rint.1. 2023.p350
- Safia, S., & Selma, K. (2019). Oil Price Shocks and Algerian Economy: Evidence from The New Economic Model. *Roa Iktissadia Review*, 9(1), 13-26.
- Salem, L., Nouira, R., Saafi, S., & Rault, C. (2024). *How Do Oil Prices Affect the GDP and Its Components? New Evidence from a Time-Varying Threshold Model* (IZA Discussion Paper No. 16970). IZA Institute of Labor Economics.
- Sanusi, K.A. (2020). Oil prices asymmetric and exchange rate volatility: Case of oil exporting emerging countries. *Journal of International Studies*, 13(4), 101-109.
- Saraswat, G. B. & Saraswat, M. (2023). A Study on Oil Price Volatility Exposure to Stock Market Return: Evidence From China. In Anubha & H. Sharma (Eds.), *Data-Driven*

*Approaches for Effective Managerial Decision Making* (pp. 199-227). IGI Global.  
<https://doi.org/10.4018/978-1-6684-7568-3.ch010>.

Schorderet, Y. (2003). *Asymmetric Cointegration* Working paper no.2003.01. Geneva: University of Geneva.

Sek, S. K., Teo, X. Q., & Wong, Y. N. (2015). A Comparative Study on the Effects of Oil Price Changes on Inflation. *Procedia Economics and Finance*, 26(15), 630–636.

Shrestha, M. B., & Bhatta, G. R. (2018). Selecting appropriate methodological framework for time series data analysis. *The Journal of Finance and Data Science*, 4(2), 71–89.

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

Sidra, N., & Qayyum, A. (2014). Impact of oil Impact of Oil Price and Shocks on Economic Growth of Pakistan: Multivariate Analysis. *MPRA\_paper; Paper No.55929*, 1-23.  
Retrieved from <https://mpra.ub.uni-muenchen.de/55929/>

Soofi, A., & Cao, L. (2002). *Modelling and Forecasting Financial Data*. Boston, MA: Springer US.

Stare, J. (1995). Some Properties of  $R^2$  in Ordinary Least Squares Regression. In A. Ferligoj & A. Kramberger (Eds.), *Contributions to Methodology and Statistics, Metodološki zvezki*, 10. (pp. 134–145). Ljubljana, Slovenia.

- Suliman, T. H., & Abid, M. (2020). The impacts of oil price on exchange rates: Evidence from Saudi Arabia. *Energy Exploration and Exploitation*, 38(5), 2037–2058.
- Taguchi, H. (2016). Analysis of "Dutch Disease Effects" on Asian Economies. *MPRA Paper No. 78075*, 1-19. Retrieved from: <https://mpra.ub.uni-muenchen.de/78075/>.
- Taiwo, I. A., Jayeola, L. A., & Adefokun, A. S. (2024). Impact of oil price volatility on economic growth in united states: an ordinary least square analysis. *International Journal of Science and Research Archive*, 13(01), 477-485
- Tang, W., Wu, L., & Zhang, Z. (2010). Oil Price Shocks and Their Short- and Long-Term Effects on the Chinese Economy. *Energy Economics*, 32, 3–14.
- Taşar, İ. (2017). asymmetric relationship between oil price and exchange rate: the case of Romania. *Fırat Üniversitesi Sosyal Bilimler Dergisi*, 1-12.
- Taufani, A., Hakim, D. B., & Widyastutik, W. (2022). The impact of oil price shocks on macroeconomic indicators: Evidence from four ASEAN countries. *Economic Journal of Emerging Markets*, 257-272.
- Thuy Tien, H. (2022). Oil price shocks and Vietnam's macroeconomic fundamentals: quantile-on-quantile approach. *Cogent Economics & Finance*, 10(1).
- Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 66(1-2), 225-250.
- Trang, N., & Hong, D. (2016). Nonlinear effects of oil prices on inflation, growth, budget deficit, and unemployment. *Journal of Economics Development*, 24(1), 73-89.

- Trang, N., Tho, T., & Hong, D. (2017). The Impact of Oil Price on the Growth, Inflation, Unemployment and Budget Deficit of Vietnam. *International Journal of Energy Economics and Policy*, 7(3), 42-49.
- Turner, P. (2010). Power properties of the CUSUM and CUSUMSQ tests for parameter instability. *Applied Economics Letters*, 17(11), 1049–1053.
- TWB, & DFID. (2015). The Republic of Yemen Unlocking the Potential for Economic Growth. The World Bank.
- TWB. (2024). Yemen Economic Monitor: Navigating Increased Hardship and Growing Fragmentation. Washington, D.C.: The World Bank.
- TWB. (2019). Yemen economic monitoring brief. The World Bank.
- TWB. (2020a). World Development Indicators | DataBank. Retrieved from [databank.worldbank.orgwebsite:https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.PETR.RT.ZS&country=YEM#](https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.PETR.RT.ZS&country=YEM#).
- TWB. (2020b). Yemen monthly economic update. Washington, D.C.: The World Bank.
- TWB. (2020c). Oil rents (% of GDP) - Yemen, Rep. Washington, D.C.: The World Bank.
- TWB. (2023a). labor force, total- Yemen, Rep. Washington, D.C.: The World Bank.
- TWB. (2023b). Unemployment, total (% of total labor force)- Yemen, Rep. Washington, D.C.: The World Bank.
- TWB. (2023c). gender data portal- Yemen, Rep. Washington, D.C.: The World Bank.

- TWB. (2025). *Yemen Economic Monitor, Spring 2025: Persistent Fragility amid Rising Risks*. Washington, DC: The World Bank.
- UN. (2020). *The World Economic Situation and Prospects 2020*. New York.: The United Nations.
- UN. (2022). *The World Economic Situation and Prospects 2022*. New York.: The United Nations.
- UN. (2023). *The World Economic Situation and Prospects 2023*. New York.: The United Nations.
- UN. (2024). *The World Economic Situation and Prospects 2024*. New York.: The United Nations.
- Uri, N. D., & Boyd, R. (1996). The impact of crude oil price fluctuations on unemployment in the United States. *International Journal of Energy Research*, 20(11), 1003–1014.
- Wang, D., & Tomek, W. G. (2007). Commodity Prices and Unit Root Tests. *American Journal of Agricultural Economics*, 89(4), 873–889.
- Wang, Y., & Wu, C. (2012). Energy prices and exchange rates of the U.S. dollar: Further evidence from linear and nonlinear causality analysis. *Economic Modelling*, 29(6), 2289-2297.
- Wong, H. T., Mansur, K. M., & Cheong, J. Q. (2023). Asymmetric effects of oil price shock on disaggregated consumer prices. *Jurnal Ekonomi Malaysia*, 57(2), 15–27.
- World Energy Council (2016). *World Energy Resources*. London: World Energy Council.

- Wijnbergen, S. V. (1984). Inflation, Employment, and the Dutch Disease in Oil-Exporting Countries: A Short-Run Disequilibrium Analysis. *The Quarterly Journal of Economics*, 99(2), 233-250.
- Zhao, B. (2024). The Impact of International Oil Price Shock on China's Economic Growth. *Open Access Journal of Data Science & Artificial Intelligence, OAJDA*, 2(1), 1–14.
- Živkov, D., Đurašković, J., & Manić, S. (2019). How do oil price changes affect inflation in Central and Eastern European countries? A wavelet-based Markov switching approach. *Baltic Journal Of Economics*, 19(1), 84-104.
- Zikmund, W., Babin, B., & Griffin, M. (2012). Business Research Methods (9th ed.). Mason, Ohio: South-Western.
- Zumba, Y. I., Abe, M., Goshit, G. G., & Paul, U. (2025). OIL Price and Unemployment in Oil Importing Economies: Linear and Nonlinear Panel ARDL Evidence from Africa. *Journal of Business and Economic Analysis*, 6(Supp. 1), 17–36.

## APPENDICES

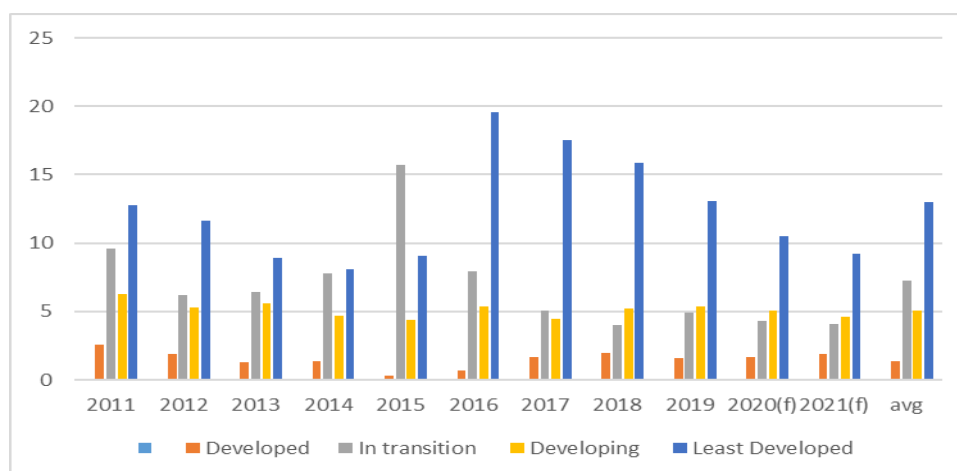
### *Appendix 1.1: Historical Oil Price Shocks and Contributing Factors to Them*

| # | Causing factor of the shock        | #  | Causing facotr of the shock.           |
|---|------------------------------------|----|----------------------------------------|
| 1 | US Spare Capacity Exhausted        | 8  | OPEC cuts production targets 1.7 mmbpd |
| 2 | Arab Oil Embargo                   | 9  | 9-11 attacks                           |
| 3 | Iranian Revolution                 | 10 | Low spare capacity                     |
| 4 | Iran-Iraq War                      | 11 | Global financial collapse              |
| 5 | Saudis abandon swing producer role | 12 | OPEC cuts production targets 4.2 mmbpd |
| 6 | Iraq invades Kuwait                | 13 | OPEC production quota unchanged        |
| 7 | Asian financial crisis             | 14 | Global pandemic reduces oil demand     |

Source :EIA(2024)

### *Appendix 2.1: The Inflation Rate of the 4 Broad Categories of World Economies*

| classification  | 2011      | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020(f) | 2021(f) | avg    |
|-----------------|-----------|------|------|------|------|------|------|------|------|---------|---------|--------|
|                 | Inflation |      |      |      |      |      |      |      |      |         |         |        |
| Developed       | 2.6       | 1.9  | 1.3  | 1.4  | 0.3  | 0.7  | 1.7  | 2    | 1.6  | 1.7     | 1.9     | 1.3625 |
| In transition   | 9.6       | 6.2  | 6.4  | 7.8  | 15.7 | 7.9  | 5.1  | 4    | 4.9  | 4.3     | 4.1     | 7.25   |
| Developing      | 6.3       | 5.3  | 5.6  | 4.7  | 4.4  | 5.4  | 4.5  | 5.2  | 5.4  | 5.1     | 4.6     | 5.0625 |
| Least Developed | 12.8      | 11.6 | 8.9  | 8.1  | 9.1  | 19.6 | 17.5 | 15.9 | 13.1 | 10.5    | 9.2     | 12.975 |



Source: Author's construct based on UN (2020)

**Appendix 2.2: least Developed Countries (LDCs) as of 2018**

| <b>Africa</b>                                                                                                                                                                                    |                                                                                                                                                                                                            | <b>East Asia</b>                                                                                                           | <b>South Asia</b>                            | <b>Western Asia</b> | <b>Latin America and the Caribbean</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------------------|----------------------------------------|
| Angola<br>Benin<br>Burkina Faso<br>Burundi<br>Central African Republic<br>Chad<br>Comoros<br>Congo<br>Djibouti<br>Eritrea<br>Ethiopia<br>Gambia<br>Guinea<br>Guinea-Bissau<br>Lesotho<br>Liberia | Madagascar<br>Malawi<br>Mali<br>Mauritania<br>Mozambique<br>Niger<br>Rwanda<br>Sao Tome and Principe<br>Senegal<br>Sierra Leone<br>Somalia<br>South Sudan<br>Sudan<br>Togo<br>Uganda<br>Tanzania<br>Zambia | Cambodia<br>Kiribati<br>Lao People's Democratic Republic<br>Myanmar<br>Solomon Islands<br>Timor Leste<br>Tuvalu<br>Vanuatu | Afghanistan<br>Bangladesh<br>Bhutan<br>Nepal | Yemen               | Haiti                                  |

**Source:** UN (2020)

**Appendix 2.3: Western Asia Countries**

| <b>Western Asia</b>                                                                               |                                                             |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>Oil exporters</b>                                                                              | <b>Oil importers</b>                                        |
| Bahrain<br>Kuwait<br>Oman<br>Qatar<br>Saudi Arabia<br>United Arab Emirates (UAE)<br>Yemen<br>Iraq | Palestine<br>Jordan<br>Lebanon<br>Syria<br>Israel<br>turkey |

**Source:** UN (2020)

#### *Appendix 2.4: Data Represented By Some Figures*

| <i>year</i> | <i>population(m)</i> | <i>GDP growth %</i> | <i>Unemployment %</i> | <i>Inflation %</i> | <i>Exchange rate(YER/\$)</i> |
|-------------|----------------------|---------------------|-----------------------|--------------------|------------------------------|
| 1991        | 13.63                | 6.29                | 8.34                  | 44.91              | 12.01                        |
| 1992        | 14.16                | 8.21                | 8.33                  | 51.20              | 12.01                        |
| 1993        | 14.71                | 4.00                | 8.37                  | 61.75              | 12.01                        |
| 1994        | 15.27                | 6.72                | 8.34                  | 71.28              | 12.01                        |
| 1995        | 15.84                | 5.67                | 8.97                  | 63.89              | 57.57                        |
| 1996        | 16.37                | 4.64                | 9.60                  | 38.79              | 126.91                       |
| 1997        | 16.86                | 5.23                | 10.21                 | 4.64               | 130.46                       |
| 1998        | 17.36                | 6.01                | 10.81                 | 11.54              | 141.65                       |
| 1999        | 17.86                | 3.78                | 11.46                 | 7.91               | 159.10                       |
| 2000        | 18.37                | 6.18                | 11.56                 | 10.96              | 165.59                       |
| 2001        | 18.89                | 3.80                | 11.72                 | 11.92              | 173.27                       |
| 2002        | 19.40                | 3.94                | 11.85                 | 12.24              | 179.01                       |
| 2003        | 19.92                | 3.75                | 11.98                 | 10.83              | 184.31                       |
| 2004        | 20.46                | 3.97                | 12.10                 | 12.49              | 185.87                       |
| 2005        | 21.01                | 5.59                | 12.21                 | 9.87               | 195.08                       |
| 2006        | 21.63                | 3.17                | 12.37                 | 10.85              | 198.50                       |
| 2007        | 22.30                | 3.34                | 12.50                 | 7.91               | 199.54                       |
| 2008        | 22.98                | 3.65                | 12.62                 | 18.98              | 200.08                       |
| 2009        | 23.68                | 3.87                | 12.75                 | 3.68               | 207.32                       |
| 2010        | 24.38                | 7.70                | 12.83                 | 11.18              | 213.80                       |
| 2011        | 25.11                | -12.72              | 13.25                 | 19.54              | 213.80                       |
| 2012        | 25.85                | 2.39                | 13.17                 | 9.89               | 214.89                       |
| 2013        | 26.60                | 4.82                | 13.26                 | 10.97              | 214.89                       |
| 2014        | 27.37                | -0.19               | 13.47                 | 8.16               | 214.89                       |
| 2015        | 28.14                | -28.00              | 13.78                 | 22.00              | 245.00                       |
| 2016        | 28.89                | -9.38               | 13.41                 | 21.30              | 303.75                       |
| 2017        | 29.65                | -5.07               | 13.25                 | 30.40              | 214.89                       |
| 2018        | 30.42                | 0.75                | 13.08                 | 33.65              | 214.89                       |
| 2019        | 31.17                | 1.40                | 12.98                 | 15.43              | 612.00                       |
| 2020        | 31.93                | -8.50               | 13.58                 | 19.59              | 669.00                       |
| 2021        | 32.64                | -1.00               | 13.89                 | 26.02              | 952.00                       |
| 2022        | 33.32                | 1.50                | 13.59                 | 29.07              | 1,242.00                     |

**Source:** Author's construct based on figures presented in chapter 2

**Appendix 3.1: Summary of Literature Reviewed Concerning SoOP & GDP**

| <i>Author(s)</i>         | <i>Country(ies)<br/>+Economy<br/>classification</i> | <i>Study's period</i>                    | <i>Methodology(ies)/ (unit root tests)</i> | <i>Key results</i>                                                                                                                                                               |
|--------------------------|-----------------------------------------------------|------------------------------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Taufani et al. (2022)    | 4 ASEAN<br><br>(Developing)                         | 1995-2020(Q)                             | VECM                                       | Malaysia's & Brunei GDPs fall in response to -ve shocks while Thailand's and Indonesia's GDPs fall in response to +ve shocks implying more of a symmetric effect than asymmetric |
| Kriskkumar et al. (2022) | Malaysia<br><br>(developing)                        | 1981-2017(Y)                             | ARDL/NARDL<br><br>(ADF/KPPS)               | Both -ve +ve shock impacts the Malaysian GDP asymmetrically.                                                                                                                     |
| Bass (2019)              | Russia<br><br>(In transition)                       | 1996-2017(Y)                             | VEC<br><br>(ADF/PP)                        | SoOP significantly affect GDP in LR only                                                                                                                                         |
| Niran et al. (2018)      | Nigeria & Angola<br><br>Developing +LDC)            | 1980-2015(Y)                             | NARDL<br><br>(ADF)                         | (+ve) & (-ve) asymmetric impact on GDP of Nigeria & only negative impact on Angola's GDP                                                                                         |
| Gbatu et al. (2017)      | ECOWAS members<br><br>(Developing+LDCs)             | 1985-2015(Y)                             | Fixed effect model<br><br>(Fisher-ADF/PP)  | Both symmetric & asymmetric impact for SoOP on all ECOWAS states oil imports states and no significant effect on ECOWAS oil exporters states.                                    |
| Alsamara et al. (2017)   | Saudi Arabia & Turkey<br><br>(Developing)           | 1968-2008(Y)                             | NARDL<br><br>(ADF/PP/Zandrews)             | strong LR nexus is found but with (+ve) shocks affecting Saudi GDP significantly compared to (-ve) ones and (-ve) shocks affecting turkey GDP over (+ve) ones                    |
| Moshiri (2015)           | 9 OPEC members<br><br>(Developed + Developing).     | 1970-2009(Y)                             | VAR<br><br>(ADF)                           | (+ve) & (-ve) SoOP insignificant on developed OPEC GDP (i.e., neutral asymmetry) while only (-ve) shocks significant on developing OPEC GDP (i.e., Clear asymmetry).             |
| Nusair (2016)            | GCC                                                 | 1968 -2014 (Y) sample period differ from | Panel-NARDL                                | (+ve) shocks have stronger positive impact                                                                                                                                       |

|                                                                                                                                                 | (Developing)                                                                            | country to another | (Zivot and Andrews test*)                   | on GCCs' GDP comparing to (-ve) ones.                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Aziz and Dahalan (2015)                                                                                                                         | Asean members<br><br>(Developing)                                                       | 1991-2014(Y)       | Panel-VAR<br><br>(IPS/ LLC/ Breitung tests) | (+ve) SoOP impacts ASEAN GDP in both SR&LR in a greater manner than (-ve) SoOP do.                        |
| An et al. (2014)                                                                                                                                | USA<br><br>(Developed)                                                                  | 1959-2006(Q)       | FAVAR                                       | The higher the OP the greater the (-ve) impact on GDP, particularly in SR. thus, asymmetric impact found. |
| Lwayemi and Fowowe (2011)                                                                                                                       | Nigeria<br><br>(Developing)                                                             | 1985-2007(Q)       | UVAR<br><br>(ADF/PP)                        | No response to (+ve) SoOP but GDP significantly response to (-ve) shocks.                                 |
| Lardic and Mignon (2008)                                                                                                                        | G7, Europe and Euro area economies<br><br>(Developed + In transition)                   | 1970-2004(Q)       | Asymmetric co-integration<br><br>(ADF/PP)   | Asymmetric LR is found with (+ve) shocks impose greater impact on targeted countries GDP over (-ve) ones. |
| Cunado and Gracia (2005)                                                                                                                        | Japan, Singapore, Malaysia, Philippines, and South Korea<br><br>(Developed +Developing) | 1975-2002(Q)       | Granger causality test.<br><br>(PP)         | Evidence for asymmetry is found but with the impact limited to SR.                                        |
| Y=yearly, M=monthly, Q=quarterly, D=daily, OP=oil price, LR=Long-run, SR=short-run, SoOP=shocks of oil prices, (+ve) positive, (-ve) = negative |                                                                                         |                    |                                             |                                                                                                           |
| *Breakpoint type unit root test:<br>Zivot and Andrews test (1992) allows for unknown single breakpoint detection in the series.                 |                                                                                         |                    |                                             |                                                                                                           |

**Source:** Author's construct

**Appendix 3.2: Summary of Inflation & SoOP Literature Reviewed**

| <i>Author(s)</i>             | <i>Country(ies)<br/>+Economy<br/>classification</i> | <i>Study's period</i> | <i>Methodology(ies)<br/>/(unit root tests)</i>                   | <i>Key results</i>                                                                                                                                                           |
|------------------------------|-----------------------------------------------------|-----------------------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sa'ad, et al.<br>(2023)      | Nigeria<br>(developing)                             | 1970-2020(Y)          | NARDL<br><br>(PP)                                                | Asymmetry found with +ve shocks impact on variables being greater than the one caused by -ve ones                                                                            |
| Taufani, et al. (2022)       | 4 ASEAN<br>(Developing)                             | 1995-2020(Q)          | VECM                                                             | +ve shocks cause Malaysia and Brunei inflation to decline and Indonesia and Thailand to rise and vice versa in relation to -ve shocks. The overall results suggest asymmetry |
| Lacheheb and Sirag<br>(2019) | Algeria<br>(Developing)                             | 1970-2014(Y)          | NARDL<br>(ADF/KPSS)                                              | INFR responds asymmetrically to (+ve) shocks only in both LR&SR.                                                                                                             |
| Živkov et al. (2019)         | Central & easter Europe<br>(Developed)              | 1996-2018(M)          | Wavelet-based Markov-switching<br><br>(No unit roots test used)* | 1-6 % changes in INFR as OP changes by 100 % (low response)                                                                                                                  |
| Long and Liang<br>(2018)     | China<br>(Developing)                               | 1998-2018(Q)          | ARDL-NARDL<br><br>(ADF/PP)                                       | Unclear impact through ARDL. But asymmetric impact in the LR in response to (+ve) SoOP is transmitted to INFR stronger than effect of (-ve) ones.                            |
| Chin and Bala (2018)         | African members of OPEC<br>(Developing)             | 1995-2014(Y)          | Panel-NARDL<br>(Fisher-ADF/PP)                                   | Both (+ve) &(-ve) shocks impact INFR positively but with (-ve) ones being the stronger.                                                                                      |
| Jiranyakul (2018)            | Thailand<br>(Developing)                            | 1993-2016(M)          | UVAR<br>(Zivot and Andrews test)**                               | Symmetric rather than asymmetric nexus between INFR & SoOP.                                                                                                                  |
| Jiranyakul (2016)            | Thailand                                            | 1993-2015(M)          | UVAR                                                             | Symmetric rather than asymmetric                                                                                                                                             |

|                                                                                                                                                                     |                                                                           |              |                                             |                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|--------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                     | (Developing)                                                              |              | (PP)                                        | nexus between INFR & SoOP.                                                                                    |
| Kose and Baimaganbetov (2017)                                                                                                                                       | Kazakhstan<br>(In transition)                                             | 2000-2013(M) | SVAR<br>(ADF)                               | No inflationary impact found for both (+ve) & (-ve) SoOPs.                                                    |
| Choi et al. (2017)                                                                                                                                                  | 72 different countries<br>(Developed<br>Developing)                       | 1970-2016(Y) | IRF                                         | INFR rises with 0.4 % on average responding to a 10 % hike in OP.                                             |
| Malik (2016)                                                                                                                                                        | Pakistan<br>(Developing)                                                  | 1985-2014(Q) | Augmented Philip curve<br>(ADF/PP)          | asymmetric impact appears as OP changes continue increasing over every four past quarters.                    |
| Al Rasasi and Yilmaz (2016)                                                                                                                                         | Turkey<br>(Developing)                                                    | 1987-2015(Q) | VEC-VAR<br>(ADF/PP)                         | INFR raises as OP rises significantly. asymmetric impact evidenced.                                           |
| Sek et al. (2015)                                                                                                                                                   | 20 countries (low versus high oil dependency)<br>(Developed+, developing) | 1980-2010(Y) | ARDL<br>(LLC)                               | Both low & high-oil reliant countries INFR is affected by OP changes but indirectly in high-oil reliant ones. |
| Chou and Lin (2013)                                                                                                                                                 | Taiwan<br>(Developing)                                                    | 1981-2011(M) | Nonlinear-ECM<br>(ADF/PP/KPSS)              | LR-SR impact for SoOP on INFR of Taiwan.                                                                      |
| Huang and Chao (2012)                                                                                                                                               | Taiwan<br>(Developing)                                                    | 1999-2011(M) | Multivariate threshold<br>(ADF/PP/KPSS/KSS) | Only global Op effects INFR but not the local OP as prices exceeded the threshold level.                      |
| Cologni and Manera (2008)                                                                                                                                           | G-7 counties<br>(Developed)                                               | 1980-2003(Q) | SVAR<br>(ADF)                               | INFR increase in response to OP shocks in all G-7 nations                                                     |
| Hooker (2002)                                                                                                                                                       | USA<br>(Developed)                                                        | 1962-2001(Q) | Philip-curve                                | Strong impact of OP shock to US INFR Before 1981 but little or no effect after.                               |
| Y=yearly, M=monthly, Q=quarterly, D=daily, OP=oil price, LR=Long-run, SR=short-run, SoOP=shocks of oil prices, (+ve) positive, (-ve) =negative, INFR=inflation rate |                                                                           |              |                                             |                                                                                                               |
| *no unit root tests used as the wavelet-based model used assumes stationarity by default.                                                                           |                                                                           |              |                                             |                                                                                                               |
| **breakpoint unit root test                                                                                                                                         |                                                                           |              |                                             |                                                                                                               |

**Source:** Author's construct

**Appendix 3.3: Summary of Literature Reviewed Concerning SoOP & Unemployment Rate.**

| <i>Author(s)</i>                 | <i>Country(ies)<br/>+Economy<br/>classification</i> | <i>Study's period</i> | <i>Methodology(ies)<br/>/(unit root tests)</i>           | <i>Key results</i>                                                                                                                                     |
|----------------------------------|-----------------------------------------------------|-----------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Thuy Tien<br>(2022)              | Vietnam<br><br>(developing)                         | 1999-2020(Y)          | QQR<br><br>(Quantile unit root)                          | Negative & significant asymmetric effect is found with a stronger response to +ve shocks                                                               |
| Kocaarslan<br>et al. (2020)      | USA<br><br>(Developed)                              | 2007-2019(M)          | NARDL<br><br>(DF-GLS)                                    | US UNEMP rise as OP rise implying to asymmetric impact, but OP decline imposes insignificant impact on US UNEMP.                                       |
| Kocaaslan<br>(2019)              | USA<br><br>(Developed)                              | 1974-2014(Q)          | GARCH-VAR<br><br>(DF-GLS)                                | US UNEMP goes up responding to (+ve) SoOP & down responding to (-ve) ones.                                                                             |
| Cheratian et<br>al. (2019)       | MENA region<br><br>(Developing)                     | 1991-2017(A)          | Panel NARDL<br><br>(Fisher-<br>ADF/IPS/LLC/<br>Breitung) | +ve SoOP effects UNEMP in both MENA oil importers & MENA oil exporters positively in the LR & only exporters on the SR. negative shocks has no effect. |
| Driouchi and<br>Hamrit<br>(2019) | Algeria<br><br>(Developing)                         | 1990-2017(A)          | NARDL<br><br>(ADF/PP)                                    | Asymmetric cointegration is found between SoOP & UNEMP plus LR-SR asymmetric impact on UNEMP.                                                          |
| Trang et al.<br>(2017)           | Vietnam<br><br>(Developing)                         | 2000-2015(Y)          | VAR                                                      | unclear effect for (+ve) SoOP on UNEMP.                                                                                                                |
| Rahma et al.<br>(2016)           | Sudan<br><br>(LDC)                                  | 2000-2014(Y)          | VAR                                                      | (-ve) SoOP effect UNEMP significantly compared to (+ve) ones.                                                                                          |
| Bocklet and<br>Baek (2016)       | Alaska, USA<br><br>(Developed)                      | 1987-2014(Q)          | NARDL<br><br>(ADF)                                       | SR asymmetric and the impact is significant in response to (+ve) SoOP.                                                                                 |
| Ahmad<br>(2013)                  | Pakistan<br><br>(Developing)                        | 1991-2010(M)          | Toda Yamamoto<br><br>(ADF/PP)                            | +ve impact in the LR on UNEMP caused by SoOP.                                                                                                          |

|                                                                                                                                                                         |                                         |              |                                               |                                                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|--------------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Doğrul & Soytaş (2010)                                                                                                                                                  | Turkey<br>(Developing)                  | 2005-2009(M) | Toda Yamamoto<br><br>(ADF/ADF-GLS/PP/KPSS/NP) | +ve impact in the LR on Turkey's UNEMP caused by (+ve) SoOP.                                                                           |
| Cuestas and Gil-Alana (2018)                                                                                                                                            | Central & eastern Europe<br>(Developed) | 2000-2015    | ARDL-NARDL<br><br>(BP)*                       | any increase or decrease in the OP leads to an increase or decrease in natural unemployment & not the UNEMP rate (i.e., direct nexus). |
| Trang and Hong (2016)                                                                                                                                                   | Vietnam<br>(Developing)                 | 2000-2015(Y) | TVAR                                          | UNEMP rises as OP passed threshold of \$27.6 / bbl implying clear effect.                                                              |
| Ordóñez et al. (2011)                                                                                                                                                   | USA<br>(Developed)                      | 1957-2003(Q) | STAR model<br>(Sollis test)                   | OP hike can increase the UNEMP in US by 12 %.                                                                                          |
| Löschel and Oberndorfer (2009)                                                                                                                                          | Germany<br>(Developed)                  | 1973-2008(M) | VAR<br><br>(ADF/PP/KPSS)                      | UNEMP in Germany rises as OP rises.                                                                                                    |
| Y=yearly, M=monthly, Q=quarterly, D=daily, OP=oil price, LR=Long-run, SR=short-run, SoOP=shocks of oil prices, (+ve) positive, (-ve) =negative, UNEMP=Unemployment rate |                                         |              |                                               |                                                                                                                                        |
| *Breakpoint unit root test.                                                                                                                                             |                                         |              |                                               |                                                                                                                                        |

**Source:** Author's construct

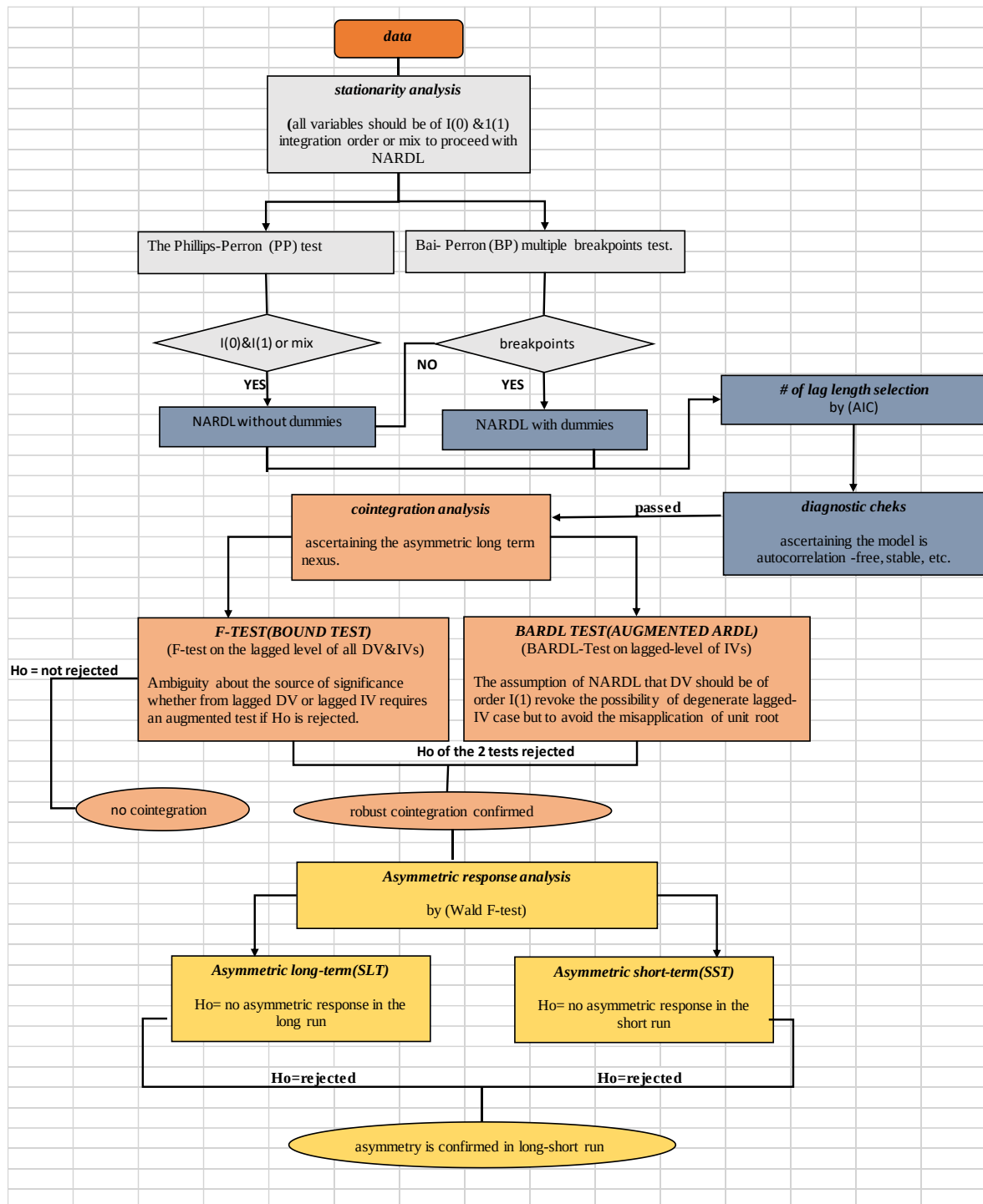
**Appendix 3.4: Summary of Literature Reviewed Concerning SoOP & Exchange Rate.**

| <i>Author(s)</i>               | <i>Country(ies)<br/>+Economy<br/>classification</i> | <i>Study's period</i> | <i>Methodology(ies)<br/>/ (unit root tests)</i>   | <i>Key results</i>                                                                                                                                              |
|--------------------------------|-----------------------------------------------------|-----------------------|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Deheri and Ramachandran (2023) | India<br>(developing)                               | 1994-2021(M)          | Impulse response +<br>Wald test<br><br>(DF/PP)    | Currency appreciated in response to +ve shocks indicating asymmetry in the response.                                                                            |
| Gao et al. (2022)              | Southeast Asia<br><br>(developing)                  | 1983-2018(M)          | non-causality tests +<br>Wavelet coherence method | bi-directional relation was found among variables in India and Bangladesh, and uni-directional was found in Pakistan and Sri Lanka.                             |
| Baek (2021)                    | OPEC<br><br>(developing, developed)                 | 2000-2017(M)          | NARDL<br><br>(DF-GLS)                             | The asymmetric nexus was found in the long-short run for countries adopting floating regimes only but not in members practicing the fixed exchange rate regime. |
| Sharma et al. (2018)           | India<br>(Developing)                               | 2015-2018 (D)         | Toda and Yamamoto<br>(ADF/PP)                     | oil price shocks granger causes Indian exchange rate                                                                                                            |
| Mohammed et al. (2019)         | Nigeria<br>(Developing)                             | 2010-2017(D)          | GARCH+EGARCH<br>(ADF)                             | Nigerian money increases as OP increases & vice versa.                                                                                                          |
| Abed et al. (2016)             | MENA<br>(Developing)                                | 2001-2015(D)          | GJR-GARCH +IRF<br>(ADF)                           | Asymmetric response & dynamic nexus between variables found. The impact is greater in the SR.                                                                   |
| Benhabib et al. (2014)         | Algeria<br>(Developing)                             | 2003-2013(M)          | VAR<br>(ADF/PP)                                   | No cointegration is found, yet + in oil price negatively impact Algeria currency in the SR.                                                                     |
| Riman et al. (2013)            | Nigeria<br>(Developing)                             | 1970-2010(Y)          | VAR<br>(ADF/PP)                                   | Local currency is negatively impacted by oil shocks on the LR (depreciation)                                                                                    |
| Coleman et al. (2011)          | 13 African countries                                | 1970-2004(Q)          | VECM, STR                                         | SoOP play key role in determining the rates                                                                                                                     |

|                                                                                                                                                |                                                                                                                                       |              |                                                                                                 |                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                | (Developing)                                                                                                                          |              | (Johansen test)                                                                                 | of exchange in most African countries, but the impact is different.                                           |
| Ghosh (2011)                                                                                                                                   | India<br>(Developing)                                                                                                                 | 2007-2008(D) | GARCH+EGARCH<br><br>(ADF/PP/KPSS)                                                               | SoOP-exchange rate nexus is symmetric rather than asymmetric                                                  |
| Basher et al. (2015),                                                                                                                          | Exporters (Brazil, UK, Russia, Norway, Canada) and importers (India, S. Korea & Japan).<br><br>(Developed +In transition +Developing) | 1976-2014(M) | Markov-switching<br><br><br>(DF-GLS/KPSS)                                                       | Both categories exchange rate significantly impacted by demand shock not with supply ones.                    |
| Taşar (2017)                                                                                                                                   | Romania<br>(Developed)                                                                                                                | 2004-2014(M) | Hatemi J (2012)-Roca (2014) test, Toda-Yamamoto test, Hacker and Hatemi-J test.<br><br>(ADF/PP) | Asymmetric nexus found through negative SoOP to Romanian exchange rate.                                       |
| Fratzscher et al. (2014)                                                                                                                       | Vietnam<br>(developing)                                                                                                               | 2001-2012(D) | SVAR<br><br>(Andrew's test) *                                                                   | Negative bi-directional association found between USD exchange rate and OP shocks.                            |
| Volkov and Yuhn (2016)                                                                                                                         | Canada, Norway, Brazil, Mexico & Russia<br><br>(developed, in transition & developing)                                                | 1998-2012(M) | GARCH-M<br><br><br>(PP)                                                                         | appreciation in the local currencies as OP rise. The OP impact is more significant in Russia, Brazil & Mexico |
| Y=yearly, M=monthly, Q=quarterly, D=daily, OP=oil price, LR=Long-run, SR=short-run, SoOP=shocks of oil prices, (+ve) positive, (-ve) =negative |                                                                                                                                       |              |                                                                                                 |                                                                                                               |
| *Breakpoint unit root test                                                                                                                     |                                                                                                                                       |              |                                                                                                 |                                                                                                               |

**Source:** Author's construct

#### Appendix 4.1. Steps of Performing NARDL-CEM



Source: Author's construct

#### Appendix 4.2. KPSS Test Results

| KPSS <sup>a</sup>      |                   |           |                            |           |          |
|------------------------|-------------------|-----------|----------------------------|-----------|----------|
|                        | Level             |           | 1 <sup>st</sup> difference |           |          |
|                        | Trend & intercept | Intercept | Trend & intercept          | Intercept | Decision |
| 1 % *                  | 0.2160            | 0.7390    | 0.2160                     | 0.7390    |          |
| 5 % **                 | 0.1460            | 0.4630    | 0.1460                     | 0.4630    |          |
| 10 % ***               | 0.1190            | 0.3470    | 0.1190                     | 0.3470    |          |
| Variables <sup>b</sup> |                   |           |                            |           |          |
| Gdpy                   | (9.5863)          | (0.8152)  | (0.0233)*                  | -         | I (1)    |
| Inflry                 | (0.6912)          | (0.8152)  | (0.0233)*                  | -         | I (1)    |
| Exchry                 | (1.2392)          | (26.9597) | (290.5441)                 | (0.1952)* | I (1)    |
| Unemplry               | (1.0407)          | (41.0968) | (0.2080)*                  | -         | I (1)    |
| SoOP                   | (57.3111)         | (14.7723) | (0.0315)*                  | -         | I (1)    |
| GDPcY                  | (8.8936)          | (28.4794) | (0.0616)*                  | -         | I (1)    |
| BM2                    | (0.0472)*         | -         | -                          | -         | I (0)    |

Notes:

<sup>a</sup>: KPSS tests the null hypothesis of the “variable is stationary”, The lag length is based on AIC under AR Spectral OLS;

\*, \*\*, \*\*\* : H<sub>0</sub> of KPSS is not rejected at 1 %, 5 % & 10 % significance level, respectively; values in () are the LM-stats which are compared with the critical values at the different significance levels 1 %, 5 % and 10 % for the decision of stationarity; null is accepted (i.e., variable is stationary) as LM value is smaller than given critical values at different significance level.

<sup>b</sup> : Yemen’s gross domestic product “Gdpy”, Yemen’s inflation rate “Inflry”, Yemen’s exchange rate “Exchry”, Yemen’s unemployment rate “Unemplry”, GDP per capita “GDPcY, money supply” BM2”.;

**Source:** Author’s construct based on EViews output

The KPSS results show that all variables, except BM2, are stationary at first difference under both trend-and-intercept and intercept specifications, indicating I(1). For GDPY, INFLRY, UNEMPLRY, GDPcY, and SoOP, the LM-stat values (0.0233, 0.0233, 0.2080, 0.0315, 0.0616) are below the critical values (0.2160, 0.1460, 0.1190) at all significance levels, except UNEMPLRY at the 1% level. EXCHRY, with an LM-stat of 0.1952, is stationary under intercept, showing slight divergence from ADF and PP results. Overall, KPSS confirms the variables are I(1), except BM2, which is I(0), consistent with ADF and PP findings.

### Appendix 4.3. Case 3 of Critical Values of Nayaran (2004)

Critical values for the bounds test: case III: unrestricted intercept and no trend

| 1 per cent  |        |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
|-------------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| n           | k = 0  |        | k = 1 |       | k = 2 |       | k = 3 |       | k = 4 |       | k = 5 |       | k = 6 |       | k = 7 |       |
|             | I(0)   | I(1)   | I(0)  | I(1)  | I(0)  | I(1)  | I(0)  | I(1)  | I(0)  | I(1)  | I(0)  | I(1)  | I(0)  | I(1)  | I(0)  | I(1)  |
| 30          | 13.680 | 13.680 | 8.170 | 9.285 | 6.183 | 7.873 | 5.333 | 7.063 | 4.768 | 6.670 | 4.537 | 6.370 | 4.270 | 6.211 | 4.104 | 6.151 |
| 35          | 13.290 | 13.290 | 7.870 | 8.960 | 6.140 | 7.607 | 5.198 | 6.845 | 4.590 | 6.368 | 4.257 | 6.040 | 4.016 | 5.797 | 3.841 | 5.686 |
| 40          | 13.070 | 13.070 | 7.625 | 8.825 | 5.893 | 7.337 | 5.018 | 6.610 | 4.428 | 6.250 | 4.045 | 5.898 | 3.800 | 5.643 | 3.644 | 5.464 |
| 45          | 12.930 | 12.930 | 7.740 | 8.650 | 5.920 | 7.197 | 4.983 | 6.423 | 4.394 | 5.914 | 4.030 | 5.598 | 3.790 | 5.411 | 3.595 | 5.225 |
| 50          | 12.730 | 12.730 | 7.560 | 8.685 | 5.817 | 7.303 | 4.865 | 6.360 | 4.306 | 5.874 | 3.955 | 5.583 | 3.656 | 5.331 | 3.498 | 5.149 |
| 55          | 12.700 | 12.700 | 7.435 | 8.460 | 5.707 | 6.977 | 4.828 | 6.195 | 4.244 | 5.726 | 3.928 | 5.408 | 3.636 | 5.169 | 3.424 | 4.989 |
| 60          | 12.490 | 12.490 | 7.400 | 8.510 | 5.697 | 6.987 | 4.748 | 6.188 | 4.176 | 5.676 | 3.783 | 5.338 | 3.531 | 5.081 | 3.346 | 4.895 |
| 65          | 12.400 | 12.400 | 7.320 | 8.435 | 5.583 | 6.853 | 4.690 | 6.143 | 4.188 | 5.694 | 3.783 | 5.300 | 3.501 | 5.051 | 3.310 | 4.871 |
| 70          | 12.240 | 12.240 | 7.170 | 8.405 | 5.487 | 6.880 | 4.635 | 6.055 | 4.098 | 5.570 | 3.747 | 5.285 | 3.436 | 5.044 | 3.261 | 4.821 |
| 75          | 12.540 | 12.540 | 7.225 | 8.300 | 5.513 | 6.860 | 4.725 | 6.080 | 4.168 | 5.548 | 3.772 | 5.213 | 3.496 | 4.966 | 3.266 | 4.801 |
| 80          | 12.120 | 12.120 | 7.095 | 8.260 | 5.407 | 6.783 | 4.568 | 5.960 | 4.096 | 5.512 | 3.725 | 5.163 | 3.457 | 4.943 | 3.233 | 4.760 |
| 5 per cent  |        |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 30          | 8.770  | 8.770  | 5.395 | 6.350 | 4.267 | 5.473 | 3.710 | 5.018 | 3.354 | 4.774 | 3.125 | 4.608 | 2.970 | 4.499 | 2.875 | 4.445 |
| 35          | 8.640  | 8.640  | 5.290 | 6.175 | 4.183 | 5.333 | 3.615 | 4.913 | 3.276 | 4.630 | 3.037 | 4.443 | 2.864 | 4.324 | 2.753 | 4.209 |
| 40          | 8.570  | 8.570  | 5.260 | 6.160 | 4.133 | 5.260 | 3.548 | 4.803 | 3.202 | 4.544 | 2.962 | 4.338 | 2.797 | 4.211 | 2.676 | 4.130 |
| 45          | 8.590  | 8.590  | 5.235 | 6.135 | 4.083 | 5.207 | 3.535 | 4.733 | 3.178 | 4.450 | 2.922 | 4.268 | 2.764 | 4.123 | 2.643 | 4.004 |
| 50          | 8.510  | 8.510  | 5.220 | 6.070 | 4.070 | 5.190 | 3.500 | 4.700 | 3.136 | 4.416 | 2.900 | 4.218 | 2.726 | 4.057 | 2.593 | 3.941 |
| 55          | 8.390  | 8.390  | 5.125 | 6.045 | 3.987 | 5.090 | 3.408 | 4.623 | 3.068 | 4.334 | 2.848 | 4.160 | 2.676 | 3.999 | 2.556 | 3.904 |
| 60          | 8.460  | 8.460  | 5.125 | 6.000 | 4.000 | 5.057 | 3.415 | 4.615 | 3.062 | 4.314 | 2.817 | 4.097 | 2.643 | 3.939 | 2.513 | 3.823 |
| 65          | 8.490  | 8.490  | 5.130 | 5.980 | 4.010 | 5.080 | 3.435 | 4.583 | 3.068 | 4.274 | 2.835 | 4.090 | 2.647 | 3.921 | 2.525 | 3.808 |
| 70          | 8.370  | 8.370  | 5.055 | 5.915 | 3.947 | 5.020 | 3.370 | 4.545 | 3.022 | 4.256 | 2.788 | 4.073 | 2.629 | 3.906 | 2.494 | 3.786 |
| 75          | 8.420  | 8.420  | 5.140 | 5.920 | 3.983 | 5.060 | 3.408 | 4.550 | 3.042 | 4.244 | 2.802 | 4.065 | 2.637 | 3.900 | 2.503 | 3.768 |
| 80          | 8.400  | 8.400  | 5.060 | 5.930 | 3.940 | 5.043 | 3.363 | 4.515 | 3.010 | 4.216 | 2.787 | 4.015 | 2.627 | 3.864 | 2.476 | 3.746 |
| 10 per cent |        |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 30          | 6.840  | 6.840  | 4.290 | 5.080 | 3.437 | 4.470 | 3.008 | 4.150 | 2.752 | 3.994 | 2.578 | 3.858 | 2.457 | 3.797 | 2.384 | 3.728 |
| 35          | 6.810  | 6.810  | 4.225 | 5.050 | 3.393 | 4.410 | 2.958 | 4.100 | 2.696 | 3.898 | 2.508 | 3.763 | 2.387 | 3.671 | 2.300 | 3.606 |
| 40          | 6.760  | 6.760  | 4.235 | 5.000 | 3.373 | 4.377 | 2.933 | 4.020 | 2.660 | 3.838 | 2.483 | 3.708 | 2.353 | 3.599 | 2.260 | 3.534 |
| 45          | 6.760  | 6.760  | 4.225 | 5.020 | 3.330 | 4.347 | 2.893 | 3.983 | 2.638 | 3.772 | 2.458 | 3.647 | 2.327 | 3.541 | 2.238 | 3.461 |
| 50          | 6.740  | 6.740  | 4.190 | 4.940 | 3.333 | 4.313 | 2.873 | 3.973 | 2.614 | 3.746 | 2.435 | 3.600 | 2.309 | 3.507 | 2.205 | 3.421 |
| 55          | 6.700  | 6.700  | 4.155 | 4.925 | 3.280 | 4.273 | 2.843 | 3.920 | 2.578 | 3.710 | 2.393 | 3.583 | 2.270 | 3.486 | 2.181 | 3.398 |
| 60          | 6.700  | 6.700  | 4.145 | 4.950 | 3.270 | 4.260 | 2.838 | 3.923 | 2.568 | 3.712 | 2.385 | 3.565 | 2.253 | 3.436 | 2.155 | 3.353 |
| 65          | 6.740  | 6.740  | 4.175 | 4.930 | 3.300 | 4.250 | 2.843 | 3.923 | 2.574 | 3.682 | 2.397 | 3.543 | 2.256 | 3.430 | 2.156 | 3.334 |
| 70          | 6.670  | 6.670  | 4.125 | 4.880 | 3.250 | 4.237 | 2.818 | 3.880 | 2.552 | 3.648 | 2.363 | 3.510 | 2.233 | 3.407 | 2.138 | 3.325 |
| 75          | 6.720  | 6.720  | 4.150 | 4.885 | 3.277 | 4.243 | 2.838 | 3.898 | 2.558 | 3.654 | 2.380 | 3.515 | 2.244 | 3.397 | 2.134 | 3.313 |
| 80          | 6.720  | 6.720  | 4.135 | 4.895 | 3.260 | 4.247 | 2.823 | 3.885 | 2.548 | 3.644 | 2.355 | 3.500 | 2.236 | 3.381 | 2.129 | 3.289 |

Source: Nayaran (2004)

**Appendix 4.4. Case 3 of Sam et al. (2018) Critical Values.**

| p = 0.010 |      |       |      |      |      |      |      |      |      |      |      |      |      |      |
|-----------|------|-------|------|------|------|------|------|------|------|------|------|------|------|------|
| n         | k=1  |       | k=2  |      | k=3  |      | k=4  |      | k=5  |      | k=6  |      | k=7  |      |
|           | I(0) | I(1)  | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) |
| 30        | 7.82 | 12.57 | 5.46 | 9.05 | 4.67 | 7.58 | 4.30 | 7.01 | 4.00 | 6.66 | 3.77 | 6.25 | 3.70 | 6.00 |
| 35        | 7.65 | 12.51 | 5.33 | 8.92 | 4.54 | 7.59 | 4.02 | 6.69 | 3.87 | 6.26 | 3.58 | 5.91 | 3.43 | 5.69 |
| 40        | 7.46 | 12.21 | 5.25 | 8.82 | 4.42 | 7.32 | 3.94 | 6.55 | 3.69 | 5.96 | 3.46 | 5.68 | 3.33 | 5.45 |
| 45        | 7.33 | 12.39 | 5.14 | 8.79 | 4.34 | 7.17 | 3.82 | 6.37 | 3.59 | 5.91 | 3.37 | 5.61 | 3.20 | 5.33 |
| 50        | 7.19 | 12.12 | 5.12 | 8.62 | 4.27 | 6.98 | 3.76 | 6.19 | 3.52 | 5.72 | 3.29 | 5.44 | 3.10 | 5.15 |
| 55        | 7.13 | 12.11 | 5.00 | 8.43 | 4.13 | 7.04 | 3.71 | 6.19 | 3.42 | 5.67 | 3.23 | 5.34 | 3.05 | 5.13 |
| 60        | 7.04 | 12.22 | 5.16 | 8.31 | 4.13 | 6.99 | 3.67 | 6.08 | 3.42 | 5.67 | 3.16 | 5.33 | 3.01 | 5.07 |
| 65        | 7.08 | 11.85 | 5.06 | 8.28 | 4.14 | 6.86 | 3.64 | 6.11 | 3.37 | 5.62 | 3.17 | 5.25 | 2.97 | 5.01 |
| 70        | 7.03 | 11.80 | 4.89 | 8.38 | 4.08 | 6.70 | 3.66 | 5.99 | 3.28 | 5.52 | 3.10 | 5.20 | 2.94 | 5.04 |
| 75        | 7.07 | 12.22 | 4.92 | 8.28 | 4.06 | 6.83 | 3.61 | 6.00 | 3.30 | 5.51 | 3.04 | 5.24 | 2.95 | 4.91 |
| 80        | 7.10 | 12.05 | 4.90 | 8.30 | 4.02 | 6.77 | 3.56 | 5.97 | 3.28 | 5.50 | 3.00 | 5.17 | 2.91 | 4.86 |
| ∞         | 6.65 | 11.76 | 4.58 | 7.94 | 3.86 | 6.46 | 3.40 | 5.68 | 3.05 | 5.12 | 2.81 | 4.79 | 2.68 | 4.54 |

| p = 0.050 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30        | 4.22 | 7.51 | 3.36 | 5.90 | 2.96 | 5.14 | 2.80 | 4.70 | 2.65 | 4.54 | 2.53 | 4.37 | 2.47 | 4.30 |
| 35        | 4.19 | 7.42 | 3.31 | 5.64 | 2.93 | 5.05 | 2.70 | 4.67 | 2.59 | 4.40 | 2.47 | 4.22 | 2.40 | 4.15 |
| 40        | 4.10 | 7.41 | 3.26 | 5.68 | 2.85 | 4.97 | 2.64 | 4.54 | 2.49 | 4.36 | 2.37 | 4.15 | 2.32 | 4.02 |
| 45        | 4.11 | 7.33 | 3.21 | 5.62 | 2.81 | 4.94 | 2.60 | 4.55 | 2.46 | 4.24 | 2.36 | 4.09 | 2.26 | 3.96 |
| 50        | 4.03 | 7.29 | 3.22 | 5.62 | 2.83 | 4.94 | 2.55 | 4.49 | 2.45 | 4.25 | 2.32 | 4.03 | 2.24 | 3.93 |
| 55        | 4.01 | 7.36 | 3.13 | 5.54 | 2.79 | 4.92 | 2.55 | 4.51 | 2.42 | 4.17 | 2.29 | 4.02 | 2.22 | 3.86 |
| 60        | 4.00 | 7.29 | 3.15 | 5.56 | 2.78 | 4.88 | 2.54 | 4.42 | 2.37 | 4.18 | 2.28 | 3.98 | 2.19 | 3.84 |
| 65        | 4.08 | 7.28 | 3.14 | 5.59 | 2.74 | 4.85 | 2.55 | 4.38 | 2.36 | 4.13 | 2.26 | 3.95 | 2.17 | 3.82 |
| 70        | 3.90 | 7.22 | 3.14 | 5.54 | 2.75 | 4.80 | 2.51 | 4.37 | 2.37 | 4.13 | 2.25 | 3.91 | 2.16 | 3.79 |
| 75        | 4.01 | 7.17 | 3.12 | 5.50 | 2.74 | 4.79 | 2.54 | 4.40 | 2.36 | 4.12 | 2.25 | 3.90 | 2.15 | 3.76 |
| 80        | 3.98 | 7.09 | 3.12 | 5.54 | 2.73 | 4.77 | 2.51 | 4.39 | 2.34 | 4.05 | 2.23 | 3.90 | 2.14 | 3.75 |
| ∞         | 3.79 | 7.21 | 3.01 | 5.42 | 2.62 | 4.65 | 2.39 | 4.18 | 2.24 | 3.90 | 2.12 | 3.72 | 2.01 | 3.58 |

| p = 0.100 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 30        | 2.88 | 5.34 | 2.53 | 4.54 | 2.30 | 4.11 | 2.22 | 3.84 | 2.12 | 3.76 | 2.06 | 3.62 | 2.02 | 3.55 |
| 35        | 2.85 | 5.31 | 2.48 | 4.43 | 2.30 | 4.04 | 2.14 | 3.82 | 2.07 | 3.67 | 2.00 | 3.52 | 1.95 | 3.48 |
| 40        | 2.84 | 5.37 | 2.45 | 4.46 | 2.23 | 4.03 | 2.11 | 3.76 | 2.03 | 3.63 | 1.95 | 3.49 | 1.92 | 3.39 |
| 45        | 2.87 | 5.30 | 2.41 | 4.43 | 2.20 | 3.97 | 2.08 | 3.76 | 2.00 | 3.58 | 1.94 | 3.46 | 1.88 | 3.38 |
| 50        | 2.82 | 5.29 | 2.40 | 4.44 | 2.23 | 3.99 | 2.06 | 3.74 | 2.00 | 3.57 | 1.90 | 3.42 | 1.86 | 3.34 |
| 55        | 2.83 | 5.36 | 2.38 | 4.37 | 2.20 | 4.02 | 2.06 | 3.72 | 1.99 | 3.54 | 1.90 | 3.41 | 1.85 | 3.31 |
| 60        | 2.80 | 5.31 | 2.41 | 4.40 | 2.19 | 3.99 | 2.05 | 3.67 | 1.95 | 3.55 | 1.89 | 3.41 | 1.83 | 3.31 |
| 65        | 2.86 | 5.34 | 2.42 | 4.37 | 2.15 | 3.94 | 2.05 | 3.68 | 1.96 | 3.51 | 1.87 | 3.39 | 1.83 | 3.28 |
| 70        | 2.73 | 5.32 | 2.38 | 4.43 | 2.17 | 3.91 | 2.04 | 3.67 | 1.95 | 3.49 | 1.86 | 3.36 | 1.82 | 3.25 |
| 75        | 2.78 | 5.24 | 2.37 | 4.34 | 2.16 | 3.94 | 2.04 | 3.68 | 1.92 | 3.51 | 1.87 | 3.37 | 1.80 | 3.26 |
| 80        | 2.80 | 5.24 | 2.36 | 4.36 | 2.16 | 3.93 | 2.04 | 3.66 | 1.92 | 3.45 | 1.86 | 3.35 | 1.80 | 3.25 |
| ∞         | 2.67 | 5.31 | 2.31 | 4.33 | 2.08 | 3.86 | 1.96 | 3.58 | 1.86 | 3.39 | 1.78 | 3.25 | 1.72 | 3.15 |

**Source:** Sam et al. (2018)

### *Appendix 5.1: Optimal Lag Selection Results*

| Lag selection |           |            |                 |           |            |
|---------------|-----------|------------|-----------------|-----------|------------|
| Variables     | # of Lags | AIC        | Variables       | # of Lags | AIC        |
| <b>Gdpy</b>   | 0         | 0.746998   | <b>Exchry</b>   | 0         | 2.215135   |
|               | 1         | -3.663919  |                 | 1         | -2.313997  |
|               | 2         | -4.304653* |                 | 2         | -2.580739* |
| <b>Inflry</b> | 0         | 4.033245   | <b>Unemplry</b> | 0         | --1.207568 |
|               | 1         | -0.196623* |                 | 1         | -9.090575* |
|               | 2         | 0.112051   |                 | 2         | -8.799056  |

Notes:

\* # of lag selected

AIC: Akaike information criterion

**Source:** Authors construct based on EViews output.

### *Appendix 5.2 : Mackinnon (1996) Critical Values*

| Sig.level   | Level               |           | First difference    |           |
|-------------|---------------------|-----------|---------------------|-----------|
|             | Trend and intercept | Intercept | Trend and intercept | Intercept |
| <b>1 %</b>  | -4.2845             | -3.6616   | -4.2967             | -3.6701   |
| <b>5 %</b>  | -3.5628             | -2.9604   | -3.5683             | -2.9639   |
| <b>10 %</b> | -3.2152             | -2.6191   | -3.2183             | -2.6210   |

**Source:** Authors construct based on EViews output.