The Implications of Covid-19 on the Imports of Oil from Saudi Arabia: The Case of Highest-importer Asian Countries

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Abstract: - There is a widespread consensus that COVID-19 pandemic is an unprecedented global crisis, as it has triggered waves of economic recession worldwide. Since the onset of the pandemic and until recently, a heightened theoretical debate about the dynamics and the economic implications of the pandemic is going on. In the context of this newly emerged literature on the macroeconomics of pandemics, the differences in the numbers of infection cases, along with the associated containment measures of the pandemic, are considered key factors to interpret the extent and magnitude of the adverse economic impacts. The objective of this study is to deliver a theoretical interpretation as well as empirical evidence about the implications of the global recession triggered by the pandemic on international trade with special emphasis on the exports of oil commodities from Saudi Arabia. To do so, an auto-regressive distributed lag (ARDL) econometric model was applied to data about the monthly infection cases of some Asian Countries with the previous highest record of oil imports from Saudi Arabia for the period from January 2019 to December 2022. These countries include China, Japan, South Korea, and India. The findings of the study indicate the existence of an indirect negative relationship between the number of corona infection cases in the selected countries and the quantities of oil imports from Saudi Arabia. In the short-run, an increase of one unit in corona cases is associated with a decrease of 0.08 in the quantity of oil imported from Saudi Arabia, while in the long-run an increase of one unit in corona cases, is associated with a decrease of 0.39. In addition, the findings indicate that the recession associated with the pandemic containment measures reflects a W-Shaped or double dip pattern.

Key-Words: - COVID-19 pandemic, infection cases, global recession, oil imports, Saudi Arabia, Asian Countries

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1 Introduction

There is a worldwide consensus that the COVID-19 pandemic is an unprecedented global crisis, as its adverse implications have pervaded more than 200 countries and territories along with considering it the most serious challenge faced by the world economy in more than a century. The negative economic implications of the pandemic were wide-ranging. According to [1], these implications vary by the stringency of the pandemic containment measures (e.g., social distancing, lockdowns, and related policies), its length of implementation, and the degree of compliance.

It is necessary to mention that the adopted containment measures to flatten the pandemic curve have led to a slowdown in production and mobility worldwide. In this context, the International Monetary Fund (IMF) expected that the contraction of the global economy would be of far greater magnitude than that of the 2008-2009 Global Financial Crisis. Whereas an early report from the IMF forecasted that, the global economy would contract by about 3% in 2020. However, this forecast was revised in a subsequent study to 4.9%, [1].

In the domain of international trade, the COVID-19 pandemic caused remarkable changes in the structure as well as the flow of this trade. A study published by the OECD reported that the changes in the structure of global trade in a single year were of a similar magnitude to the changes typically seen over 4-5 years, [2]. While the flow of international trade in 2020 marked the largest reductions in trade and output volumes since the Second World War episode, [3].

Taking the oil commodity as an example of vital good, the global contraction was highly synchronized with a significant drop in demand for

oil commodity during the year 2020. Consequently, the oil-exporting countries underwent severe economic and financial disruptions, particularly countries that are net exporters of oil. The vast majority of these countries experienced an unprecedented blow in April 2020 when the global oil market collapsed and the oil prices briefly went negative in real terms for the first time in history, [4]. What seems ever surprising is that the global demand for oil commodities under such lucrative prices was within its minimum limits.

However, the pattern of the pandemic-specific adverse effects is more pronounced in countries like Saudi Arabia. This is due to the fact that Saudi Arabia is the largest exporter of oil in the world and maintains the world's largest oil production capacity at nearly 12 million barrels per day. Furthermore, oil exports account for a large share of Saudi Arabia's economy. They accounted for nearly 70% of the country's total exports in terms of value in 2020, and about 53% of the Saudi government's revenues, [5].

Given the fact that the outbreak and rapid spread of COVID-19 were across Asian countries, which receive the lion's share of Saudi Arabia's oil exports (estimated in 2020 at 77%), Saudi Arabia underwent a real economic dilemma. This dilemma manifested itself in harsh fiscal and monetary measures from 2020 onwards. This is mainly because the major trade partners from Asia have adopted syncretized anti-epidemic measures to prevent its spread.

Therefore, this study aims to apply economic theoretical hypotheses about the dynamics and mechanisms of the pandemic in an attempt to deliver empirical evidence about the impact of the infection cases of the Covid-19 pandemic in these countries on the flow of oil imports from Saudi Arabia.

The rest of this study is structured as follows. Section 2 deals with the statement of the study problem in which the research question, research objective, and research hypothesis are highlighted. Section 3 focuses on a review of the literature related to the COVID-19 pandemic, including its dynamics and transmission mechanism into the economics domain, the patterns of economic recession and its recovery along with investigating the nexus between COVID-19 and oil. Section 4 is devoted to reviewing the empirical results of the study including the methodology, the model, and details about the findings of the study. While section 5 focuses on discussing the study findings and the conclusion.

2 Statement of the Problem

Although the economic consequences of Covid-19 have been a massive focus and substantial argument from the first generation of papers with the onset of the pandemic, there is a knowledge gap regarding the empirical evidence, particularly the negative impacts on oil exports of Saudi Arabia. To bridge this gap, our study will address the following aspects:

2.1 Research Question

The study tried to find out answers to the following questions:

- How do the infection cases in the major trade partner's countries in Asia contribute to the global recession in general and in the domain of international trade specifically?
- To which extent, has this global recession affected the imports of oil commodities from Saudi Arabia?

2.2 Research Aim and Objective

The study aims to:

- Show the nexus between the COVID-19 driven recession and the imports of oil commodities from Saudi Arabia.
- Test empirically the validity of the emerging economic hypotheses or approaches in the context of the so-called "coronanomics" or economics of corona pandemic.
- Suggest research topics, which might contribute to the theoretical and empirical debate related to the pandemics and international economics nexus.

2.3 Research Hypotheses

This research addresses two hypotheses:

Hypothesis 1 (H1):

There is a negative indirect relation between the number of infection cases in the trade partner countries in Asia and the quantities of oil imported from Saudi Arabia during the times of Covid-19 spread.

Hypothesis 2 (H2):

On the country level, the recession associated with the pandemic containment measures has heterogeneous patterns (not one size fits all countries). While on the global level, this recession reflects a pattern (shock geometry) of W-Shaped or double dip recession.

3 Literature Review

3.1 Background

At the very early stage of the pandemic, rapidly growing literature emerged to synthesize the insights around likely global recession driven by the pandemic. Although the magnitude of the pandemic and its economic impacts remain uncertain and difficult to predict. This is mainly due to the rare scientific contributions in this area and the unknown number of likely infections and death cases. The main interest of this growing literature was to answer the questions:

- What is the appropriate theoretical framework for interpreting the cross-border transmission mechanisms of the pandemic in the domain of economics (which is later denoted as coronanomics)?
- How deep are the devastating consequences of the global recession induced by the pandemic among the different international trade partners?
- Would the recession arising from the pandemic be V-shape, U-shape, W-shape, or L-shape (the recession durability)?

During this early stage and due to the lack of uncertainty about the pandemic behavior, the vast majority of the contributions tend to be explorative or prospective-oriented. In a later stage, when it seems that the pandemic will last longer, most of the contributions tend to be empirical and address economic policy issues. For more details about the literature and documents focusing on the economic and social consequences of the COVID-19 pandemic, see the contribution of [1].

3.2 Pandemic Dynamics and Transmission Mechanism into the Economics Domain

To understand the negative economic implications of the COVID-19 pandemic, it is important to understand the dynamics and economic mechanisms through which the pandemic will adversely affect the global economy so as stated by [1]. In this context, [6], delivered a lecture (At the London School of Business) under the title "The economics of a pandemic: the case of Covid-19". Both authors took the initiative to submit a pioneer theoretical interpretation for the likely global recession caused by the outbreak of the pandemic, [6]. The authors built their interesting analysis on the hypothesis of the so-called "race between supply and demand", which underlines four inter-related economic shocks induced by the outbreak of the pandemic as shown in Table 1 and Fig. 1:

Table 1. Scenarios of the race between supply and demand

Cycle/event	Stimulus	Ultimate consequence
First, Supply Shock	- Disruption in global supply chains. - Quarantine and social distancing. - Decreasing labor supply.	Aggregate supply (AS) moves from AS0 to AS1
Second, Demand Shock	- Uncertainty about the progress of the disease. - Uncertainty about economic policies. - Non-permanent workers affected industries will lose income. - Households increase precautionary savings - Firms are wary of investing until the situation clears (while many firms lack the liquidity to do so).	Aggregate demand (AD) shifts from AD0 to AD1
Third, Supply Shock	- Feedback loop into supply arises from the side of the firms lacking liquidity to fulfill commitments. - Some of the above firms are facing lower demand and thus are forced to file for bankruptcy.	Aggregate supply (AS) moves from AS1 to AS2
Fourth, Demand Shock	- Another feedback loop into demand arises from workers who lose jobs from closing businesses and do not have an income anymore. - Eventually, lower consumption from jobless workers depresses aggregate demand.	Aggregate demand (AD) shifts from AD1 to AD2

Source: Based on the analysis in Surico P. and Galeotti A., [6]

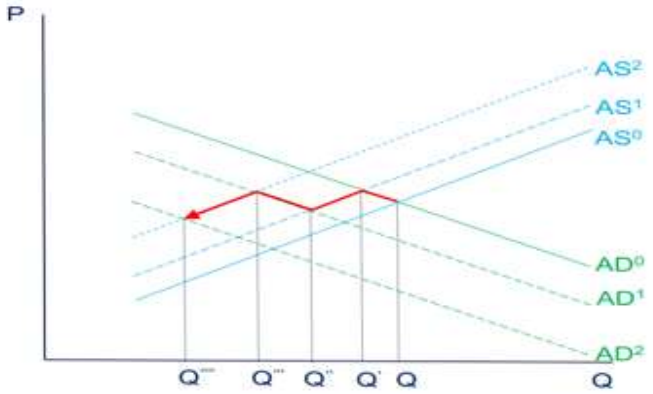

Fig. 1: Hypothesis of Race between Supply and Demand
Source: Surico P. and Galeotti A., [6]

Also in the same context, Baldwin R. and di Mauro (eds.) compiled an e-Book containing briefs of different authors. In an attempt to answer the question of how COVID-19 affects the economy, [7], adopted the so-called triple hit hypothesis. According to this hypothesis, the wide-ranging containment measures adopted worldwide to flatten the pandemic curve have the following implications, [7]:

"1. Direct supply disruptions will hinder production since the disease is focused on the world's manufacturing heartland (East Asia) and spreading fast in the other industrial giants – the US and Germany.

2. Supply-chain contagion will amplify the direct supply shocks as manufacturing sectors in less-affected nations find it harder and/or more expensive to acquire the necessary imported industrial inputs from the hard-hit nations ،and subsequently from each other.

3. There will be demand disruptions due to: (1) macroeconomic drops in aggregate demand (i.e. recessions); and (2) wait-and-see purchase delays by consumers and investment delays by firms."

[8], discussed in another contribution how trade volumes collapsed at the same time in all nations and for almost all products at a pace never seen before the spread of the pandemic. According to Richard Baldwin and Eiichi Tomiura, the interplay between the supply shock and the demand shock are likely responsible for slowing down global trade flows significantly. This is apparent from two dimensions:

"1. To the extent that COVID-19 is a supply shock, exports will fall, and they will fall most in the nations that are most severely hit.

2. To the extent that COVID-19 is a demand shock ،imports will fall ،and they will fall most in the trade partners of the nations that are most severely hit."

As a consequence, some argue that a large negative shock for oil prices would happen specifically in the oil-producing countries, in particular in the Middle East, [9].

Another interesting theoretical attempt at the economic implications of COVID-19 was delivered by Barua S. who tried to launch a model about the economics of COVID-19 or the so-called "coronanomics". In this attempt, she adopted a comprehensive approach to identifying the likely current and future economic implications of the pandemic, [10].

This model suggests general time-dependent (short-run and long-run) mapping of the likely macroeconomic impacts – such as on production, supply chain, trade, investments, prices, finances, exchange rates, growth, and cross-border cooperation (See Fig. 2). This model systematically reviews the impacts observed so far in the context of the mapping.

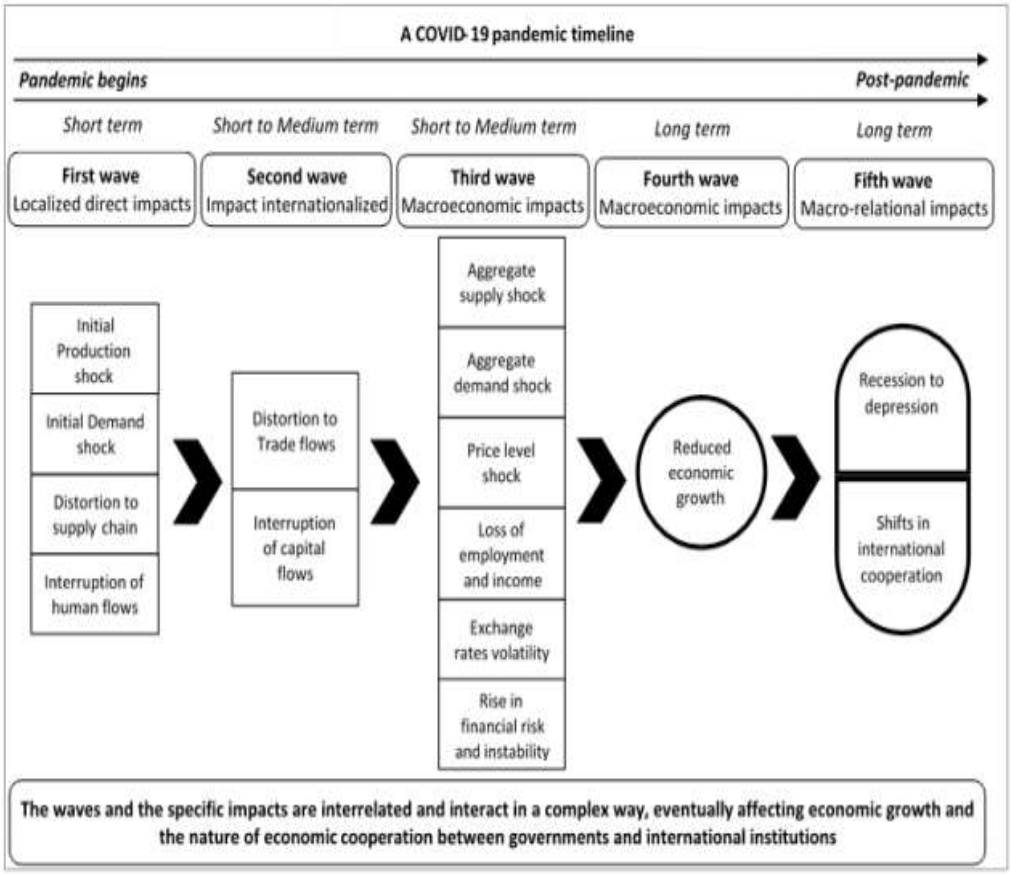

Fig. 2: Mapping of economic impacts of COVID-19
Source: [10]

It is necessary to mention that, the three reviewed economic models are unanimous about the fact that the recent global recession was triggered by a supply shock resulting from the containment measures to flatten the pandemic curve. Nevertheless, there is no consensus among these models regarding the depth and the length of interplay mechanisms between supply and demand.

On one side, the Surico and Galeotti model and the model of Baldwin and di Mauro seem to great extent similar. On the other hand, the model of Barua seems to be inclusive and more appropriate to deliver a solid theoretical interpretation of the implications of the COVID-19 pandemic on the Imports of Oil from Saudi Arabia. Furthermore, the latter model gives the possibility to interpret the likelihood of post-recession phase secondary effects (i. e. the recovery phase), which is not the case in the other two models.

3.3 Patterns of Economic Recession and Its Recovery

Recession as a sub-phase within a business cycle can take variant patterns and forms, which are depicted using alphabetic notations. The alphabets generally denote the graph of growth rate, which resembles the shape of the letter. The fundamental difference between the different kinds of recession is the time taken for economic activity to normalize. The time taken is often a factor of multiple things such as the depth of the economic crisis where the deeper the recession, the longer the time to get back to normal. Table 2. as well as Fig. 3 illustrate the most commonly known alphabetical analogies for the likelihood of a recession and its recovery:

Table 2. Scenarios of the race between supply and demand

Pattern	Characteristics
V-shaped	- The V-shaped recession or the so-called single dip recession is deep, a swift plunge but short-lived usually followed by bounces back strongly. - The recession of 1953 in the United States is an example of a V-shaped recession that economists typically attribute to the Korean War and the government's monetary policy at the time.
U-shaped	- A U-shaped recession is longer than a V-shaped recession and has a less-clearly defined through GDP - Examples of U-shaped recoveries are the 1973-75 Nixon recession and the 1990-91 recession following the S&L crisis in the US.
W-shaped	- In a W-shaped recession (also known as a double-dip recession), the economy falls into recession, recovers with a short period of growth, then falls back into recession before finally recovering, giving a "down up down up" pattern resembling the letter W. - The United States experienced a W-shaped recovery in the early 1980s. From January to July 1980 the U.S., the economy experienced the initial recession, and then entered recovery for almost a full year before dropping into a second recession from 1981 to 1982.
L-shaped	- L-shaped recession is and by far the worst pattern of depression, which occurs when an economy has a severe recession and does not return to trend line growth for many years, if ever. The steep decline, followed by a flat line makes the shape of an L. - What is known as the lost decade in Japan is widely considered an example of an L-shaped recovery. Leading up to the 1990s, Japan was experiencing remarkable economic growth.

Source: Compiled from [11], [12], [13], [14].

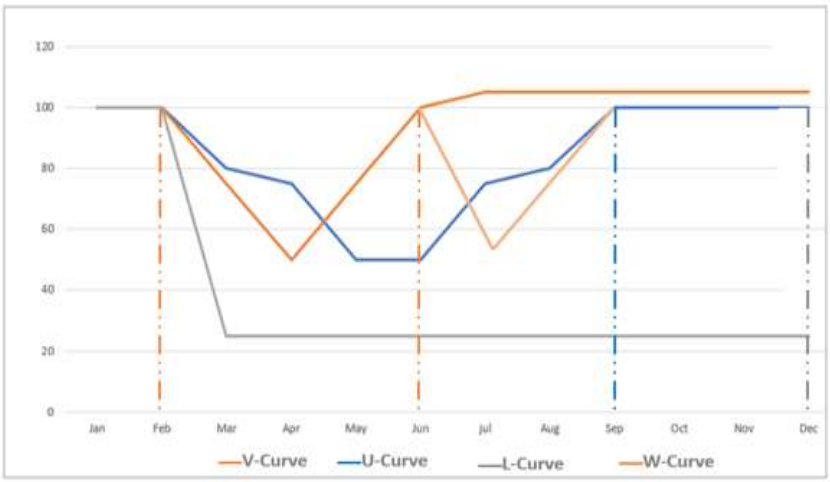

Fig. 3: Scenarios for alphabetical analogies of recession and its recovery

The bigger scenario question about the pattern or geometry of the shock, at the early stage of the outbreak of the pandemic, was the subject of speculation. However, when there was a high degree of likelihood that the COVID-19 pandemic would last longer, rare empirical contributions emerged to address this issue. For instance, [15], applied a qualitative assessment of the impact of Covid-19 on the economy using the Mark-0 Agent-Based Model. Depending on the amplitude and duration of the shock, this model described different kinds of recoveries (V-, U-, W-shaped), or even the absence of full recovery (L-shape). Furthermore, the findings of an empirical study conducted by [16], point in the direction of gradual, lengthy global recovery without identifying its displayed pattern whether it is U-shaped or it is L-shaped.

3.4 COVID-19 and Oil Commodities Nexus: Global Perspective

During the episode of the COVID-19 pandemic oil as a strategic commodity became one of the hottest issues and subject to continuous debate, particularly regarding the oil flow and the oil prices plunge during 2020.

In this context, a pioneer work by [17], tried, specifically to answer the question about what has been the source of the 2020 oil price collapse. In this paper, a three-pronged approach was used: an assessment of the drivers of the oil price decline at that time using a structural vector autoregression model (SVAR); an examination of previous oil market disruptions since 1970; and an estimation of the impact of previous oil price plunges on output using a local projections model. The study came out with the finding that the predominant oil price plunge is demand-driven and mainly arising from the pandemic outbreak and the restrictions needed to stem its spread. These restrictions have triggered a global recession and a steep drop in oil demand.

The dynamics of oil price volatility in the context of covid-19 were also examined by the study, [18]. This study also applied the Vector Autoregressive (VAR) econometric model. The study concluded that the pandemic has had a negative impact on the global oil industry in two manners:

> "First, it led to a demand shock as it reduced global demand for crude oil while increasing uncertainty for most developed and emerging economies. Second, it led to a supply shock as COVID-19 triggered an oil trade war between the major oil-producing nations (Saudi Arabia and Russia). Both shocks appear to have led to excessive oil price volatility".

[19], conducted a study about quantifying the long-term impacts of COVID-19 and oil price shocks in a Gulf oil economy (Kuwait as an example). The study used an economy-wide model in a CGE framework to enable assessing both direct and second-best effects of economic shocks or policies, making them the ideal structure for evaluating policy options or large-scale shocks such as COVID-19. The findings of the model indicate that the combination of COVID-19 shocks, its mitigation measures, and oil price declines largely harms the economy's GDP and causes a fiscal deficit.

Likewise, [20], tried to investigate the impact of the number of daily infection cases of corona on crude oil prices in Saudi Arabia. Using the ARDL model, the results of the study showed that the COVID-19 daily reported cases of new infections have a marginally negative impact on crude oil prices in the long-run. Nevertheless, by amplifying the financial markets' volatility, COVID-19 also has an indirect effect on the recent dynamics of crude oil prices. More about the relationship between the COVID-19 pandemic and the oil prices in Saudi Arabia is to be found in contributions of [21], [22].

3.5 The Difference between the Current Study and the Available Literature

The following aspects show the difference between our study and the previous studies in the literature review:

First: From the theoretical perspective, this study tried to compile inclusively the new emerging theoretical approaches related to pandemic economics or the so-called "coronanomics" in an attempt to deliver a realistic interpretation of the global recession induced by the pandemic.

Second: From an empirical perspective, the study laid special emphasis on two influential players in the domain of international trade, which include Saudi Arabia as the largest exporter of oil in the world and maintaining the largest oil production capacity in the world on one side. On the other side, the group of importer countries (China, Japan, South Korea, and India), are considered as manufacturing heartland of Asia and the world as well. To the best knowledge of the authors, the interaction between the two players (during the phase of the pandemic) has not yet been a major concern to any of the previous studies.

Third: Since there is no single standard COVID-19 recession in different parts of the world (No 'one size fits all'), but rather a variety of recession experiences, often varying with the reasons, timing, and complexity of the circumstances of the contraction, this study might come out with some new insights on the theoretical as well as on the empirical levels.

4 Empirical Results

4.1 Introduction

For testing the hypotheses of this study, four countries within the Asian sphere (China, Japan, South Korea, and India) were selected as they receive the lion's share of Saudi Arabia's oil exports. Out of this share 26%, 15%, 13%, and 11% went to China, Japan, South Korea, and India respectively (Fig. 4).

Secondary data about these countries was collected which includes statistics about corona infection cases and the quantities of oil imports from Saudi Arabia and the real GDP. The main source of this data was the IEA database (https://www.iea.org/data-and-statistics/data-tools/oil-stocks-of-iea-count).

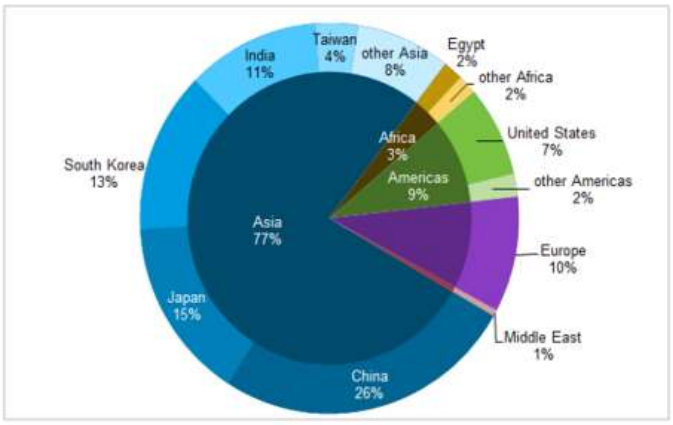

Fig. 4: Saudi Crude Oil Exports by Destination
Sources: EIA, [5]

4.2 Model Description

Equation (1) clarifies the linkage between Saudi oil exports Qxs and oil price P, Corona Cases in China CCc, Corona Cases in India CCi, Corona Cases in Japan CCj Corona Cases in South Korea CCk, Gross Domestic Product (GDP) in China GDPc, GDP in India GDPi, GDP in Japan GDPj GDP in South Korea GDPk, as follows :

$$Q_{xs} = f\left(P, CC_C, CC_I, CC_J, CC_K, GDP_C, GDP_I, GDP_J, GDP_K\right) \quad (1)$$

Table 3. Description of variables

Variable	Notation	Unit (b)
Saudi oil export	Q_{xs}	Barrels
Oil price	P	U.S. dollars per barrel
Corona Cases in China	CC_C	infection
Corona Cases in India	CC_I	infection
Corona Cases in Japan	CC_J	infection
Corona Cases in South Korea	CC_K	infection
GDP in China	GDP_C	Constant 2021 US$
GDP in India	GDP_I	Constant 2021 US$
GDP in Japan	GDP_J	Constant 2021 US$
GDP in South Korea	GDP_K	Constant 2021 US$

Table 3 presents the description of the variables. Moreover, we are overseeing the Autoregressive Distributed-Lag (ARDL) in this research. The ARDL model is one of the most recent dynamic approaches that takes the element of time into account. With the aim of identifying the short and

long-run rapport among the variables, as well as the speed of the system's convergence to equilibrium, we analyze long-run rapport between variables based on time series data. This model consists of two components:

(1) Autoregressive (AR) i.e., a model depending on its lagged values; meaning it uses the dependent variable as a Lagged independent variable, (2) Distributed Lagged (DL); indicating that the dependent variable is influenced by the changes in the independent variables and their lagged values.

Table 4. Variables Statistical analysis

variables	lnQ_{xs}	lnP	$lnCC_C$	$lnCC_I$	$lnCC_J$	$lnCC_K$	$lnGDP_C$	$lnGDP_I$	$lnGDP_J$	$lnGDP_K$
Mean	0.855	29.567	28.677	56.934	62.202	80.261	25.047	74.725	1.1082	4.603
Median	1.206	29.058	28.830	55.941	63.437	89.578	20.320	66.343	0.4961	7.151
Maximum	5.450	36.338	34.944	61.686	73.743	96.048	21.346	102.67	7.2321	7.524
Minimum	-5.148	21.284	22.758	53.732	50.491	56.622	19.292	47.742	-6.995	5.863
Std. Dev.	2.868	3.3863	3.2145	2.557	5.678	14.973	0.5792	11.012	2.6321	0.475
Skewness	-0.430	-0.1584	0.1508	0.539	-0.257	-0.381	-0.0608	-0.5558	-0.0524	1.041
Kurtosis	2.372	3.3497	2.4974	1.8724	2.992	1.372	1.7571	3.2636	3.5848	2.783
Jarque-Bera	3.969	0.7795	1.2025	8.5223	0.927	11.311	1.3981	3.7478	2.3140	9.463
Probability	0.137	0.677	0.5481	0.0141	0.628	0.0034	0.3744	0.0943	0.2186	0.0032
Sum	71.840	2483.6	2408.907	4782.48	5225.04	6741.962	894.62	2925.2	44.322	307.3
Sum Sq. Dev.	682.96	951.79	857.691	543.023	2676.30	18607.92	16.947	6128.2	349.98	11.43
Observations	48	48	48	48	48	48	48	48	48	48

Table 4 shows the descriptive statistics for the variables, to the homogeneity of the values of these variables, while the rest of the variables by percentage, when we applied logs, the distribution is better behaved.

The following equation shows the ARDL model for our study, as follows:

$$
\begin{aligned}
dLQ_{xs\ t} &= \alpha_0 + \alpha_1 LP_{t-1} + \alpha_2 LQ_{xs\ t-1} + \alpha_3 LCC_{C_{t-1}} + \alpha_4 LCC_{I_{t-1}} + \alpha_6 LCC_{J_{t-1}} \\
&+ \alpha_7 LCC_{K_{t-1}} + \alpha_7 LGDP_{C_{t-1}} + \alpha_8 LGDP_{I_{t-1}} + \alpha_9 LGDP_{J_{t-1}} + \alpha_{10} LGDP_{K_{t-1}} \\
&+ \sum_{j=1}^{l} \beta_{1j} \Delta LP_{t-j} + \sum_{j=0}^{m} \beta_{2j} \Delta LQ_{XS\ t-j} + \sum_{j=0}^{n} \beta_{3j} \Delta LCC_{C_{t-j}} + \sum_{j=0}^{o} \beta_{4j} \Delta LCC_{I_{t-j}} \\
&+ \sum_{j=0}^{p} \beta_{5j} \Delta LCC_{J_{t-j}} + \sum_{j=0}^{q} \beta_{6j} \Delta LCC_{K_{t-j}} + \sum_{j=0}^{r} \beta_{7j} \Delta LGDP_{C_{t-j}} + \sum_{j=0}^{s} \beta_{8j} \Delta LGDP_{I_{t-j}} \\
&+ \sum_{j=0}^{t} \beta_{9j} \Delta LGDP_{J_{t-j}} + \sum_{j=0}^{u} \beta_{10j} \Delta LGDP_{K_{t-j}} \\
&+ \mu_{it} \qquad (2)
\end{aligned}
$$

Where (d) refers to the second-difference operator; l, m, n, o, p, q, r, s, t, and u indicate lags; (α1 to α10) refer to long-run parameters; (β1 to β10) refer to short-run parameters; (α0) refers to the intercept; (μt) refers to the error term. The short-run effects are estimated from the following:

$$\begin{aligned} \mathrm{dLQ}_{xst} = \alpha_0 &+ \sum_{j=1}^{l} \beta_{1j} \Delta LP_{t-j} + \sum_{j=0}^{m} \beta_{2j} \Delta LQ_{XS\,t-j} + \sum_{j=0}^{n} \beta_{3j} \Delta LCC_{C_{t-j}} \\ &+ \sum_{j=0}^{o} \beta_{4j} \Delta LCC_{I_{t-j}} + \sum_{j=0}^{p} \beta_{5j} \Delta LCC_{J_{t-j}} + \sum_{j=0}^{q} \beta_{6j} \Delta LCC_{K_{t-j}} \\ &+ \sum_{j=0}^{r} \beta_{7j} \Delta LGDP_{C_{t-j}} + \sum_{j=0}^{s} \beta_{8j} \Delta LGDP_{I_{t-j}} + \sum_{j=0}^{t} \beta_{9j} \Delta LGDP_{J_{t-j}} \\ &+ \sum_{j=0}^{u} \beta_{10j} \Delta LGDP_{K_{t-j}} + \mu_{it} \end{aligned} \tag{3}$$

μ_ represents the speed of adjustments towards long-run equilibrium. If the system is moving out of equilibrium in one direction, then it will pull back to equilibrium, [23]. The steps followed are illustrated in Fig. 5 below:

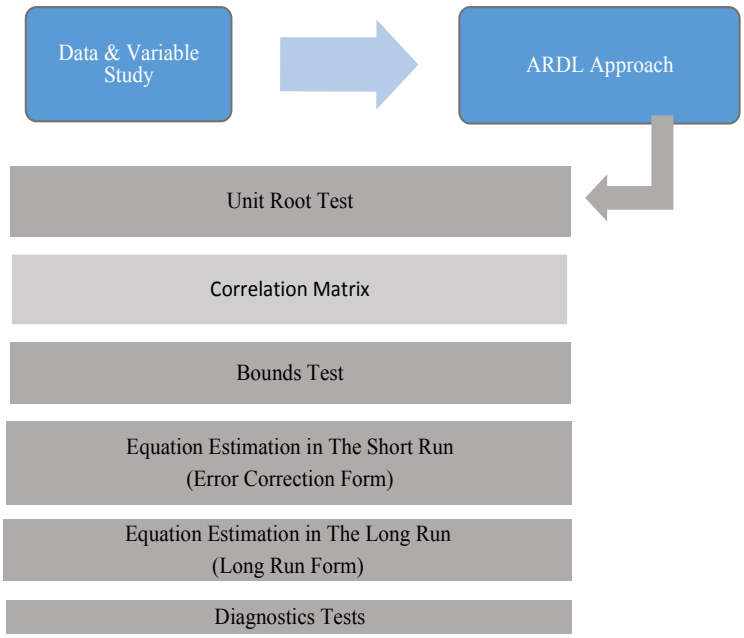

Fig. 5: Steps of Applied Study

4.3 Study Findings

We refer to unit root tests to ensure that the data fit the ARDL approach. A unit root test is performed to verify whether our time series data have a unit root. If it has a unit root, then the data is said to be not stationary. Several approaches, such as Philip Peron and Augmented Dickey–Fuller, were used to examine data stationarity. The test was performed to prevent us from developing a spurious or false regression. Table 5 shows the results of unit root tests, all variables were found to meet the stationary, which is required for the application of standard ARDL. Therefore, hypothesis testing could be carried out.

Table 5. PP Test and ADF Test Results

	PP Test				ADF Test			
Variable	**Level**		**1st difference**		**Level**		**1st difference**	
	t-Statis.	Prob.	t-Statis.	Prob.	t-Statis.	Prob.	t-Statis.	Prob.
LnP	-0.2102	0.2344	-6.3804	0.0016**	-2.1300	0.2344	-6.3804	0.0000***
LnQ_{xS}	-0.1674	0.4258	-5.0449	0.0004***	-1.6965	0.4258	-5.0449	0.0002***
$LnCC_C$	-0.3473	0.7121**	-9.9726	0.0000*	-3.5190	0.0121**	-9.9726	0.0000***
$LnCC_I$	-0.0402	0.0986	-7.1287	0.0096***	-0.4083	0.8986	-7.1287	0.0000***
$LnCC_J$	-0.2102	0.2544	-6.3804	0.0000***	-2.1300	0.2344	-6.3804	0.0000***
$LnCC_K$	-0.1674	0.4258	-5.0449	0.0002***	-1.6965	0.4258	-5.0449	0.0002***
$LnGDP_C$	-0.0868	0.1780	-2.4931	0.0000*	-0.8797	0.003025	-2.4931	0.0000***
$LnGDP_I$	-0.0105	0.0246	-1.7821	0.0096***	-0.1020	0.22465	-1.7821	0.0000***
$LnGDP_J$	-0.0525	0.0636	-1.5951	0.0000***	-0.5325	0.0586	-1.5951	0.0000***
$LnGDP_K$	-0.0418	0.1064	-1.2612	0.0002***	-0.4241	0.10645	-1.2612	0.0002***

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 6. Correlation Matrix Result - pair-wise correlations

	LnQ_{xS}	LnP	$LnCC_C$	$LnCC_I$	$LnCC_J$	$LnCC_K$	$LnGDP_C$	$LnGDP_I$	$LnGDP_J$	$LnGDP_K$
LnQ_{xS}	1.000									
LnP	0.554	1.000								
$LnCC_C$	0.685	0.636	1.000							
$LnCC_I$	0.671	0.594	0.183	1.000						
$LnCC_J$	0.583	0.234	0.196	0.236	1.000					
$LnCC_K$	0.562	0.698	0.539	0.274	0.451	1.000				
$LnGDP_C$	0.671	0.570	0.773	0.007	0.008	0.009	1.000			
$LnGDP_I$	0.717	0.447	0.031	0.795	0.007	0.004	0.556	1.000		
$LnGDP_J$	0.645	0.573	0.013	0.005	0.696	0.002	0.359	0.544	1.000	
$LnGDP_K$	0.665	0.448	0.066	0.001	0.009	0.658	0.406	0.471	0.482	1.000

Table 7. Bound Test Results

F-Statistic = 6.4265		
Significant Level	**Lower Bound**	**Upper Bound**
1%	2.08	3.25
5%	1.97	3.07
10%	**1.87**	**2.37**

One of the most important problems facing standard models and regression analysis is the linear correlation (multicollinearity) between the independent variables. It relates to the failure to fulfill one of the assumptions of the OLS method that in the absence of a strong linear regression model there is a correlation linkage between the independent variable and dependent, which makes it tricky to disconnect their individual effects on the dependent variable, [24].

However, according to [25], there are some indicators to detect this problem. Among these indicators, we can use the correlation matrix between the independent variables and the variance-inflating factor (VIF). A VIF greater than 10 and a pair-wise or zero-order correlation

coefficient between two regressions excess of 0.8 reveal severe multicollinearity, [26].

From Table 6, the correlation matrix indicates that there is no multicollinearity linkage between the independent variables as long as the Pearson correlation coefficient is less than (0.8).

A bound test was carried out to determine a co-integration relationship, and the results are reported in Table 7. The F-statistical value of 6.4265 is significant at 1%, higher than the upper bound of 3.25 and the lower bound of 2.08. Therefore, this indicates that there is a long-term cointegration relationship. However, there is no cointegration relationship if the F-statistic is lower than the upper and lower bounds. However, the results remain inconclusive if the F-statistic is between the upper and the lower bounds.

4.3.1 Short-run Estimation Results

The analysis of short-run and long-run relationships is based on the result in Table 8. As the table indicates the short-run CCc, CCi, CCj, and CCk significantly affect the P and Qxs in Saudi Arabia, and the parameter (P and Qxs) is positive, which means that there is a direct relationship between oil prices and the quantity imported. Whenever corona cases and GDP in selected countries increase by one unit, the quantity of oil imported from Saudi Arabia decreases by approximately (8%).

With regard to the results of the error correction model (C), the table shows that the error correction term (C) is highly significant at a specified level of significance, 5%, with the expected negative sign. That means the existence of a short-run equilibrium relationship cointegration among the model variables equals (3.6). This indicates the deviations corrected by approximately (3.6) within one year towards the short-run equilibrium. Based on the R-squared estimates in the model, the explanatory variables have an effect of (0.8913) of corona cases on the oil imports from Saudi Arabia.

4.3.2 Long-run Estimation Results

While the estimates of the long-run reveal that there is a statistically significant and negative economic relationship between both prices and the quantities imported from Saudi Arabia and the number of corona cases. That means a negative relationship in the long-run. That is an increase of one unit in corona cases, the prices and quantities of the exported oil decreased by (0.852), and (0.398) respectively.

The results of diagnostic tests reported in Table 9 are based on Jarque–Bera test, the Breusch–Godfrey serial correlation, the heteroskedasticity, and Ramsey's stability test. All these results showed insignificant F-statistics. Although these results indicate that the model used has no diagnostic problems, the variables of the study (imports, oil price, corona cases, and GDP in the selected countries) do not suffer from diagnostic problems as Table 9 depict.

To ensure the stability of the model, we refer to Cumulative Sum (CUSUM) as well as Cumulative Sum of Squares (CUSUMSQ) graphs (see Fig. 6 below). Since the two diagrams in the figure, show that all the plotted points were between the two red-colored bounds that mean the used model was stable.

Table 8. Long-run and Short-run Coefficient Results

Variables	Coefficient	Probability	Variables	Coefficient	Probability
	Long-run			Short-run	
LnQ_{xS}	0.398 ***	0.020	D(LnP)	0.015	0.010
LnP	0.852 ***	0.001	$D(LnQ_{XS})$	0.088	0.060
$LnCC_C$	−0.637 **	0.044	$D(LnCC_C)$	−0.266	0.008
$LnCC_I$	−0.314 **	0.007	$D(LnCC_I)$	−0.011 ***	0.003
$LnCC_J$	−0.149	0.111	$D(LnCC_J)$	−0.015	0.010
$LnCC_K$	−0.012	0.001	$D(LnCC_K)$	−0.266	0.000
$LnGDP_C$	0.579	0.009	$D(LnGDP_C)$	0.2417	0.005
$LnGDP_I$	0.285	0.028	$D(LnGDP_I)$	0.009	0.047
$LnGDP_J$	0.135	0.098	$D(LnGDP_J)$	0.0136	0.072
$LnGDP_K$	0.0109	0.035	$D(LnGDP_K)$	0.241	0.008
C	−58.4600	0.0049	ECT (-1)	−3.6502	0.0037
			R^2 = 0.8913	Adjusted R^2 = 0.8701	

*Note: ***, **, and * are significant at 1%, 5% and 10%, respectively.*

Table 9. Diagnostic Tests Results

F-Statistic = 6.4265		
Statistical Tests	**F-Statistics**	**Probability**
Jarque-Bera	0.082	0.673
Breush Godfrey collecting series	0.175	0.795
Heteroskedastisity test	1.870	0.102
Reset Ramsey Stability	1.435	0.1687

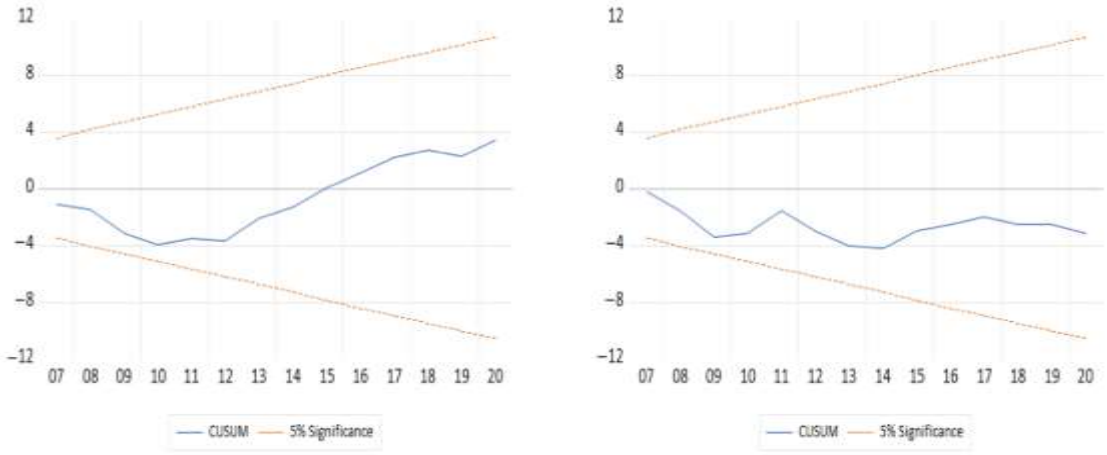

Fig. 6: Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMQ)

5 Conclusion

This study was conducted to investigate the implications of the global recession driven by the COVID-19 pandemic on the imports of oil commodities from Saudi Arabia. The study is based on the following hypotheses:

First Hypothesis:

There is a negative indirect relation between the number of infection cases in the trade partner countries in Asia and the quantities of oil imported from Saudi Arabia during the times of Covid-19 spread.

To test the validity of this hypothesis, the study used the econometric ARDL model where the short-run and long-run coefficient results indicate the existence of an indirect negative relationship between the number of corona cases in the selected countries from Asia (China, Japan, South Korea, and India) and the quantity of oil imported from Saudi Arabia. In numerical terms, an increase of one unit in corona cases in short-run, associated with a decrease of 8.8% in the quantity of oil imported from Saudi Arabia, in the long-run an increase of one unit in corona cases, is associated with a decrease by 39.8% in the quantities of the imported oil from Saudi Arabia. Therefore, these results provide evidence of the validity of the first hypothesis.

The interpretation of this indirect negative relation is as follows:

- Due to the increase in the number of corona cases, China, Japan, South Korea, and India must apply simultaneous containment measures to flatten the pandemic curve.
- These measures trigger a global recession in the form of supply shocks in the above group of oil-importing countries along with disruptions in the global supply chain (the triple hit hypothesis by Baldwin R. and di Mauro (2020).
- As a consequence of the supply shocks in the group of the oil importing countries, Saudi Arabia faces demand shocks related to its exports of oil along with a remarkable decrease in the oil price (the hypothesis of race between supply and demand by Surico and Galeotti (2020).

In light of these circumstances, a crucial question arises for how long Saudi Arabia remains suffering from this dilemma. The answer to this question is found in the second hypothesis.

Second Hypothesis:

On the country level, the recession associated with the pandemic containment measures has heterogeneous patterns (not one size fits all countries). While on the global level, this recession reflects a pattern (shock geometry) of W-Shaped or double dip recession.

As earlier mentioned, the fundamental difference between the variant patterns of recession is the time taken for economic activity to normalize in terms of the contraction or expansion in the GDP. In this context, Fig. 7 depicts the changes in GDP in the group of oil-importing countries from Saudi Arabia. Based on this figure the following was observed:

- In panel (a), the GDP for China reflects the classic (dip) V-shaped pattern of recession.
- In panel (b), the GDP for India reflects a pattern that is similar to the W-shaped recession.
- In panel (c), the GDP for South Korea reflects a pattern more or less similar to the U-shaped recession.
- In panel (d), the GDP for Japan reflects a pattern more or less similar to the V-shaped recession with a longer span of time.

There is no doubt, that this heterogeneity in the depth and the length of the recession among the selected group of the oil importing countries from Saudi Arabia provides one of the types of evidence about the validity of the second hypothesis about the pandemic-induced recession (not one size fits all countries).

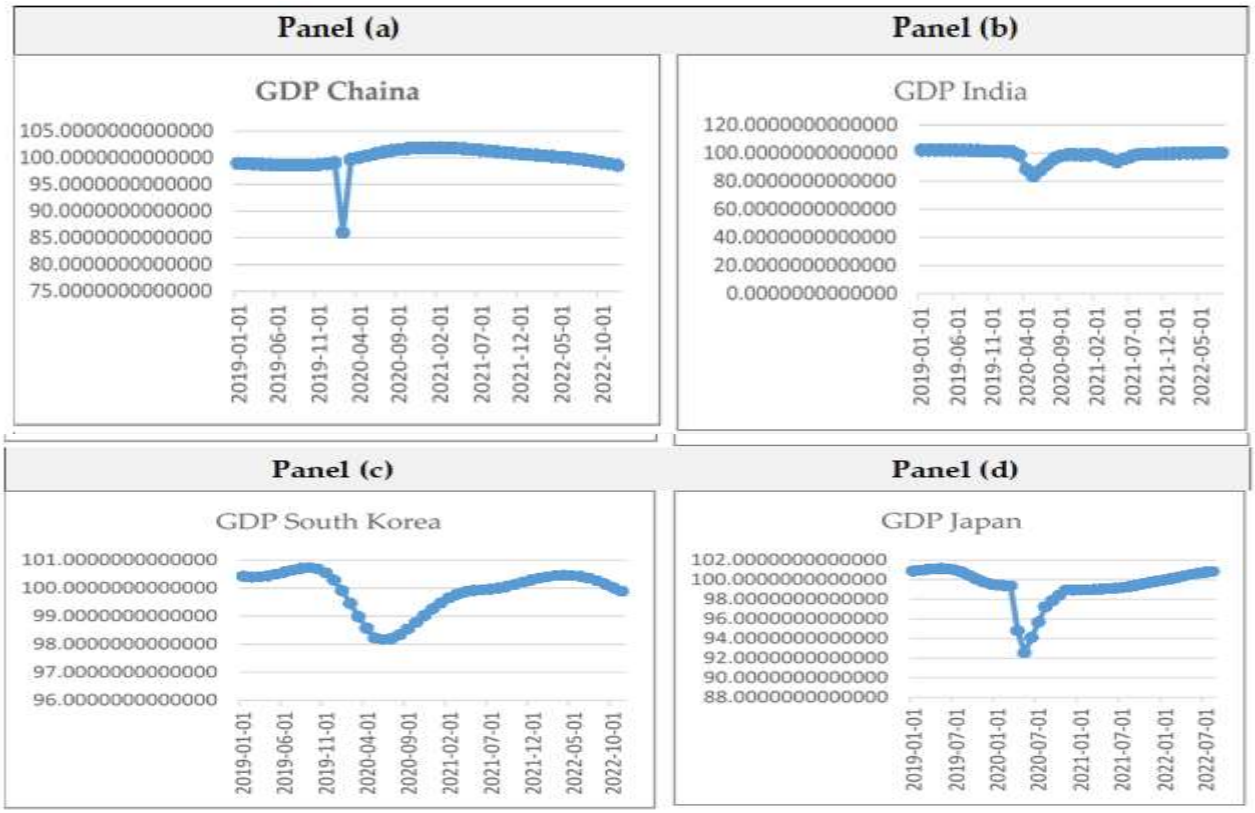

Fig. 7: GDP in the Selected Countries from 2019 to 2022

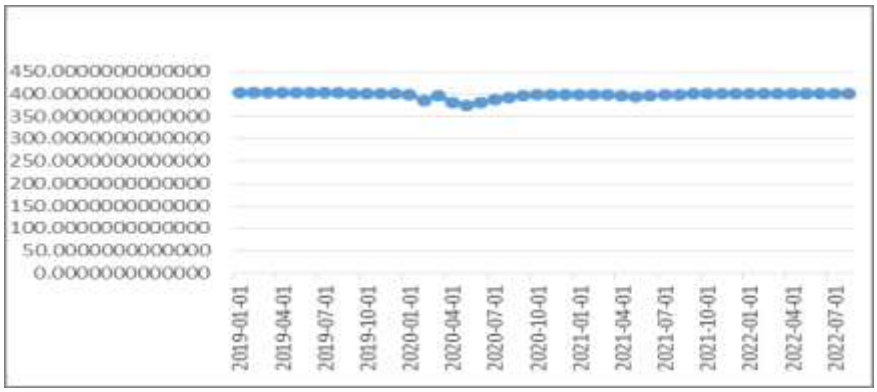

Fig. 8: GDP of the country group from 2019 to 2022

When it came to the recession on the global level, the total GDP for oil importing countries from Saudi Arabia has been used as a proxy for that (see Fig. 8). Figure 8 reflects a soft W-shaped pattern of recession between the periods from January 2020 up to November 2020. This particular pattern of the recession contributed to the evolution of the COVID-19 pandemic into four spikes/waves and India was at the heart of one of these waves. This analysis gives evidence for the second hypothesis.The findings of our study underscore the importance of a better understanding of the implication of the COVID-19 pandemic shocks on the flow of the oil commodity as well as oil prices. That means policy-makers and market stakeholders should explicitly consider any adverse consequences that might threaten the conditions of global health and at the same time, trigger global economic shocks to avoid any conflicts or contradicted outcomes between the policies in the health domain and policies and economics domain. This is typical, of what many countries face during the time of corona pandemic.

To summarize, the evidence from the preceding findings of our empirical study suggests the following lessons:

- No doubt, the experience of COVID-19 identified the fragility of our existing global trading system and its intricate supply chains.

- Economic diversification offers a kind of immunity against shocks akin to COVID-19.
- A high level of regional economic integration suggests adaptability and resilience against the likely global crisis including pandemic-driven crisis.
- Our current economic orthodoxy should be reassessed; in particular, those about our global trading order e.g. the *Ricardian* "theory of comparative advantage".

Against the backdrop of these lessons, policymakers and scientific research circles are seriously required to heed these lessons; otherwise, the next pandemic will hit us with even greater force.

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