A predictive strategy to mitigate the impact of the COVID-19 pandemic on the Saudi economy

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A B S T R A C T

This study aimed to examine the impact of the COVID-19 pandemic on Saudi Arabia's economy and to propose a strategy based on forecasting to lessen the negative effects of the pandemic while looking ahead to economic opportunities after the pandemic. The research utilized ARIMA models to predict important economic measures in Saudi Arabia, such as GDP, exports, imports, investment in assets, consumer spending, unemployment rates, inflation rates, and oil production, up to 2028, using the Box-Jenkins method. The results showed that the pandemic initially had a detrimental effect on the Saudi economy, with decreases in GDP, exports, and imports, as well as increases in unemployment and inflation. However, the study forecasts a positive recovery and growth in the economy after COVID-19. It recommends the adoption of a national policy to address the COVID-19 challenges, emphasizing the need for a comprehensive economic strategy to tackle the issues brought by the pandemic and to navigate the post-pandemic economic environment. This approach is in line with Vision 2030 and is intended to guide policymakers in developing and implementing strategies to reduce the pandemic's economic impact and support economic recovery.

1. Introduction

The world has witnessed an alarming pandemic, instilling terror and fear among populations worldwide. This unprecedented outbreak is attributed to the novel coronavirus, COVID-19, which emerged in December 2019 in Wuhan, Hubei Province, China. Since its initial identification, the infection has rapidly proliferated across the globe (Hu et al., 2021). Although the disease was first recognized in China, it has since spread to numerous other nations, either through cases directly traced to China or via international travelers originating from the country. While some countries managed to contain isolated cases, the unpredictability of new outbreaks remained a pressing concern (McKibbin and Fernando, 2021).

Therefore, the World Health Organization (WHO) declared a public health emergency of international concern, acknowledging the potential global pandemic scale of COVID-19. Effective response to this disease necessitates coordinated efforts among all nations to establish a unified policy in controlling its spread. The world's capability to accomplish such a task significantly influences mitigating financial losses, as instability can further exacerbate damage.

In emerging economies, the COVID-19 pandemic laid bare and amplified preexisting economic vulnerabilities, causing severe repercussions. This global crisis significantly worsened the economic fragilities already present in these regions, resulting in substantial income losses. For instance, in the Arab region, the pandemic induced an estimated 5.7% contraction in the economy in 2020, leading to a staggering loss of $152 billion in revenue. This dire situation has put numerous businesses and entire economic sectors at risk of collapse. Governments have implemented specific schemes targeted at the corporate sector, offering support in three main structures: government guarantees, low-interest rate debts, other forms of financial aid such as convertible bonds, and direct equity injections.

The pandemic has accelerated a shift from "great integration" to "great fragmentation." This shift is exemplified by emerging trade and investment restrictions and the closure of borders across

regions. Economies' resilience varies based on factors such as the timing and intensity of the impact of the virus, healthcare system preparedness, sectorial specialization, and financial capacity to address the shock. Emerging market economies have been particularly affected by the COVID-19 crisis.

Furthermore, the COVID-19 pandemic has triggered several economic repercussions, including workforce reductions, decreased consumption, and revenue, resulting in diminished profits and tax payments, thereby reducing investment capacity. Companies have reallocated assets toward current expenses, leading to increased unemployment and significant declines in revenue, affecting the tax base.

The COVID-19 pandemic wielded dual impacts: initially, the virus directly affected human development and capabilities, subsequently diminishing economic productivity and amplifying vulnerability. The Arab world's economies bore the brunt of numerous consequences stemming from this global crisis, encompassing an oil shock, trade disruptions, and economic turmoil. Tangible effects such as plummeting oil prices, a decrease in remittances, reduced visitor arrivals, and a pronounced surge in unemployment across several industries have become glaring realities.

The decline in oil and gas exports is predicted to be the most substantial channel through which COVID-19's impact will be felt in MENA nations. Since the pandemic's emergence in early 2020, oil prices have markedly decreased.

Researchers have confirmed the pandemic's adverse effects on the economies of all countries, notably affecting various economic indicators such as services, retail and wholesale trade, manufacturing, sales, revenues, and shipment values.

The COVID-19 pandemic has generated socioeconomic disruptions and affected all sectors of the economy. It has already had a significant passive influence on the international economy. The initial effect of stun is that profitability is antagonistically influenced, as a significant number of laborers are willfully or unintentionally missing from their working environments. This can upset inventory chains as organizations cease production or work below their ordinary limits. Specialists may require and have required lockdowns that upset typical business activity with the end goal of slowing the spread of the disease.

In this context, Jackson et al., 2020 asserted that the coronavirus outbreak has had an impact on the world economy because its appearance has had a negative impact on the economy. With it, investors lost confidence in the financial market, and many of them stopped their economic activities for fear that the situation would continue to deteriorate. This state of panic is not limited to investors, but also affects ordinary citizens. Many people go to the bank to withdraw their savings because they are worried that they will lose the money they earn in case of economic difficulties.

In addition, it is thought that COVID-19 may cost the global economy nearly one billion dollars in global product sales if it progresses into a pandemic. This has pushed Oxford University to warn about the spread of the disease out of Asia, as it led to a decrease in global income by 1.3% in 2020. It may also cause an increase in healthcare expenditure, an increase in absenteeism in the workforce, and a reduction in consumption.

The economic repercussions of the virus can be attributed to "aversion behavior," stemming from three primary sources. Firstly, government-imposed restrictions on specific activities contribute to this behavior. Secondly, firms and institutions proactively implement measures to prevent the spread of the virus, often resulting in business closures and subsequent wage losses for employees. Finally, individuals themselves decrease participation in market activities, travel, social outings, and various other social interactions (Evans and Over, 2020).

The World Development Report (WBG, 2022) affirmed that the COVID-19 pandemic has triggered the most severe global economic crisis in over a century, causing profound shockwaves across the world economy. This crisis has significantly amplified inequality within and among nations. Initial data suggests that the recovery from this crisis will be uneven, with emerging economies and marginalized groups requiring considerably more time to recover from income and livelihood losses caused by the pandemic.

Furthermore, countries facing high infection rates coupled with significant levels of production are expected to endure the most substantial economic impact. Projections indicate potential GDP losses in 2025 ranging from 0.76% in a base-case scenario to over 1% in a pessimistic scenario for countries with high infection rates and productivity levels. For instance, this could result in a loss of up to US$25 billion for a nation the size of the UK. In contrast, a reference nation with lower infection rates and productivity would experience losses of 0.019% to 0.023% of its GDP (approximately US$1 billion for an economy the size of the UK).

In response, developed nations have implemented protective measures to mitigate the impacts of COVID-19 on their economies. Germany, for instance, swiftly enforced regulations and financial support mechanisms to shield individuals and businesses from the abrupt halts in economic activity. Shutdowns have led to a drastic reduction in economic output across OECD countries, reaching as high as 20 to 30 percent in some nations. Border closures and trade disruptions have been experienced. Governments have swiftly implemented substantial policies. Germany specifically focused on offering financial support to businesses, especially small and medium-sized enterprises, through loan programs, liquidity assistance, and tax policy adjustments. These measures indicate a robust effort to stabilize the economy in the face of the pandemic.

In the USA, the economic impact of the COVID-19 pandemic hinges significantly on the effectiveness of

policymakers and business leaders in mitigating structural harm to the economy while curbing the virus. Amid this rapidly changing situation, the top priority is supporting workers and businesses affected by the initial lockdown. Policymakers have outlined substantial fiscal relief programs aimed at aiding individuals and businesses; the crucial next step involves implementing these plans. In this fast-evolving environment, both public and private sectors must remain adaptable and innovative, learning from successes and failures and making necessary adjustments as circumstances evolve (Lund et al., 2020).

In response to the COVID-19 outbreak, the Chinese government swiftly implemented supportive policies and protective measures to aid companies in resuming production. These measures include financial support, preferential tax incentives, improved social insurance policies to facilitate work and production resumption, service optimization, and cost reductions (Zhao et al., 2022).

In a globally interconnected landscape, Gulf countries, including KSA, have felt the impact of the Chinese economic slowdown due to China's significant oil imports. Consequently, this downturn may lead to a decline in global oil prices and diminish Saudi Arabia's reliance on China as its primary source of essential products. The financial markets in the Gulf region have experienced a decline due to reduced American shares, depreciation of petrochemicals, and inflation expectations, potentially exerting a negative effect on the Saudi economy.

The study aimed to assess the impact of the coronavirus pandemic on the Saudi economy. This was accomplished by developing models utilizing univariate time series, employing both seasonal and non-seasonal Autoregressive Integrated Moving Average (ARIMA) models to forecast key economic indicators. These indicators encompassed the Gross Domestic Product (GDP), exports, imports, Gross Capital Formation (GCF), Consumption Expenditure (CE), and Unemployment Rate (UR) among Saudi citizens, Consumer Price Index (CPI), and Crude Oil Production (COP). Leveraging the outcomes of these forecasts, a strategy was formulated to mitigate the economic repercussions caused by the pandemic.

2. Research significance and justifications

The current research holds significant importance due to its emphasis on a vital subject that ranks high among the concerns of all countries, including Saudi Arabia: The repercussions and influences of the COVID-19 outbreak on the Saudi economy. The outbreak of the coronavirus is deemed a threat to economic and social stability. This research provides justifications by addressing two primary aspects: first, aligning with Saudi Arabia's efforts to control the virus's spread, and second, understanding the passive impacts of the outbreak on the strength of the Saudi economy. Additionally, the study aims to propose a strategy to alleviate the

consequences and impacts of COVID-19 on various economic facets within Saudi Arabia.

This research can be immensely beneficial for health and economic sector managers, offering insights derived from anticipated results. These insights can aid in formulating necessary policies and procedures to counteract the negative effects of COVID-19. Furthermore, the selected economic indicators serve as crucial measures in evaluating the Saudi economy's performance amidst the ongoing pandemic.

Forecasting, both theoretically and practically, holds substantial significance as it offers invaluable insight into the future trajectory of the economy. While prior research utilizing ARIMA models focused on one or two economic indicators, this study sets a foundation for further research by analyzing a comprehensive set of the most crucial economic indicators within Saudi Arabia.

3. Literature review

Naseer et al. (2023) vividly illustrated the significant global economic repercussions of the COVID-19 pandemic. The article emphasized the widespread challenges posed by the virus and the uncertainty surrounding its full impact. Estimates from Bloomberg economists suggested that the virus, not yet at its peak, had already claimed numerous lives and could result in significant economic losses. Capital economists warned that without immediate action to curb the spread of COVID-19, China might face losses of up to $62 billion in the first quarter of the year, while the global impact could exceed $280 billion. The World Bank's projections indicated that even a mild influenza-like pandemic, such as the 2009 H1N1 outbreak, could slash global GDP by roughly half, equating to around $300 billion.

Vrontis et al. (2023) highlighted the COVID-19 impact on tourism and hospitality workers, emphasizing fears of virus exposure and job insecurity due to lockdowns. These employees, reliant on close interactions, faced increased job uncertainties as restrictions disrupted their roles. Amid the crisis, they leaned on societal support and employed personal problem-solving skills. Effective management support, providing practical aid and healthcare access, was identified as vital in mitigating mental health decline, crucial for employees facing pandemic-induced crises in these industries.

Cai and Xu's (2023) comprehensive study delved into the factors shaping the tourism-related economic resilience of China's coastal cities, examining their spatiotemporal evolution. Their findings unveiled intriguing trends. Initially, the fluctuation trends in tourism-related economic resilience across cities pre and post-pandemic showcased relative stability and convergence over time, with only a handful experiencing notable variations in fluctuation amplitudes in 2021. Secondly, factors such as a city's overall economic

standing, industrial structure, and tourism resource endowment, among others, significantly influenced the determinants of tourism's economic resilience pre and post-pandemic.

Rahman et al.'s (2023) study scrutinized the impact of COVID-19 on Kochi Heritage City, Kerala, analyzing its effect on the local economy and tourism-related services. Employing descriptive analysis, the study highlighted a negative impact on employability within tourism-related services, evidenced by declining local economic growth and reduced earnings. Notably, the impact on jobs and working hours displayed an asymmetrical pattern.

Stemmler's (2022) research investigated the pandemic's economic impact on businesses and their corresponding responses, distinguishing between essential and non-essential companies. The study noted substantial discrepancies in governmental assistance and the stringency of physical barriers across nations. Nearly 90% of countries responded to the economic strain by providing liquidity to businesses, fostering entrepreneurship, and extending financial support to small enterprises, aiming to alleviate the hardships faced.

Alharbi (2021) utilized a combination of a Computable General Equilibrium (CGE) model and micro-simulation to evaluate the impact of the COVID-19 pandemic on the economy of Saudi Arabia. The author conducted two simulations, severe and mild, based on existing literature and government guidelines due to limited data. The severe scenario, assuming prolonged lockdowns and a slowdown in global trade, resulted in a significant GDP decrease of approximately 10.14%, while the mild scenario showed a GDP decline of around 5.30%. The economic downturn heavily affected lower-skilled employees, leading to a sharp rise in unemployment due to the shutdown of numerous economic activities.

Takyi and Bentum-Enninb (2021) attempted to clarify the financial impact of COVID-19 from 2019 on the financial exchange execution in thirteen African nations, utilizing daily time arrangement securities exchange information from October 2019 to 3 June 2020 and affirmed that the coronavirus pandemic affected securities exchanges execution in African economies, which have decreased over the course of the pandemic by between −2.7% and −20%.

Similarly, He et al. (2020) investigated the direct and spill-over effect of COVID-19 on stock markets in some countries, including China, Italy, South Korea, France, Spain, Germany, Japan, and the USA. The results showed that the COVID-19 pandemic has a negative but short-term effect on stock markets, and the effect of COVID-19 on these stock markets has bidirectional spillover effects between Asian countries and European and American countries.

Initial indications imply that the post-pandemic recovery is poised to mirror the unevenness of its initial economic impact, with emerging economies and disadvantaged groups requiring considerably more time to rebound from the income and livelihood losses inflicted by the pandemic. As highlighted in the World Development Report (WBG, 2022), the COVID-19 pandemic reverberated across the global economy, instigating the most significant economic crisis witnessed in over a century. This crisis starkly exacerbated inequality, leading to a pronounced surge in disparities both within and among nations.

All governments have implemented some preventive procedures to reduce the harmful effects of COVID-19, as in such a circumstance, increased demand will only lift expansion, conceivably prompting stagflation (feeble or falling gross domestic product development closely followed by rising costs, which has occurred in China, Italy, and Germany). Unfortunately, this recession may be prolonged in the KSA, as it is one of the main nations producing and exporting oil, which forms the principal basis of its economy.

In the labor market, Germany's measures to contain the COVID-19 pandemic have affected the provision of services and the production of goods. For people who work for pay, this usually means short-term work (less or no working hours) and an indefinite decrease in income. The federal government hopes to reduce the impact of the new crown crisis on the labor market by promoting access to short-term work benefits and other tools. However, many people may still be unemployed.

In response to the COVID-19 pandemic, which affected all segments of Saudi society, the government has exerted considerable effort to counter the effects of the pandemic. In fact, it planned initiatives through a financial stimulus package of over 70 billion SAR to aid the private sector, particularly small and medium enterprises, which are the most affected.

The Saudi economy shrank in 2020 to 4.1%. This may be mainly due to the shrank of the oil sector, which was 6.7%, as a result of the low production of the Saudi Kingdom oil, according to the GAT agreement, in addition to the low international demand for energy products. In addition, the non-oil sector shrank to 2.3% because of the implementation of preventive actions and procedures to master the outbreak.

In addition, King Salman allocated 9 billion SAR to finance up to 60% of Saudi workers' compensation for those who are affected by the pandemic and provided a 30% rebate on power bills for purchasers in mechanical operations, business, and rural areas for an extended period (April–May), with the option to extend. The Saudi Arabian Monetary Agency (SAMA) further cut repo and converse repo rates by 75 premise focuses to 1.00% and 0.50%, respectively, to protect financial dependability in the midst of the pandemic. This could relieve the tension on borrowers if banks transmit the advantages to their clients. Moreover, the public authorities arranged pressing drives that cost more than 120 billion SAR to help the private sector, and most monetary exercises were influenced by the pandemic.

Furthermore, some economic measures were taken to support the private sector. They include the suspension of government tax payments, fees, and other fees to provide liquidity to the sector commissions to increase the financing through the National Development Fund, as well as temporary electricity appropriations for the commercial, industrial, and agricultural sectors. As the decline in oil prices will lead to a decrease in the government revenue, the government also announced that it would reduce expenditures in non-priority areas of the 2020 budget by SAR 50 billion (1.9 percent of GDP) to adapt to the new initiatives within the budget envelope (UN, 2020).

Giwa-Daramola and James (2023) attempted to determine the differential impacts of the COVID-19 pandemic on household microeconomic resilience in Sub-Saharan Africa by using direct measurements of economic indicators to measure the impact of the pandemic on 6249 households across Ethiopia and Nigeria. The Study findings showed that government containment measures improved household microeconomic resilience while self-containment measures lowered.

The study of Zdolšek and Beloglavec (2023) aimed to show how the ecology of sustainability reporting announcements, particularly those utilized by organizations, changed during the COVID-19 epidemic. It depicts the ecosystem's changes and future dynamics based on the examination of past events and written materials, including the main standard-setters (the International Sustainability Standards Board and the European Financial Reporting Advisory Group, or EFRAG). The study demonstrates that despite the alterations that took place during the COVID-19 pandemic, they had no impact on the ecosystem's growth and neither slowed nor stopped it. There was no lag caused by the COVID-19 epidemic. Alrashed et al. (2020) clarified that KSA imposed severe containment procedures and policies to control the spread of disease in the country, including partial lockdowns that actually contributed to significantly delay the spread in KSA by 5–6 months from anticipated 2.5 months when there is no lockdown at all.

KSA also placed restrictions on inbound Umrah pilgrimage, suspended the e-Visa program, banned inbound travel of individuals from COVID-19-affected countries, and restricted travel for GCC nationals who traveled to COVID-19-affected countries. The decision to ban Umrah pilgrimage services comes at an enormous cost to the economy of the country, including the airline, transport, and hospitality sectors, and has an adverse effect on the employment and livelihood of both local and immigrant workers in the holy cities of the kingdom (Ebrahim and Memish, 2020).

Alboaneen et al. (2020) sought to provide an accurate local forecast of the outbreak in Saudi Arabia in order to forecast verified COVID-19 cases across the country in real time by using two models: the Logistic Growth and the Susceptible-Infected-Recovered.

Yezli and Khan (2020) asserted that the Saudi government took some key measures to mitigate the transmission of COVID-19, including social distancing, closure of educational institutions, and suspensions or cancelations of the Umrah. These measures were taken in the interest of public and global health despite the socioeconomic, political, and religious challenges. The effect of these actions on the epidemic curve of Saudi Arabia and on the global fight against COVID-19 remains to be seen.

Despite the best efforts of the government, the decline in demand for oil driven by COVID-19 led to lower oil prices, thereby affecting the KSA's oil revenue and increasing the financial deficit, resulting in an expected double-digit fall in the nominal GDP. There are forecasts of a fall in real GDP of 5%, with both oil and non-oil sectors reporting contractions after the first half of 2020 (UN, 2020).

Moreover, Saudi Arabia's unrefined fares tumbled to a record low of 4.98 mm barrels each day (b/d) in June 2020, as COVID-19 has burdened worldwide oil interest and costs, provoking OPEC to announce cuts in production. Unrefined fares have begun a sluggish recuperation since the fall and reached a seven-month high of 6.35 mm b/d in November 2020. This was, in any case, below the all-around nine-year low of 6.82 mm b/d in 2019. Low oil income has burdened Saudi Arabia's present record balance, with an extended uncommon shortage of USD 17.1 billion in 2020, against an excess of USD 47 billion per year previously. Saudi Arabia's uncharacteristic income was additionally affected by a partial restriction on the Hajj—the Muslim journey—as Saudi specialists restricted the passage of far-off nationals to moderate the spread of COVID-19.

This deficit is projected to be limited over the next several years, hitting USD 8.3 billion by 2022. Saudi specialists performed financial alleviation measures and assessed approximately 7.3% of gross domestic product (WBG, 2020) to curb the impact of COVID-19 on the private sector. This consequently raises the public obligation to a projected 33.4% of the gross domestic product in 2020 from 22.8% the year prior. Public obligation is expected to increase imperceptibly in subsequent years, peaking at 34.3% in 2021. The inflation rate increased to an expected 3.6% from a low 2.1% every year prior, as the public authority increased the tank rate from 5% to 15% in July. Repercussions of this climb are projected to be felt well into 2021–2022, with inflation expected to top 3.7% in 2021. This follows further increases in vigorously financed energy and water duties.

Furthermore, the Saudi government has implemented procedures needed to support the financial requirements associated with the preventive steps taken to tackle COVID-19 and inhibit its spread in governmental institutions. The government is working to support all further funds, supporting health services for treatment, and increasing financial and economic performance. Therefore, there is a critical need for analysis of the potential consequences and impacts of the COVID-19 outbreak on the Saudi economy, a proposed strategy

to reduce these impacts, and a comprehensive plan of action to implement this strategy so people can feel economically safe and socially secure.

The impacts of the COVID-19 outbreak on the economy, as well as the modeling and use of economic prediction indicators, have been considerably studied from different perspectives by Althaqafi (2020). The study focused on the negative effects of the COVID-19 outbreak on the Saudi economy, how the kingdom attempted to deal with the crisis and confront it and plans for life after COVID-19. Algaissi et al. (2020) presented a review of Saudi Arabia's response to the COVID-19 pandemic and the lessons learned from the Middle East respiratory syndrome coronavirus (MERS-CoV) since 2012 that enable better preparation for the current pandemic. The findings confirmed the nation's availability, improvement in innovative work, and the extraordinarily quick, prudent steps that were taken by the Saudi government.

Additionally, Al-Youbi et al. (2020) investigated the implications of COVID-19 on the labor market of Saudi Arabia. The results demonstrated that virtual abilities, self-governing working, and powerful correspondence are the main abilities needed for the labor force in the medical care, administration, and instruction areas during and after pandemics.

Similarly, Ali and Mahgoub (2020) predicted the consumer price index (CPI) of Saudi Arabia for the next twelve months by applying Holt's linear model. The results indicated that the costs of completely bought merchandise will increase in the next eleven months. The creators suggested the application of different combinations of models with Holt's straight method while avoiding the constraint of forecast exactness of the considered model.

Alflayyeh et al. (2020) attempted to clarify the impact of the coronavirus (COVID-19) crisis on the retail business in KSA. The study results confirmed that customer preferences and purchasing behavior are also experiencing a gradual shift from the earlier patterns. In the wake of such adversity, where businesses have collapsed.

Awwad et al. (2021) estimated COVID-19 cases in Makkah region of Saudi Arabia: Space-time ARIMA modeling. The results show that STARIMA models are more reliable in forecasting future COVID-19 epidemics than ARIMA models during the period in which the curfew was lifted.

Algamdi et al. (2021) attempted to investigate the impact of COVID-19 deaths on oil prices and set probable scenarios for Saudi Arabia's economy. The findings showed that the death toll of COVID-19 has a significant impact on oil prices in Saudi Arabia. However, the preliminary results are mainly influenced by the situation reported in the USA.

The study by Eissa (2020) used an annual time series to predict the GDP per capita, using the Box–Jenkins autoregressive integrated moving-average (ARIMA) model for the Egyptian and Saudi Arabian economies. The model was applied to forecast the GDP per capita for Egypt and Saudi Arabia until 2030. The results conveyed that the most exact measurable models were ARIMA (1,1,2) and ARIMA (1,1,1), respectively. The symptomatic tests revealed that the two models were both steady and dependable, and their results were in line with past literature.

Havrlant et al. (2021) aimed to clarify the impact on sectorial and overall GDP by designing three scenarios to be applied to the Saudi economy, reflecting the seriousness of the stun, its sectoral dissemination, and the time required for recuperation. The outcomes affirmed that the adverse consequence for feature gross domestic product in 2020 was expected to go from −4.8% to −9.8%, contrasted with the gauge level, while the public authority's monetary countermeasures brought about a constructive outcome of 2.5% in genuine gross domestic product.

Abuhasel et al. (2022) applied the SIR model to predict the most elevated number of cases that might be reached and the flattening of the curve thereafter. The ARIMA model was utilized to anticipate the frequency of cases. The outcomes demonstrated that the regulation strategy utilized by Saudi Arabia to check the spread of the illness was effective. Close association among individuals may drive the public authority to make estimates that are considerably more severe. The authors presumed that the ARIMA model would become a decent anticipatory strategy using current information.

Alzahrani et al. (2020) employed the ARIMA model to predict the daily numbers of COVID-19 cases in Saudi Arabia in a future time frame. The prediction results showed that, for the example of Saudi Arabia, the number will continue to increase, and the Umrah and Hajj excursions may be suspended. The authors proposed severe preventive and control measures to limit the spread of the infection, such as the implementation of a national curfew.

McKibbin and Fernando (2020) investigated seven unique scenarios for how COVID-19 may develop over the coming year by analyzing the effects of various situations on macroeconomic results and monetary business sectors in a worldwide mixture DSGE/CGE general balance model. The scenarios demonstrated that even a contained episode could influence the worldwide economy in the short term.

Havrlant et al. (2020) attempted to apply the input-output framework to assess the impact of the COVID-19 pandemic on Saudi gross domestic product and planned three distinct situations to address the increased vulnerability associated with future events. The V2030 IOT was utilized to interpret the arrangement of stuns into sectoral and feature gross domestic product impacts. An NTL satellite picture examination was also used to evaluate the adjustment of Saudi Arabia's monetary movement during the COVID-19 lockdown. The examination of two NTL pictures demonstrated a general effect on the monetary movement of −7.9% on a yearly basis, which was in accordance with the

assessed adverse consequences in the medium IOT simulation scenario.

Along with the preceding studies, Stannard et al. (2020) analyzed the economic impacts of COVID-19 containment measures. The results demonstrated that the effect ranged from an estimated 4% reduction in GDP under alert level 1 up to 37% of GDP under level 4 and that this impact would not be uniform across the economy, with some sectors, such as tourism, being more heavily affected than others. The results were used to perform projections and scenarios.

Hutt (2020) examined the monetary influences of COVID-19 on the worldwide economy by concentrating on certain nations, for example, China and the USA, and the methods they used to control the spread of the virus, from one viewpoint, and their financial losses and the negative consequences, from another viewpoint. The study demonstrated that the administrations in nations with the pandemic made several choices that influenced financial losses, but COVID-19 still significantly negatively affected their economies. China's monetary development is expected to ease back to 4.5% in the principal quarter of 2020. Moreover, the demand for oil has diminished because of the closure of certain production lines.

In addition, Nicola et al. (2020) affirmed that the COVID-19 pandemic has generated fears of an approaching financial emergency and downturn. Social isolation, self-segregation, and travel limitations have prompted a diminished labor force across every financial area and caused the loss of numerous positions, and the demand for wares and produced goods has diminished.

It can be extracted that the impact of COVID-19 on economic activities is of great importance. Previous studies focused on the effect of COVID-19 on the GDP, economic growth, unemployment rate, and inflation. The empirical studies shed light on the importance of the ARIMA models and recommend their application in analyzing and predicting economic indicators.

The current research seeks to assess the impact of the COVID-19 outbreak on Saudi economic activities through the analysis and forecasting of relevant indicators: GDP, exports, imports, Gross Capital Formation, consumption expenditure, unemployment rate, Consumer Price Index, and the crude oil production using the non-seasonal and seasonal ARIMA models. The importance of this study consists of using econometric modeling of quarterly/monthly indicators to acknowledge the size of coronavirus shock in Saudi Arabia.

4. Research problem

The research problem can be articulated through the following questions:

1) What are the consequences and impacts of the novel coronavirus, COVID-19, on the Saudi economy?

2) Which model is most suitable for assessing changes in specific Saudi economic indicators as a result of the disease outbreak?

3) What strategies can be implemented to mitigate the consequences and impacts of COVID-19 on the Saudi economy?

5. Research objectives

The current research aims to propose a proposed strategy to mitigate the consequences and influences of the novel coronavirus COVID-19 on the Saudi economy by:

1) Assessing the consequences and impacts of the novel coronavirus, COVID-19, on the Saudi economy.

2) Recognizing the decisions related to protective procedures taken by the Saudi government to control the spread of the disease.

3) Employing ARIMA models to analyze changes in specific Saudi economic indicators resulting from the disease outbreak.

4) Developing an integrated strategy to alleviate the consequences and impacts of COVID-19 on the Saudi economy.

6. Methodology

The primary goal of the current research was to delineate and analyze the significant consequences and impacts of the virus outbreak on various economic sectors. This investigation aimed to leverage the valuable experiences in controlling the outbreak and mitigating the negative effects of COVID-19, thus contributing to the development of a proposed strategy. The analysis includes an in-depth examination of affected economic sectors in Saudi Arabia and comparative insights from similar economies in the region, fostering a comprehensive understanding of pandemic responses and their outcomes.

In pursuit of this objective, the researchers aimed to employ the most suitable models to explore the effects of the COVID-19 outbreak and forecast major Saudi economic indicators. These indicators were selected based on their accuracy and data availability. The researchers utilized Autoregressive Integrated Moving Average (ARIMA) models, a methodology developed by Box et al. (2015). This approach was founded on the world representation theorem, which asserts that every stationary time series has an infinite moving average (MA) representation. In essence, this signifies that its progression can be articulated as a function of its past developments (Jovanovic and Petrovska, 2010; Ali and Haleeb, 2020).

6.1. The significance of the use of ARIMA models

ARIMA models are widely utilized in univariate time series analysis, offering greater flexibility

compared to other statistical models such as exponential smoothing, simple linear regression, or dynamic stochastic general equilibrium (DSGE). These models are powerful tools for both analysis and forecasting, providing precise short-term forecasts for a sufficiently large volume of data on the variables under consideration (Granger and Newbold, 1986; Ali and Haleeb, 2020).

The key advantage of using ARIMA for time series forecasting lies in its ability to handle uncertainty without assuming prior knowledge of the underlying model or relationships, distinguishing it from some other methods. ARIMA models rely on past series values and previous forecast errors (Adebiyi et al., 2014). Moreover, they are advantageous for avoiding issues that may arise with multivariate models and for determining the non-seasonal variation required to achieve stationarity. Combining autoregressive and moving average characteristics along with trend data, ARIMA models capture complex relationships by observing error terms and lag terms. Therefore, they are highly valuable for handling economic time series data.

In this particular study, ARIMA models were employed to analyze and forecast the fluctuations in various economic indicators of the Kingdom of Saudi Arabia (KSA), encompassing all economic sectors. These indicators include real Gross Domestic Product (GDP), exports, imports, Gross Capital Formation (GCF), consumption expenditure (CE), Consumer Price Index (CPI), unemployment rate (UR), and crude oil production (COP). The indicators were thoroughly described, analyzed, and forecasted using the most suitable non-seasonal and seasonal ARIMA models following the Box-Jenkins approach. Model forecasting was rigorously examined through a dynamic process, with the EViews-V13 software utilized to run the models.

6.2. Mathematical formalization of ARIMA models

Mathematical formalizations are presented as follows:

- Non-seasonal ARIMA models: A non-seasonal ARIMA model is a combination of the AR (Autoregressive) and MA (Moving Average) models and is symbolized as ARIMA (p, d, q) where 'p' is the number of autoregressive lag, 'd' is the differencing lag and 'q' is the moving average lag (Dritsaki, 2016) and can be written as:

$$\Delta^d Y_t = \sum_{i=1}^{p} \beta_i \Delta^d Y_{t-i} + \sum_{i=1}^{q} \alpha_i \mu_{t-i} + \mu_t \qquad (1)$$

which can also be represented as:

$$\Delta^d Y_t = \sum_{i=1}^{p} \beta_i \Delta^d L^i Y_t + \sum_{i=1}^{q} \alpha_i L^i \mu_t + \mu_t \qquad (2)$$

where, Δ is the difference operator.
The final form of the ARIMA model is given by:

$$\varphi_p(B)\forall^d Y_t = \theta_q(B)e_t \qquad (3)$$

- Seasonal ARIMA models (SARIMA): A time-series is deemed seasonal if it contains at least one seasonal autoregressive parameter 'P' (SAR) or at least one seasonal moving average parameter 'Q' (SMA) or both parameters (P,Q) (Dritsaki, 2016). The general form of SARIMA, as proposed by Box et al. (2015) and Kendall and Ord (1990), is denoted as SARIMA (p, d, q)(P, D, Q)s, where 'P' is the number of autoregressive lag, 'D' is the differencing lag and 'Q' is the moving average lag, and 's' is the seasonal period. The model can be written as follows (Dritsaki, 2016):

$$\Delta^D Y_t = \sum_{i=1}^{P} \beta_{is} \Delta^D Y_{t-is} + \sum_{i=1}^{Q} \alpha_{is} \mu_{t-is} + \mu_t \qquad (4)$$

Which can also be represented as:

$$\Delta^D Y_t = \sum_{i=1}^{P} \beta_{is} \Delta^D L^{is} Y_t + \sum_{i=1}^{Q} \alpha_{is} L^{is} \mu_t + \mu_t \qquad (5)$$

where, Δ is the difference operator.
The final form of the SARIMA model is given by:

$$\varphi_p(B)\Psi_P(B^s)\forall^d\forall_s^D Y_t = \theta_q(B)\Theta_Q(B^s)e_t \qquad (6)$$

6.3. Box-Jenkins approach

The Box-Jenkins methodology comprises the following phases (Ma, 2022; Dritsaki, 2015; Abonazel and Abd-Elftah, 2019; Eissa, 2020; Ali and Haleeb, 2020):

- Establishment of time series stationarity: This initial phase involves verifying the stationarity of the time series data, a fundamental requirement for time series modeling. Stationarity determination is based on various analyses, including line graphs, scatter plots, Auto-Correlation Function (ACF), and Partial Auto-Correlation Function (PACF) graphs. Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and Phillips-Perron (PP) (Phillips and Perron, 1988) tests are typically used to identify and confirm stationarity. If the time series exhibits non-stationary characteristics, appropriate transformations such as differencing, variance stationarity, logarithm, or square root are applied to convert it into a stationary sequence.
- Model identification: The order of differencing is determined through the analysis of Auto-Correlation Function (ACF) and Partial Auto-Correlation Function (PACF) plots of the stationary series, establishing the order of the model.
- Model estimation: Computation algorithms are employed to calculate coefficients that best fit the selected ARIMA model. Maximum Likelihood Estimation (MLE) is used in this study. The criteria for selecting the optimum model involve the Akaike Information Criterion (AIC) and Schwartz Information Criterion (SIC).
- Model checking: The model undergoes diagnosis and optimization by subjecting the residuals to a white noise test. The residuals should demonstrate independence and remain constant in mean and

variance over time. The authors in this study employed the ARCH test to identify heteroscedasticity.

- Data forecasting: Once the selected model adheres to the specifications of a stationary univariate process, it is tested for its forecasting capabilities. Various statistical measures, including root mean squared error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE), and Theil's inequality coefficient (U), are used for forecasting evaluation.

6.4. Data description

The quarterly real Gross Domestic Product (GDP) in current prices, along with data on exports, imports, Gross Capital Formation (GCF), and Consumption Expenditure (CE) expressed in millions of Saudi Riyals (MSAR), were sourced from the Saudi General Authority for Statistics. The data spans from 2003Q1 to 2023Q2, totaling 82 observations. Quarterly data on the Unemployment Rate (UR) was obtained from the Saudi General Authority for Statistics, covering the period from 1999Q1 to 2023Q2, comprising 98 observations. Additionally, quarterly data on Crude Oil Production (COP), expressed in Million Barrels per Day (MBPD), was gathered from the Organization of the Petroleum Exporting Countries (OPEC), spanning from 1993Q1 to 2023Q3, with a total of 123 observations. The Consumer Price Index (CPI) data was collected monthly from the Saudi General Authority for Statistics, covering January 1995 to September 2023, totaling 345 observations.

Subsequently, these economic indicators were selected and studied due to their significance in evaluating the impact of the COVID-19 outbreak on macroeconomic performance. Other indicators were not studied due to data limitations, as economic aggregates are typically calculated annually, thereby lacking the precision to show the exact effect of the pandemic over each period. Leveraging this data, appropriate ARIMA models were developed and utilized to forecast the values of each indicator until 2028Q4 for real GDP, exports, imports, GCF, CE, UR, and COP. The CPI values were forecasted until December 2028.

7. Results

7.1. Stationarity of the time series

The fundamental requirement for time-series modeling is to establish the stationarity of the data. Stationarity was assessed based on various analyses, including line graphs, scatter plots, the auto-correlation function (ACF), and partial auto-correlation function (PACF) graphs of the time series. Augmented Dickey–Fuller (ADF) (Dickey and Fuller, 1979) and Phillips–Perron (PP) (Phillips and Perron, 1988) unit root tests were utilized to examine variance, trend, and seasonal variation and to confirm stationarity. The descriptive statistics for the time series are summarized in Table 1. Fig. 1 depicts the substantial impact of the COVID-19 pandemic on the real GDP. Notably, there was a significant decline in the real GDP, dropping by 7.8% from 2019Q4 to 2020Q2, signifying the profound effect of COVID-19 on the Saudi economy. These observations align with several studies by Eissa (2020), Havrlant et al. (2021, 2020), Stannard et al. (2020), and McKibbin and Fernando (2020) affirming the adverse impact of the COVID-19 pandemic on the GDP of various nations, including the United States, China, and Australia.

Table 1: Descriptive statistics of the time series

|	GDP	Exports	Imports	GCF	CE	UR	CPI	COP
Mean	538285.5	246858.8	153203.1	144877.2	295131.9	11.01020	80.82987	9.060569
Maximum	760044.3	367106.3	224442.6	235522.9	445287.2	15.40000	109.7200	10.90000
Minimum	198095.2	11154.00	42972.00	34631.50	110994.0	7.900000	62.53499	7.280000
Std. dev.	164576.3	70183.09	45447.49	51608.08	101493.5	1.560828	16.55203	0.865586
Jarque–Bera	8.677461	22.37024	16.47036	8.962241	7.249723	2.112335	40.14391	6.527150
Probability	0.013053	0.000014	0.000265	0.011321	0.026653	0.347786	0.000000	0.038251
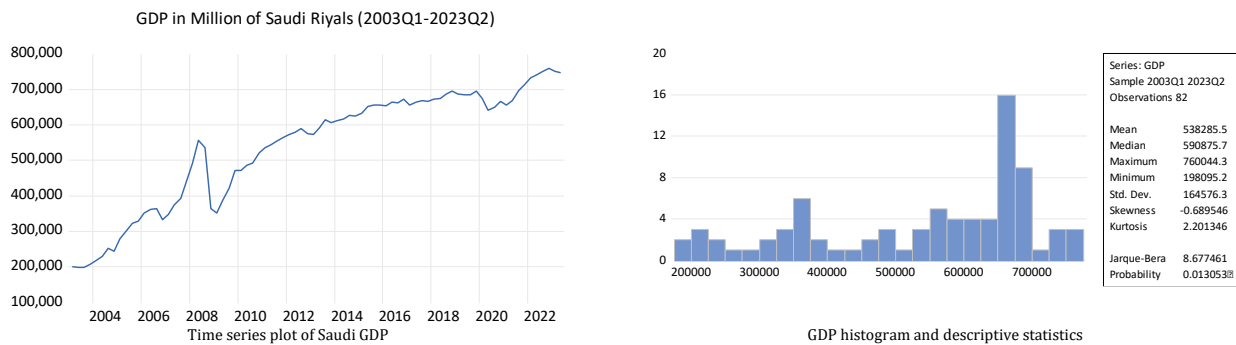
Fig. 1: Time series plot and histogram and descriptive statistics of GDP

However, following the dip in 2020Q2, a recovery ensued in the latter half of 2020, showing a steady increase of 3.8% by the year-end. This positive trend extended into 2021, indicating a rebound from the preceding downturn. Consistent growth in real GDP through 2021Q4 suggests a phase of economic expansion. The upward trajectory continued into 2022, indicating sustained economic growth. The

Saudi real GDP showcased a 1% upturn from 2022Q2 to 2023Q2 despite some intermittent fluctuations. While the overall trend signals positive economic growth from mid-2019 to mid-2023, fluctuations and a slight decrease in GDP were observed in 2020, influenced by the COVID-19 pandemic.

The impact of COVID-19 on the Saudi Arabian economy has been multifaceted, affecting various sectors in distinct ways:

- Oil industry: Saudi Arabia heavily relies on oil exports, and the pandemic caused a significant drop in global oil demand due to reduced economic activity. This led to a plunge in oil prices, impacting the kingdom's revenue and necessitating austerity measures.
- Tourism and hospitality: Travel restrictions and lockdowns severely affected tourism and hospitality. Pilgrimage restrictions notably impacted religious tourism, affecting revenues from Hajj and Umrah.
- Retail and consumer goods: Restrictions and cautious consumer behavior led to reduced spending, impacting retail sectors. However, e-commerce saw a surge as people shifted to online shopping.
- Manufacturing: Supply chain disruptions affected manufacturing, especially sectors reliant on imports/exports. Yet, local production resilience increased, especially in essentials like food and pharmaceuticals.
- Financial markets: Stock markets experienced volatility initially, reflecting global uncertainties. However, the Saudi government took measures to stabilize markets and support businesses.
- Healthcare: Investments in healthcare increased due to the pandemic. The government allocated funds for healthcare infrastructure, medical

supplies, and vaccine procurement, impacting the healthcare sector positively.
- Employment and labor: The pandemic led to job losses and affected labor markets due to lockdowns and reduced economic activity. The Saudi government introduced initiatives to support employment and mitigate the impact on the workforce.
- Digital transformation: The pandemic accelerated digital transformation across sectors. Remote work, e-learning, and digital services saw rapid adoption, fostering innovation and tech advancements.
- Government response: Saudi Arabia implemented various measures to mitigate the economic impact. These included stimulus packages, financial support to businesses, and economic reforms to diversify the economy beyond oil.
- Vision 2030 goals: The pandemic prompted a reevaluation of the Vision 2030 goals, emphasizing the need for economic diversification and resilience against external shocks.

Consequently, the impact of COVID-19 on the Saudi economy has been significant and diverse, with sectors like oil, tourism, and retail facing acute challenges. However, it also accelerated certain transformations and prompted the government to introduce reforms aimed at economic diversification and resilience in the face of future uncertainties. Fig. 2 illustrates a notable decline in Saudi exports from 2020Q2 to 2020Q3, plummeting by 11%. This period coincides with the onset of the global COVID-19 pandemic, resulting in trade disruptions, supply chain constraints, and reduced demand for goods. Although a slight upturn in exports occurred from 2020Q3 to 2020Q4, levels remained below those of 2020Q2. The subsequent recovery appears gradual, indicative of the persistent challenges posed by the pandemic.
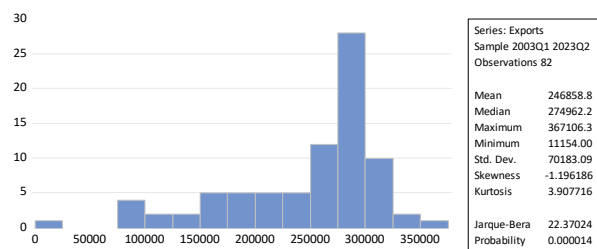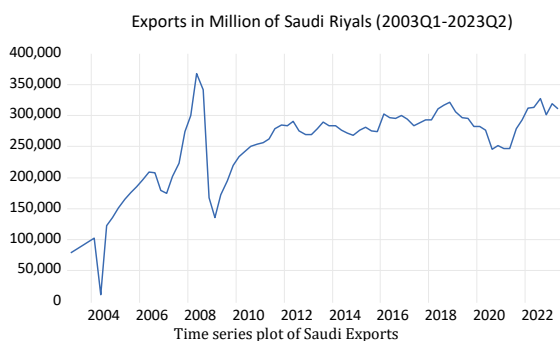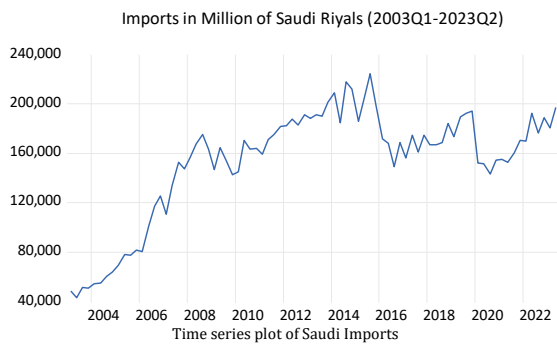

Fig. 2: Time series plot and histogram and descriptive statistics of exports

From Q4 2020Q4 to 2021Q2, there was a phase of moderate export growth, suggesting a receding initial shock and a gradual revival in global economic activity. A noticeable surge in exports by 2021Q4 indicates a robust rebound in international trade, buoyed by increased demand for goods and services as global vaccination efforts intensified and economies adapted to new norms. This positive trajectory extends into 2022, demonstrating resilient

and relatively stable export levels despite potential ongoing challenges. However, a downturn in exports in 2022Q4, possibly influenced by shifts in global demand, supply chain disruptions, or commodity price fluctuations, was followed by a subsequent recovery in 2023Q1. The slight fluctuations in 2023Q1 and 2023Q2 could stem from broader global economic conditions or specific industry challenges. In essence, the data reflects a recovery in Saudi

exports post-COVID-19, marked by fluctuations influenced by prevailing global economic conditions and pandemic-related challenges. Fig. 3 depicts a notable decline in imports from 2020Q2 to 2020Q3, a period coinciding with the onset of the COVID-19 pandemic.
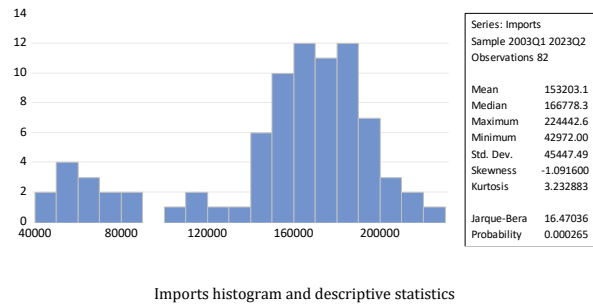

Fig. 3: Time series plot and histogram and descriptive statistics of imports

Disruptions in global supply chains, decreased consumer demand, and an overall economic slowdown likely contributed to reduced import needs during this phase. However, from 2020Q3 to 2020Q4, a modest uptick in imports signals a stabilization in global trade conditions. Countries adapted to new norms and implemented measures to mitigate the pandemic's impact, gradually improving the demand for imports. Throughout the subsequent quarters from 2020Q4 to 2021Q2, a relatively stable phase in imports emerges, suggesting a subsiding initial shock and an adjustment period amid ongoing challenges in trade activities. Between 2021Q2 and 2021Q4, a moderate increase in imports indicates further recovery in global economic activities. Progress in vaccination campaigns and societal adjustments likely boosted the demand for goods and services, contributing to increased imports. However, data from 2021Q4 to 2022Q2 implies a phase of relative stability in imports with intermittent fluctuations. External factors like shifts in global demand, disruptions in supply chains, or changes in commodity prices may account for these variations. Notably, there was a substantial increase in imports in 2022Q2, followed by a dip in 2022Q3. The surge might be attributed to economic recovery, heightened consumer demand, or specific industry dynamics, while the subsequent decline could reflect evolving global market conditions. Nonetheless, a visible rebound in imports from 2022Q4 to 2023Q2, especially in 2023Q2, suggests resilience in the import sector and potential improvements in global economic conditions.

In summary, the trends in Saudi imports depict the intricate dynamics of global trade, initially marked by a decline due to COVID-19, followed by a gradual recovery. Fluctuations observed in subsequent quarters likely stem from a mix of external factors and ongoing adaptations to the evolving economic landscape.

The impact of COVID-19 on Saudi Arabia's export and import sectors varied across different categories, including oil and non-oil exports, leading to disruptions in supply chains, shifts in demand, and changes in trade patterns.

- Oil exports: The pandemic triggered a global demand shock, leading to a significant drop in oil prices and demand. Lockdowns, travel restrictions, and reduced economic activities worldwide severely impacted oil consumption. The decline in demand was compounded by the OPEC+ price war, resulting in a supply glut that further depressed oil prices. Lower oil prices significantly affected Saudi Arabia's oil export revenues, prompting the kingdom to reassess its economic strategies and fiscal policies.

- Non-Oil exports: Various non-oil export sectors faced disruptions in supply chains due to lockdowns, transportation restrictions, and logistical challenges. This affected the timely delivery of goods. Consumer demand patterns shifted during the pandemic, impacting non-oil exports. Some sectors, such as electronics or medical supplies, experienced increased demand, while others faced a decline. The pandemic highlighted the importance of diversifying non-oil exports. Sectors like pharmaceuticals, technology, and agricultural products gained importance amid the crisis.

- Supply chain challenges: Border closures and restrictions disrupted the movement of goods, impacting both exports and imports. Businesses faced challenges in managing inventory levels due to uncertain demand and supply disruptions, affecting trade flows.

- Changes in trade patterns: With global disruptions, there was a shift towards regional trade cooperation to mitigate international supply chain risks. Non-traditional trade patterns emerged, with a surge in e-commerce and digital trade, reflecting changing consumer behaviors and preferences.

- Government interventions: The government introduced measures to support exporters and importers, offering financial assistance and incentives to mitigate the impact of the crisis. Adjustments in trade policies were made to facilitate smoother trade operations amidst the disruptions.

The COVID-19 pandemic disrupted both oil and non-oil export sectors in Saudi Arabia, leading to supply chain challenges, shifts in global demand, and changes in trade patterns. The diversification efforts and adaptability of different sectors, coupled with government support, played a crucial role in navigating the cha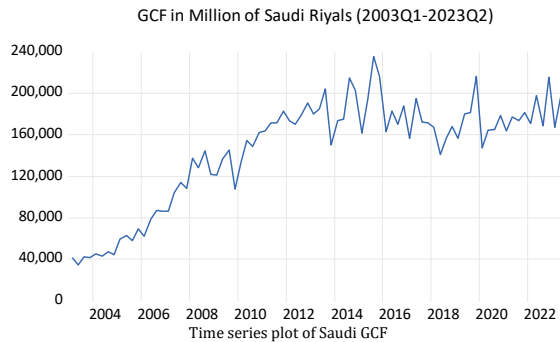llenges posed by the crisis in the trade landscape. Fig. 4 illustrates the trajectory of Saudi GCF, showcasing a modest upturn from 2020Q2 to 2020Q3, reflecting a degree of resilience during the pandemic's initial phase. Despite the uncertainties and disruptions caused by COVID-19, the Saudi economy sustained a certain level of capital formation.

Fig. 4: Time series plot and histogram and descriptive statistics of GCF
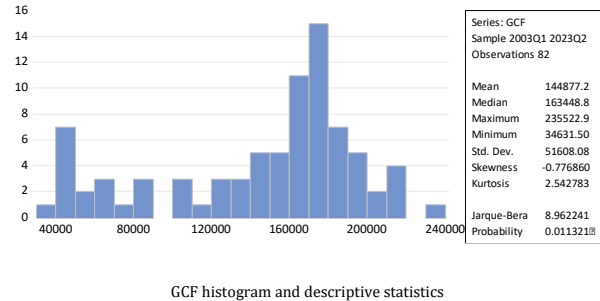
The transition from 2020Q3 to 2020Q4 reveals a notable surge in GCF, signifying a robust recovery and expansion in capital formation. This increase might be attributed to government stimulus measures, strategic economic policies, or adaptations to the new economic norms, facilitating heightened investment activities. Subsequent quarters from 2020Q4 to 2021Q2 exhibit relative stability in GCF levels alongside fluctuations, indicating the Saudi economy's gradual adaptation to the ongoing challenges posed by the pandemic. A substantial upswing in GCF is observed in 2021Q2, indicative of a phase marked by economic growth and increased investment. However, a slight downturn in 2021Q3 might be influenced by various factors, potentially including uncertainties tied to the global health situation. The GCF experiences a recovery in 2021Q4, continuing its ascent into 2022Q4, reaching its zenith. This period implies a favorable economic climate, likely propelled by infrastructure projects, governmental initiatives, and amplified private-sector investments. A dip in GCF in 2023Q1, followed by a recovery in 2023Q2, might be attributed to diverse factors such as global economic conditions or specific challenges in certain industries. Nonetheless, this subsequent recovery underscores adaptability and resilience in Saudi capital formation. The overall trend indicates that the Saudi GCF exhibited resilience amid the challenges brought by the COVID-19 pandemic. The periods of growth and recovery suggest that the economy adapted and responded positively to changing circumstances. Government policies and economic initiatives, such as Vision 2030, may have played a crucial role in driving GCF. Infrastructure projects, diversification efforts, and strategic investments could contribute to the observed trends.

During the COVID-19 pandemic, various sectors of Saudi Arabia's GCF were impacted differently:

- Private investment: Private investment, including both domestic and foreign, faced challenges during the pandemic due to economic uncertainties. Restrictions, disruptions in supply chains, and reduced consumer demand affected businesses' willingness to invest. Sectors like construction, real estate, and some industries heavily reliant on global trade experienced slowdowns or delays in investment projects.
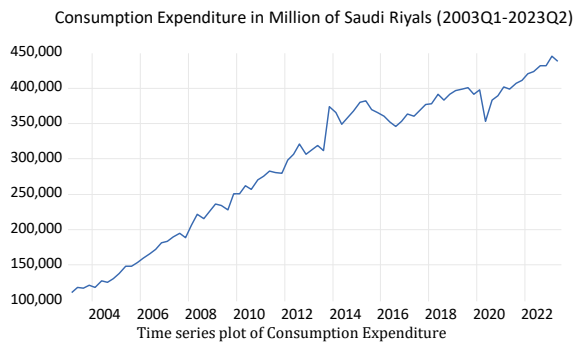- Government spending: Saudi Arabia took measures to support the economy during the pandemic, increasing government spending in certain areas. Investments in healthcare infrastructure, social welfare programs, and economic stimulus packages were initiated to mitigate the impact of the pandemic. These investments aimed to stabilize the economy, support businesses, and protect jobs.
- Household investment: Household investment, which includes spending on durable goods like homes and vehicles, might have experienced fluctuations during the pandemic. Economic uncertainty could have led some households to postpone major purchases or investments, especially in sectors sensitive to economic conditions.
- Changes in inventories: Inventory levels for certain industries have been affected by disruptions in supply chains and changes in consumer demand. Some businesses have adjusted their inventory levels due to uncertainties, impacting the GCF.

The pandemic's impact on Saudi Arabia's GCF varied across sectors. While private investment might have initially slowed down due to uncertainties, government spending increased to support the economy. Household investment and changes in inventories have experienced fluctuations based on consumer behavior and business strategies.

Moving forward, recovery in private investment might depend on factors such as increased economic stability, government policies promoting investment, global economic conditions, and confidence among

businesses and consumers. Government spending might continue to play a crucial role in stimulating economic growth and supporting key sectors during the recovery phase.

Conclusively, Saudi Arabia's GCF trends reflect a complex interplay of government initiatives, responses to the COVID-19 pandemic, economic diversification efforts, and global economic conditions. The resilience and recovery observed in the GCF indicate a proactive approach to economic challenges and a commitment to long-term economic transformation. Fig. 5 outlines the dynamics of consumption expenditure, revealing a pronounced downturn from 2020Q1 to 2020Q2, starkly indicative of the initial COVID-19 impact. Stringent lockdowns, economic uncertainties, and a decline in consumer confidence notably contributed to a substantial reduction in spending during this period.
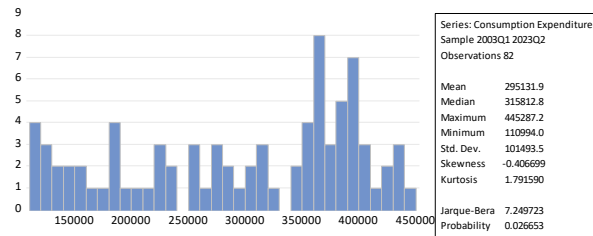

Time series plot of Consumption Expenditure

Consumption Expenditure histogram and descriptive statistics

Fig. 5: Time series plot and histogram and descriptive statistics of CE

From 2020Q2 to 2020Q4, a gradual recuperation and stabilization in consumption expenditure is observable. This suggests an adaptation to the "new normal" as countries implemented measures to mitigate the pandemic's effects, leading to a gradual improvement in consumer spending. Throughout 2021, fluctuations in consumption expenditure signal a blend of factors influencing consumer behaviors. Global uncertainties tied to the pandemic, shifts in governmental policies, and changing consumer sentiments contribute to these variations.

Despite these fluctuations, an overall growth trend in consumption expenditure from 2021 to 2023 emerges, showcasing resilience in the face of challenges. This growth is likely propelled by economic recovery, augmented consumer confidence, and government stimulus measures. The initial dip in 2020Q2 can be attributed to stringent COVID-19 measures, but as restrictions eased and economic activities resumed, consumption expenditure displayed signs of recovery.

The consistent growth observed in 2022 suggests a positive trajectory in consumer spending, potentially influenced by improved economic conditions, higher vaccination rates, and supportive government policies. This growth extends into 2023Q1, reaching higher levels, signifying sustained recovery and potentially elevated consumer confidence, fostering increased spending.

Overall, these trends underscore the resilience and adaptability of the Saudi economy in response to the COVID-19 challenges. Government interventions, economic policies, and shifts in consumer behavior collectively contribute to these observed trends.

The COVID-19 pandemic has had a significant impact on consumer behavior worldwide, and this impact has reverberated within Saudi Arabia as well:

- Shifts in spending patterns: During the initial phases of the pandemic, there was a surge in demand for essential goods such as groceries, healthcare products, and cleaning supplies. Consumers prioritized spending on items necessary for daily living, leading to increased sales in supermarkets and pharmacies. Conversely, spending on non-essential goods, especially luxury items, and discretionary purchases, experienced a decline. Economic uncertainties and concerns about job security led many consumers to cut back on non-essential spending.

- E-commerce and digital payments: The pandemic accelerated the adoption of e-commerce in Saudi Arabia. Consumers increasingly turned to online platforms for their shopping needs, including both essential and non-essential items. This shift towards digital channels was driven by safety concerns, lockdowns, and convenience. Digital payments also gained popularity as consumers sought contactless payment options to minimize physical interactions. This trend is likely to have long-term implications for the payment landscape in Saudi Arabia.

- Changing preferences and priorities: The focus on health and wellness increased, leading to a rise in demand for health-related products and services. Home-related spending saw an uptick as more people worked and studied from home. This led to increased demand for home office equipment, electronics, and home improvement products.

- Travel and entertainment: Travel restrictions and lockdowns significantly impacted the travel and entertainment sectors. Spending on international travel, tourism, and entertainment events saw a sharp decline as people adhered to social distancing measures.

- Government support and stimulus: Government stimulus packages and support measures played a role in influencing consumer spending. Initiatives aimed at supporting businesses and individuals, such as salary protection programs and financial

aid, contributed to sustaining consumer confidence and spending to some extent.

- Post-pandemic resilience: As the situation improved with vaccination efforts and the easing of restrictions, consumer confidence gradually returned. However, lingering economic uncertainties may have led to cautious spending behavior.

Fig. 6 outlines the Saudi unemployment rate's trajectory from 2020Q1 to 2023Q2, reflecting the
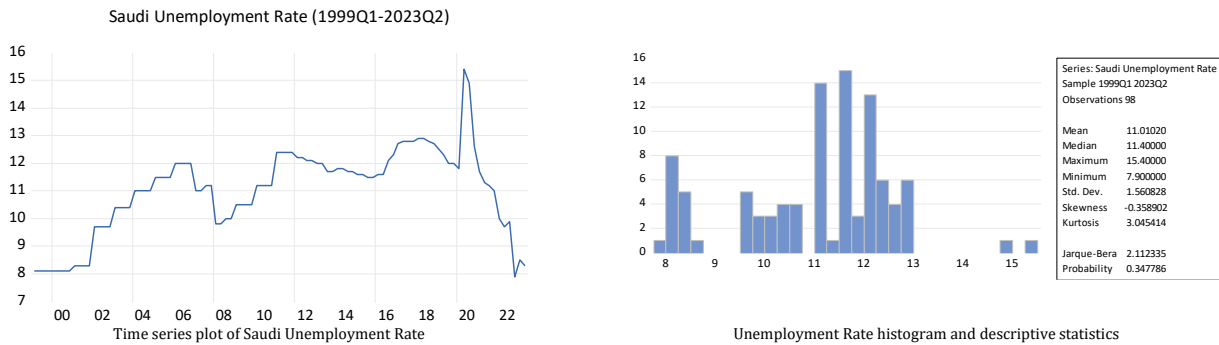
immediate impact of COVID-19 and subsequent recovery. The rate surged from 11.8% in 2020Q1 to 15.4% in 2020Q2, aligning with global trends of increased unemployment during the pandemic. These findings are consistent with studies conducted by Al-Youbi et al. (2020), Nicola et al. (2020), and Pena-Sanchez (2020), reinforcing the trend of increased unemployment during the pandemic and subsequent improvements linked to containment measures.

Saudi Unemployment Rate (1999Q1-2023Q2)

Time series plot of Saudi Unemployment Rate | Unemployment Rate histogram and descriptive statistics

Fig. 6: Time series plot and histogram and descriptive statistics of the unemployment rate

A notable decline followed, dropping to 12.6% by 2020Q4, signifying stabilization and initial economic recovery as businesses adapted and governmental support measures took effect. Throughout 2021, a sustained decline continued, from 11.7% in Q1 to 11.0% in Q4, reflecting improved labor market conditions due to eased restrictions, stimulus measures, and enhanced business confidence. Further improvement ensued in 2022, reaching 7.9% by Q4, indicating robust recovery through increased economic activities, job creation, and effective government policies.

However, a slight uptick to 8.3% in 2023Q2 hints at potential fluctuations or challenges in the labor market, emphasizing the need to monitor economic conditions, industry dynamics, and global influences.

Overall, this trend showcases Saudi Arabia's adaptation to COVID-19's impact, with governmental interventions instrumental in reducing unemployment. Sector-specific recoveries vary, influenced by business adaptability, demand, and government support. The global economic landscape's changes, including trade shifts and demand fluctuations, continue to affect Saudi employment levels.

During the COVID-19 pandemic, several sectors in Saudi Arabia faced significant job losses, changes in labor force participation rates, and hiring challenges:

- Hospitality and tourism: The hospitality and tourism sectors were among the hardest hit. Travel restrictions, border closures, and reduced demand for travel led to massive job losses in hotels, restaurants, airlines, and related services. Many businesses in these sectors faced closures or significant reductions in operations, resulting in layoffs and decreased hiring.

- Retail: Retail sectors experienced disruptions due to lockdowns and reduced consumer spending on non-essential items. Some retail stores closed temporarily, while others scaled back operations, leading to job losses and challenges in hiring.

- Construction and real estate: The construction industry, although resilient to some extent due to ongoing infrastructure projects, faced uncertainties. Some projects were delayed or put on hold, impacting employment in the construction sector. Similarly, the real estate market saw fluctuations, affecting job opportunities in this sector.

- Oil and energy: While the oil sector is a major employer in Saudi Arabia, job losses were experienced in some areas due to volatile oil prices and production cuts. However, the impact was not as severe compared to other sectors due to the strategic importance of the industry to the country's economy.

- Informal and small businesses: Many informal and small businesses faced challenges during the pandemic, leading to job losses or reduced opportunities for the labor force. These sectors often lacked adequate resources to weather the economic downturn.

- Changes in labor force participation: The pandemic influenced labor force participation rates, with some individuals, especially women and certain demographic groups, facing challenges in re-entering the workforce due to caregiving responsibilities, health concerns, or limited job opportunities.

- Hiring challenges: Several industries encountered difficulties in hiring due to uncertainties, financial constraints, and changing market dynamics. Companies in the midst of economic uncertainty

were cautious about expanding their workforce, leading to challenges for job seekers.

The Saudi government implemented various initiatives to support affected sectors and mitigate job losses, including stimulus packages, financial aid to businesses, and programs to support employment. Additionally, efforts to diversify the economy and create more job opportunities in non-oil sectors are ongoing to reduce dependence on industries vulnerable to external shocks.

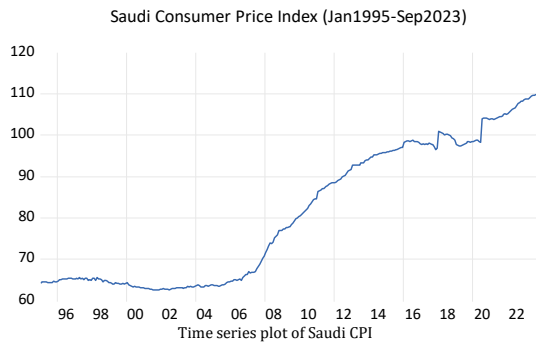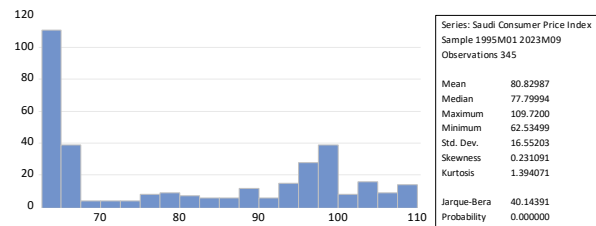In conclusion, the Saudi unemployment rate reflects the pandemic's initial shock, followed by a recovery phase and significant improvement, highlighting both the economy's adaptability and effective governmental measures. Ongoing monitoring and targeted interventions remain essential for ensuring labor market resilience. Fig. 7 illustrates the Saudi Consumer Price Index (CPI) trends from mid-2020 to 2023. The CPI began at 98.5% in May 2020 and experienced a slight dip to 98.2% in June 2020 due to initial disruptions from COVID-19. This aligns with studies by Ali and Mahgoub (2020), indicating increased price pressures during the pandemic's early stages.

Fig. 7: Time series plot and histogram and descriptive statistics of CPI

From July to October 2020, the CPI stabilized around 103.96%, signifying economic recovery and adaptation to new conditions as restrictions eased. Fluctuations between October and December 2020 showcased ongoing adjustments influenced by changing consumer demand, supply chain disruptions, and global economic uncertainties.

Throughout 2021, the CPI steadily rose, reaching 105.06% by December 2021, reflecting recovering demand and potential supply chain challenges. In 2022, a moderate CPI increase continued, hitting 108.53% by December, likely due to economic growth, rising demand, and inflationary pressures.

From January to September 2023, the CPI fluctuated between 108.75% and 109.72%, potentially influenced by global economic conditions, energy prices, and post-pandemic economic adjustments.

The initial CPI dip in mid-2020, followed by recovery and stability in 2021 and 2022, reflects the economy's response to COVID-19 challenges. The 2023 fluctuations likely indicate ongoing adaptations in the post-pandemic economic environment.

During the COVID-19 pandemic, the CPI in Saudi Arabia experienced varied impacts across its components:

- Food and beverage: Food prices, particularly for essential items, experienced fluctuations during the pandemic.
- Housing and utilities: Housing costs, including rent and utilities, remained relatively stable in some areas. However, with changes in lifestyle due to lockdowns and remote work, there have been shifts in housing demand or preferences that have influenced rental prices.

- Transportation: Transportation costs were affected significantly. With restrictions on movement, reduced travel, and fluctuating oil prices, the cost of transportation, including fuel and vehicle-related expenses, might have shown volatility. Reduced demand for flights and public transportation has led to lower prices in these sectors.
- Healthcare: Prices in the healthcare sector have seen moderate increases due to higher demand for medical supplies, services, and medications related to the pandemic. However, government interventions to control healthcare costs could have mitigated significant price hikes.
- Clothing and footwear: Spending on clothing and footwear might have decreased as people spent more time at home, leading to reduced demand for non-essential apparel. This has influenced prices in this sector.
- Miscellaneous goods and services: Prices for miscellaneous goods and services have shown mixed trends depending on demand shifts. Prices for certain leisure activities and non-essential services have decreased due to reduced demand, while prices for essential services have remained stable.

Overall, while some sectors like food and healthcare have experienced moderate price increases due to increased demand or supply chain disruptions, others such as transportation and non-essential goods have seen price declines or stability owing to reduced demand. The extent of these fluctuations would have been influenced by government interventions, supply chain resilience,

and shifts in consumer behavior during the pandemic.

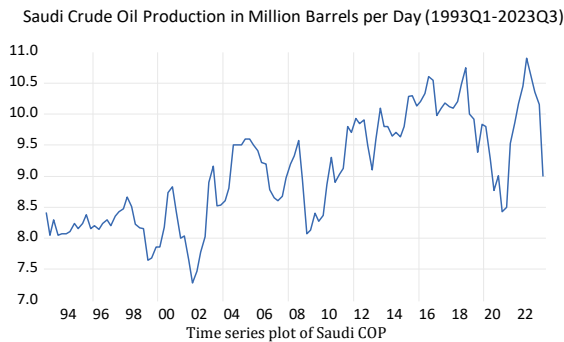To conclude, the Saudi CPI's trend signifies initial pandemic impact, subsequent recovery, and gradual increases thereafter, highlighting the economy's dynamic response to COVID-19 challenges with ongoing adjustments observed in 2023. Fig. 8 depicts the fluctuations in Saudi Crude Oil Production (COP), spanning from 2021Q1 onward, against the backdrop of broader contextual shifts.

Saudi Crude Oil Production in Million Barrels per Day (1993Q1-2023Q3)

Time series plot of Saudi COP

COP histogram and descriptive statistics

Fig. 8: Time series plot and histogram and descriptive statistics of COP
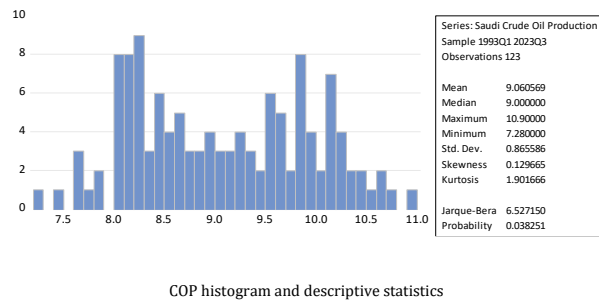
The year 2020 witnessed a substantial drop in global oil demand due to the COVID-19 pandemic, triggering a decrease in oil prices and prompting major oil-producing countries like Saudi Arabia to recalibrate their production levels accordingly. The trend observed in 2021 signifies a recovery in oil production. Starting at 8.43 million barrels per day (MBPD) in Q1, Saudi Arabia progressively increased its crude oil production, reaching 9.86 MBPD in Q4. This resurgence mirrors global efforts to ease pandemic-related restrictions, a rebound in economic activities, and a resurgence in oil demand.

Throughout 2022, Saudi Arabia sustained its upward trajectory in crude oil production, escalating from 10.16 MBPD in Q1 to 10.60 MBPD in Q4. This rise aligns with the broader global economic recovery, an upsurge in oil demand, and strategic adjustments made by major oil-producing nations to stabilize markets.

However, a slight decrease in crude oil production emerges from 10.36 MBPD in Q1 2023 to 9.00 MBPD in Q3 2023. Multiple factors could contribute to this decline, including shifts in global oil demand, geopolitical considerations, and evolving energy landscapes.

During the COVID-19 pandemic, Saudi Arabia, as a prominent member of the OPEC, experienced significant shifts in its oil production, influenced by OPEC+ decisions and global demand changes. In response to the drastic drop in global oil demand caused by the pandemic and subsequent economic slowdown, OPEC+ nations, including Saudi Arabia, agreed to implement historic production cuts. These cuts were aimed at stabilizing oil prices and rebalancing the oversupplied market. Saudi Arabia played a key role in negotiating and implementing production cuts within the OPEC+ alliance. As one of the largest oil producers globally, its decisions significantly impacted global oil markets.

Saudi Arabia, along with other OPEC+ members, adjusted its oil production levels multiple times throughout the pandemic. Initially, there were substantial production cuts to counter the oversupply caused by reduced global demand. As global economic activities gradually resumed and demand started to recover, production levels gradually increased.

The pandemic-induced lockdowns and travel restrictions led to an unprecedented decline in global oil demand. Reduced air travel, limited commuting, and economic slowdowns across various industries significantly decreased the need for oil, causing a surplus in the market.

Fluctuations in oil prices were highly volatile during the pandemic. Initially, prices plummeted due to oversupply concerns and fears of long-term demand destruction. However, as OPEC+ implemented production cuts and demand began to recover with the easing of restrictions, prices showed some level of stabilization and recovery.

OPEC+ decisions, especially those led by Saudi Arabia, influenced market sentiments and played a crucial role in stabilizing prices. However, balancing production levels with demand recovery remained a challenge as the pace and scale of demand rebound varied across regions and sectors.

With the global economy gradually recovering from the pandemic, oil demand showed signs of improvement. However, uncertainties surrounding new variants of the virus, geopolitical tensions, and the transition to renewable energy sources continue to impact the oil market dynamics and Saudi Arabia's production decisions.

Saudi Arabia's ability to adapt its oil production levels in response to changing global demand and its role in the OPEC+ alliance played a critical role in stabilizing oil markets during the pandemic. However, the ongoing transition towards renewable energy and the need for sustainable energy sources pose long-term challenges for oil-dependent economies like Saudi Arabia.

In summation, Saudi Arabia's crude oil production trend reflects a complex interplay of global economic conditions, concerted efforts to stabilize oil markets, geopolitical influences, and the ongoing repercussions of the COVID-19 pandemic. The data underscores Saudi Arabia's adaptive stance,

adjusting production levels in response to evolving market dynamics.

Therefore, the researchers propose modeling and forecasting these Saudi economic indicators to evaluate the persistent impact of the COVID-19 outbreak in subsequent periods, considering the current policies and governmental measures.

It is crucial to note that the time series plots exhibit non-stationary characteristics: the mean of each indicator fluctuates over time, indicating the variance is not constant. Additionally, the Auto-Correlation Function (ACF) and Partial Auto-Correlation Function (PACF) plots for each time series revealed high and slow-declining autocorrelation coefficients, signifying their non-stationarity. Moreover, all p-values from the Ljung–Box Q-statistic (Ljung and Box, 1978) were below 0.05, suggesting rejection of the null hypothesis that the time series were stationary.

Further confirmation of the non-stationary nature of the time series came from the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and Phillips–Perron (PP) (Phillips and Perron, 1988) unit root tests. The results indicated non-stationarity for all time series, whether considering intercept, trend, or both, as evidenced by t-statistics surpassing

critical values at significance levels of 0.01, 0.05, and 0.1, and with p-values exceeding 0.05 for both tests. To achieve stationarity, the time series required first- or second-order differencing or transformation to logarithms. Specifically, all-time series were logarithmically transformed and then differenced to achieve stationarity.

7.2. Model identification

The researchers employed the Auto-Correlation Function (ACF) and Partial Auto-Correlation Function (PACF) of the stationary series to discern the optimal model order. Varied parameters for both seasonal and non-seasonal terms in the autoregressive and moving averages were explored to identify models demonstrating superior performance. Following extensive testing and comparison of multiple models based on the Akaike Information Criterion (AIC), Schwartz Information Criterion (SIC), and the significance of coefficients, the most suitable models were selected for each time series. These chosen models were then employed for further analysis and predictive purposes, as depicted in Table 2.

Table 2: Model identification

	GDP	exports	Imports	GCF	CE	UR	CPI	COP
Model	ARIMA (2,1,1)	ARIMA (0,1,1)	SARIMA (1,1,0)(1,1,0)$_4$	ARIMA (2,1,2)	ARIMA (2,1,2)	ARIMA (4,1,4)	ARIMA (1,1,1)	ARIMA (4,1,3)
AIC	-2.834171	0.645144	-2.090909	-1.284788	-3.667129	−3.048056	−7.762149	−3.825125
SIC	-2.686366	0.733827	-1.513509	-1.107422	-3.489763	−2.782621	−7.717490	−3.61827

For GDP, Exports, GCF, CE, UR, CPI, and COP predictions, ARIMA models were utilized, whereas the SARIMA model was deemed appropriate for predicting Imports due to the evidence of seasonality in the time series.

7.3. Model checking

A thorough assessment of the residuals from both the seasonal and non-seasonal ARIMA models was conducted through a white noise test. The Auto-Correlation Function (ACF) and Partial Auto-Correlation Function (PACF) graphs of the residuals indicated that these residuals conformed to the necessary parameters, demonstrating independence and a normal distribution. Remarkably, the absence of residual serial correlation was evident, with the auto-correlation and partial auto-correlation values approaching zero across all lag orders. Furthermore,

all Q-statistics were non-significant, and the p-values of the Ljung-Box Q-statistic (Ljung and Box, 1978) significantly exceeded 0.05, confirming that the residuals portrayed white noise characteristics.

Moreover, the evaluation for heteroskedasticity involved an examination of the correlograms of the squared residuals. Similarly, all Q-statistics were non-significant, and the p-values significantly surpassed 0.05, indicating an absence of heteroskedasticity. This was further corroborated through the Auto-Regressive Conditional Heteroskedasticity (ARCH) test presented in Table 3. Notably, all p-values ranged between 0.1089 and 0.9191, clearly exceeding 0.05. Consequently, the null hypothesis of no heteroskedasticity in the residuals could not be rejected, indicating a lack of heteroskedasticity.

Table 3: ARCH test results

	GDP	Exports	Imports	GCF	CE	UR	CPI	COP
Model	ARIMA (2,1,1)	ARIMA (0,1,1)	SARIMA (1,1,0)(1,1,0)$_4$	ARIMA (2,1,2)	ARIMA (2,1,2)	ARIMA (4,1,4)	ARIMA (1,1,1)	ARIMA (4,1,3)
Obs*R^2	0.175688	2.570615	1.513509	0.551475	0.029815	0.012075	0.010321	0.465500
Prob. Chi-square	0.6751	0.1089	0.2186	0.4577	0.8629	0.9125	0.9191	0.4951

7.4. Data forecasting

The forecasting ability of each model was rigorously evaluated using various statistical

measures, including the root mean squared error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE), and the Theil inequality coefficient (U), as outlined in Table 4.

Table 4: Model forecasting accuracy tests

	GDP	Exports	Imports	GCF	CE	UR	CPI	COP
Model	ARIMA (2,1,1)	ARIMA (0,1,1)	SARIMA (1,1,0)(1,1,0)₄	ARIMA (2,1,2)	ARIMA (2,1,2)	ARIMA (4,1,4)	ARIMA (1,1,1)	ARIMA (4,1,3)
RMSE	153921.0	94733.79	56081.53	59056.39	69724.09	3.270999	7.527746	0.587778
MAE	135639.8	80499.91	48293.31	48180.76	59589.39	2.962650	5.471304	0.449589
MAPE	25.08754	39.75400	29.14707	31.21571	19.43620	25.25228	7.990925	5.131923
U	0.151691	0.213399	0.186759	0.214580	0.121247	0.167977	0.044445	0.031874

Remarkably, the Theil inequality coefficients indicated that the selected models exhibited strong forecasting capabilities. Additionally, the predicted values for each indicator closely aligned with the actual results, demonstrating relative errors of less than 10%, signifying the models' adeptness in fitting the data.

Employing the dynamic forecast mode through the graphical interface in EViews software, the predictive outcomes revealed significant insights.
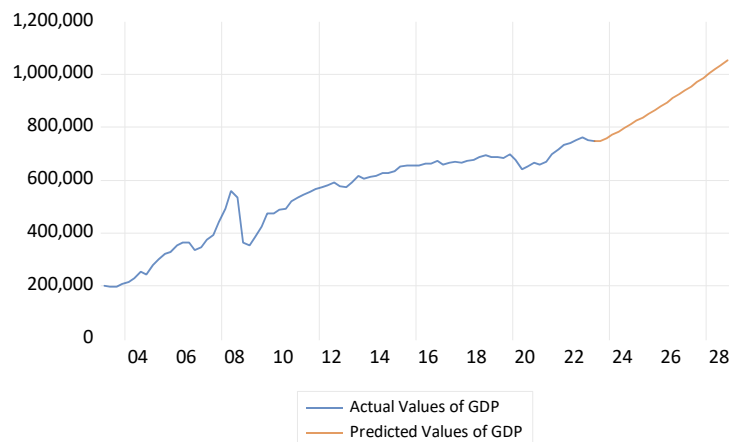
Fig. 9 portrays the forecasted trajectory of Saudi real GDP, indicating a consistent upward trend in the economy over the forecasted period from 2023Q3 to 2028Q4. There is a steady and gradual increase in the GDP, reflecting anticipated economic growth starting from 734733.2 MSAR in 2023Q3 and progressing to 1036288.5 MSAR in 2028Q4. This trend suggests an optimistic outlook for Saudi Arabia's economy, indicating potential stability and development.

Fig. 9: Actual and predicted GDP values

The upward trajectory in real GDP forecasts is likely influenced by factors such as border openings, resumption of international travel, increased oil prices, relaxation of containment measures, implementation of new economic policies across different sectors, support for the tourism sector, enhanced productivity in the industry sector, expanded external investments, the establishment of multinational companies, amplified bank savings rates, and the execution of initiatives aimed at financial stability and bolstering economic growth rates and national income.

Moreover, the Saudi government implemented fiscal stimulus measures to support businesses and individuals affected by the pandemic. This includes financial aid, subsidies, and economic relief programs. The Saudi Arabian Monetary Authority (SAMA) has adjusted monetary policies, such as interest rates and liquidity measures, to stabilize financial markets and support economic activities during the crisis. Increased government spending on healthcare infrastructure, medical equipment, and resources to manage the health crisis. Implementation of programs to support struggling industries, small businesses, and sectors directly affected by lockdowns and reduced economic activity. Encouraging the adoption of remote work and digital technologies to maintain economic activities while minimizing the spread of the virus.

These findings resonate with studies conducted by Eissa (2020), Havrlant et al. (2021, 2020), and Stannard et al. (2020), which collectively suggest that while COVID-19 will significantly impact Saudi GDP, an overall upward trend is expected to prevail.

Predicting Saudi Arabia's GDP growth or decline involves considering various sectors and their recovery rates. Some key sectors in Saudi Arabia include oil and non-oil industries like manufacturing and services, tourism, and the financial sector.

- Oil sector: Saudi Arabia heavily relies on its oil industry. Changes in global oil prices and production levels significantly impact the country's GDP. If oil prices remain stable or increase, it can positively affect Saudi Arabia's GDP growth. However, factors like geopolitical tensions or shifts towards renewable energy sources might influence oil prices and subsequently impact GDP.
- Non-Oil industries: Diversification efforts are ongoing to reduce dependence on oil. Sectors like manufacturing and services contribute to this diversification. If these sectors experience growth due to government investments, technological advancements, and increased domestic consumption, they could positively impact GDP.
- Tourism: The tourism sector has significant potential in Saudi Arabia due to initiatives like the

development of tourism sites and cultural attractions. If these efforts attract more tourists, it can boost GDP through increased spending in hospitality, transportation, and other related industries.

• Financial sector: The performance of the financial sector, including banking and capital markets, influences economic growth. Stable financial conditions and investment opportunities can support GDP growth. Factors such as government policies, global economic conditions, technological advancements, and geopolitical events also play roles in shaping sectoral performance and, subsequently, GDP growth.

If sectors like non-oil industries and tourism show robust growth due to successful government initiatives and increased domestic and international demand, they could offset potential declines in the oil sector. However, adverse global economic conditions, geopolitical tensions, or unforeseen events might pose challenges to projected growth rates. Fig. 10 displays the projected Saudi export values post-COVID-19 across various quarters, revealing a consistent upward trend from 2023Q3 to 2028Q4. These projections indicate a sustained growth pattern in export values, signaling potential expansion in the country's exports over the forecasted period. Starting at 323405.8 MSAR in 2023Q3 and ascending to 464302.3 MSAR by 2028Q4, a clear pattern of ascending export values emerges. This positive trajectory hints at an encouraging outlook for Saudi Arabia's exports, possibly influenced by factors such as heightened production, increased demand for Saudi goods or services, improved trade relations, or conducive global economic conditions favoring exports.
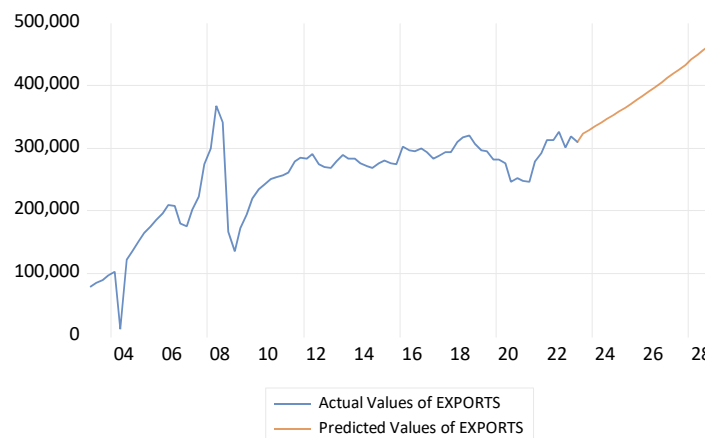

Fig. 10: Actual and predicted export values

This positive outlook stems from the government's strong support for exporters during and after the pandemic, which aligns with the goals of Vision 2030. The government has shown its commitment through various actions aimed at strengthening non-oil exports like petrochemicals, manufacturing, and technology. These efforts include improving local industries, adopting effective marketing strategies for products, and creating new opportunities for Saudi companies to export their products. The main aim is to make Saudi products more competitive in local and global markets. Fig. 11 shows the expected increase in Saudi imports from the third quarter of 2023 to the fourth quarter of 2028, indicating a steady rise. The forecast starts with imports at 231,060.9 million Saudi Arabian Riyals in the third quarter of 2023 and reaches 334,504.7 million by the fourth quarter of 2028, showing a clear trend of growth. The initial stage from the third quarter of 2023 to the fourth quarter of 2024 demonstrates a consistent increase in imports, which likely corresponds with the gradual recovery from the pandemic.
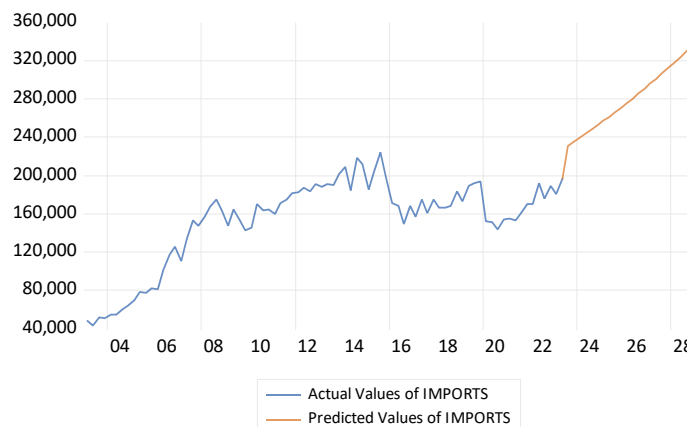

Fig. 11: Actual and predicted import values

As global economic conditions recover, there is an expected surge in demand for imported goods and materials, contributing to this upward trajectory. Furthermore, governmental initiatives aimed at stimulating economic growth, investing in infrastructure, and implementing policies fostering imports for developmental purposes might significantly bolster the rising import values. Concurrently, efforts directed at diversifying import sources and technological advancements are anticipated to widen the spectrum of imported products and streamline import processes, thereby supporting the escalating import values.

This sustained upsurge in anticipated imports signals the evolving post-pandemic economic landscape, underscoring a gradual recuperation and potential expansion in Saudi Arabia's import sphere. This growth is propelled by a blend of both domestic and global factors.

However, predicting trends in exports and imports involves considering sector-specific recoveries, global market demand, and potential policy changes affecting trade agreements. With global economic recovery, oil demand is likely to improve, potentially leading to an upward trend in oil prices. Saudi Arabia's oil exports could witness a gradual recovery, aligning with OPEC+ production adjustments. They may include:

- Sectors like technology, pharmaceuticals, and food products may continue to see growth in exports as demand for these goods remains robust. Efforts to diversify exports beyond traditional sectors might result in increased export volumes in emerging sectors, leveraging technological advancements and quality enhancement.
- The recovery of major export markets, especially in Asia and Europe, can boost demand for Saudi

exports across various sectors, driving export growth. Changing consumer preferences post-pandemic, such as increased focus on sustainability and digital products, might influence export trends.

- Bilateral and multilateral trade agreements may influence export and import trends. The evolution of agreements, such as Gulf Cooperation Council (GCC) agreements or regional partnerships, could impact trade volumes. Changes in tariffs, trade policies, and geopolitical dynamics may alter trade patterns, affecting the competitiveness of exports and imports.
- Sectors leveraging technology and e-commerce platforms might continue to expand their export potential, driven by increasing digitalization and global connectivity. Preferences for online shopping and digital services could drive exports of digital products and services, shaping export trends.
- Growing global emphasis on sustainability might lead to increased exports of environmentally friendly products or services, aligning with Saudi Arabia's sustainability goals.
- Geopolitical tensions and shifts in global alliances could impact trade dynamics, influencing trade volumes and patterns.

In conclusion, trends in exports and imports for Saudi Arabia will likely see a combination of sector-specific recoveries, shifts in global market demands, policy changes impacting trade agreements, technological advancements, and geopolitical factors. Fig. 12 presents the anticipated trajectory of Saudi GCF post-COVID-19, spanning from 2023Q3 to 2028Q4, depicting a consistent upward trend and implying a sustained increase in GCF values throughout the forecasted period.
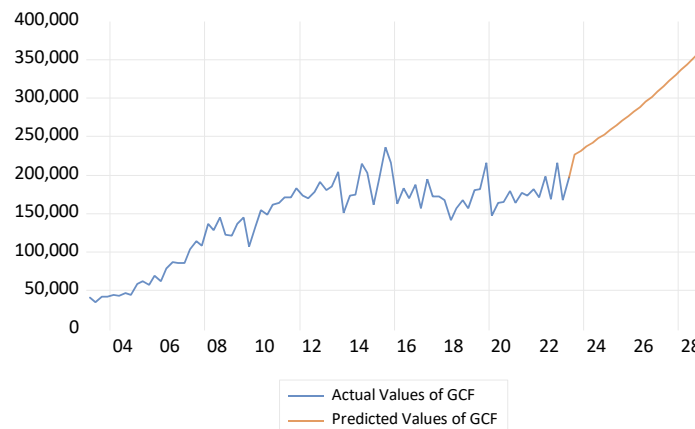

Fig.12: Actual and predicted GCF values

Commencing at 226857.5 MSAR in 2023Q3 and advancing to 359231.3 MSAR by 2028Q4, these projections delineate a definitive pattern of ascending GCF values. The initial phase, spanning from 2023Q3 to 2024Q4, showcases a steady and considerable increase in GCF, potentially indicative of the post-COVID-19 recovery phase. This growth might be attributed to a confluence of factors,

including economic stimulus measures, favorable economic conditions, and heightened investment sentiments, contributing to augmented capital formation. Subsequent quarters, extending from 2024Q1 to 2027Q4, demonstrate consistent growth interspersed with intermittent fluctuations. This phase suggests Saudi Arabia's adaptability to ongoing challenges while maintaining an overall

upward trajectory in capital formation. The pronounced upsurge in GCF observed in 2022Q2, and its sustained growth thereafter could signify amplified infrastructural projects, governmental initiatives, and increased private sector investments, fostering a conducive economic environment. Fluctuations such as the dip in 2023Q1 followed by recovery in 2023Q2 might be influenced by broader global economic conditions or industry-specific challenges, showcasing the adaptability and resilience inherent in Saudi capital formation.

In essence, the anticipated trends in Saudi GCF post-COVID-19 depict a positive outlook characterized by consistent growth, potentially steered by a confluence of factors, including economic recovery, proactive government initiatives, and dynamic shifts in the global market.

Predicting changes in Gross Capital Formation (GCF) involves considering expected recovery rates in different sectors and government initiatives aimed at boosting investments. Infrastructure projects aligned with Saudi Vision 2030, such as NEOM and Riyadh Metro, are likely to drive substantial investments and contribute significantly to GCF growth. Technology and innovation sectors, supported by government initiatives like the National Industrial Development and Logistics Program, may show robust growth potential. Global economic recovery and stabilization in oil prices

may positively influence investor confidence in Saudi Arabia, potentially driving foreign direct investments and GCF growth.

As Saudi Arabia focuses on sustainability and green initiatives under Vision 2030, investments in renewable energy projects such as solar energy may contribute to GCF growth.

Specific to Saudi Arabia, GCF growth will likely hinge on the government's continued focus on Vision 2030, investment-friendly policies, sector-specific initiatives, global economic trends, and advancements in sustainability-focused investments.

In summary, GCF is expected to show gradual growth, influenced by sector-specific recovery rates, government initiatives aimed at boosting investments, global economic trends, fiscal and monetary policies, and sustainability-focused investments. The interaction of these factors will shape the trajectory of GCF in the post-pandemic period. Fig. 13 illustrates the predicted trajectory of Saudi Consumption Expenditure (CE) post-COVID-19, spanning from 2023Q3 to 2028Q4, revealing a consistent and upward trend, signaling a continual ascent in CE values throughout the forecasted period. Starting at 433400.6 MSAR in 2023Q3 and ascending to 609033.9 MSAR by 2028Q4, these projections depict a clear and substantial growth pattern in consumption expenditure.
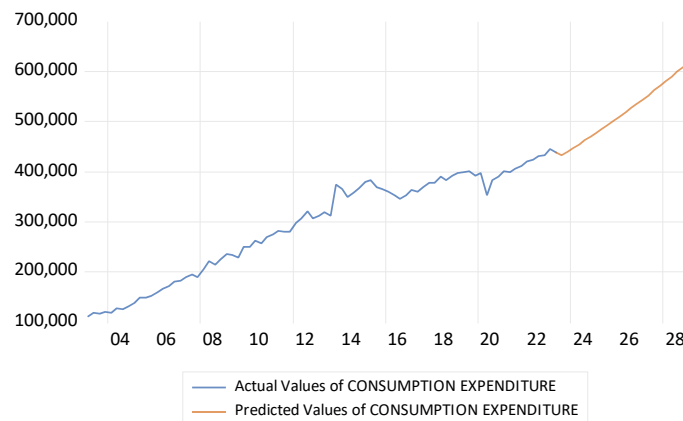

Fig. 13: Actual and predicted CE values

This sustained increase in CE from 2023Q3 to 2028Q4 mirrors an ongoing recovery post-COVID-19. As economic conditions stabilize and improve, consumer spending tends to rise, propelling the upward trajectory in consumption expenditure.

The persistent growth pattern indicates heightened consumer confidence, positively impacting spending behaviors. Factors such as burgeoning employment opportunities, rising incomes, or governmental policies fostering consumer spending potentially contribute to this trend. Additionally, government stimulus measures and policies aimed at augmenting consumer spending are instrumental in driving the steady growth observed in consumption expenditure.

Inflationary pressures or price fluctuations can further influence the rise in consumption

expenditure as the cost of goods and services escalates, thereby impacting overall spending patterns.

Moreover, industry-specific factors, market dynamics, or shifts in consumer preferences might also play a role in driving the observed growth in consumption expenditure.

This consistent increase in predicted consumption expenditure post-COVID-19 signifies a favorable outlook for Saudi Arabia's domestic consumption, indicative of sustained economic recovery and the potential for heightened consumer activity. This growth is supported by a confluence of economic, policy-driven, and market-related factors, highlighting a promising landscape for consumer spending. Displayed in Fig. 14 are the projected Saudi Unemployment Rate (UR) values post-COVID-

19, spanning from 2023Q3 to 2028Q4, depicting a remarkably stable trend, hovering consistently between 8.33% and 8.38%.
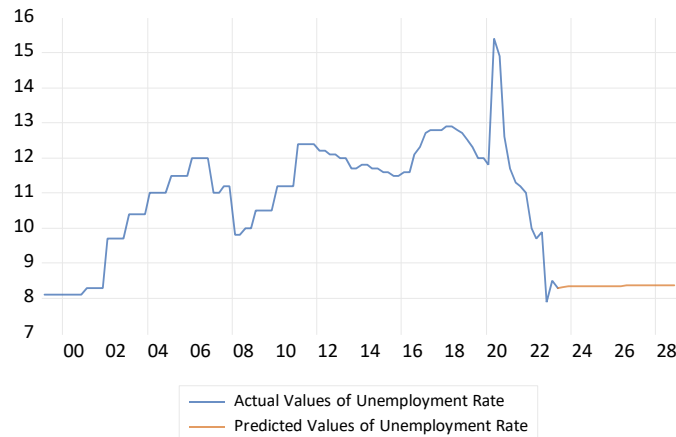

Fig. 14: Actual and predicted UR values

These predictions suggest a sustained level of unemployment throughout the forecasted period, indicating a phase post-pandemic marked by minimal quarter-on-quarter fluctuations. Such stability may imply a persistent unemployment rate, indicating potential equilibrium or stabilization in unemployment rates following the recovery phase from the initial COVID-19 impact.

This sustained unemployment rate might signify a labor market approaching relative stability, potentially influenced by factors such as structural employment challenges, industry-specific dynamics, and alterations in workforce participation rates.

Predicting future unemployment rates in Saudi Arabia involves considering multiple factors, including:

- Sectoral recovery rates: The pace and extent of recovery in various sectors, such as hospitality, tourism, retail, and oil-related industries, will significantly impact employment. Sectors experiencing faster rebounds could generate more job opportunities and lower unemployment rates.
- Government employment initiatives: The Saudi government has been implementing various initiatives to stimulate job creation, including investment in infrastructure projects, economic diversification programs, and initiatives to encourage private sector hiring. The success and continuation of these efforts can influence unemployment rates positively.
- Structural changes in the labor market: Shifts in the labor market due to technological advancements, changes in consumer behavior, and an increased focus on digitalization might create new job opportunities in emerging sectors. However, they could also lead to skill gaps, requiring retraining or upskilling programs to match the evolving job market needs.
- Economic diversification efforts: Saudi Arabia's efforts to diversify its economy away from oil dependence involve investing in non-oil sectors like technology, renewable energy, healthcare, and entertainment. The success of these diversification efforts could create employment opportunities and reduce dependency on oil-related jobs.
- Global economic conditions: Saudi Arabia's economy is interconnected with global markets. Global economic trends, trade relations, and geopolitical factors can impact job opportunities in sectors linked to international markets.
- Policies and reforms: Continued government policies and reforms aimed at attracting foreign investment, improving the business environment, and supporting entrepreneurship can foster job creation and reduce unemployment.

Given these factors, if sectors like technology, renewable energy, and non-oil industries experience significant growth and job creation, it could contribute to lowering unemployment rates. However, the pace of recovery across sectors, the effectiveness of government initiatives, and the ability of the labor market to adapt to structural changes will collectively influence the future unemployment scenario in Saudi Arabia. Fig. 15 presents the projected trajectory of the Saudi Consumer Price Index (CPI) post-COVID-19, indicating a consistent upward trajectory from 2023M10 to 2028M12, indicating a gradual increase in CPI percentages. This aligns with earlier findings by Ali and Mahgoub (2020). Starting at 110.0780% in October 2023, the CPI steadily climbs month by month, reaching 120.8258% by December 2028.

These predictions imply an ongoing rise in consumer prices over the forecasted period, potentially influenced by factors such as increased economic activities, recovering demand, and inflationary pressures. The consistent growth suggests sustained inflation rates, signifying potential economic expansion and price adjustments in the post-pandemic period.

These projections highlight the expected inflationary trends, emphasizing the importance of monitoring economic conditions and policies to manage potential impacts on consumers and the economy.
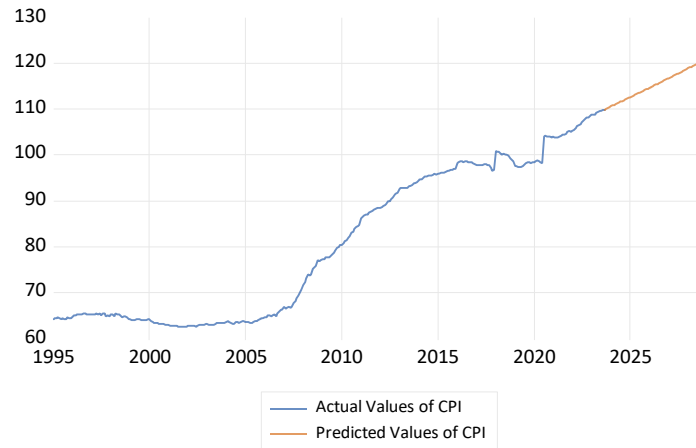
Fig. 15: Actual and predicted CPI values

Anticipating the trajectory of Saudi Arabia's CPI post-pandemic entails taking into account various influencing factors:

- Disruptions in global supply chains during the pandemic affected the availability and pricing of goods. While initial disruptions may have caused temporary price increases due to shortages, efforts to stabilize supply chains and improve logistics could lead to price stabilization or even decreases over time.
- Shifting consumer preferences and spending habits, post-pandemic could impact CPI trends. Increased demand for certain products or services, such as home entertainment and health-related items, might lead to price increases in these sectors, while reduced demand for others, such as travel-related services, could result in price reductions.
- The Saudi government implemented measures to stabilize prices and support the economy during the pandemic. Interventions such as subsidies, price controls on essential goods, and stimulus packages might have mitigated inflationary pressures or prevented steep price increases in specific sectors.

- Fluctuations in oil prices, a significant factor for the Saudi economy, can influence CPI trends, particularly in sectors related to energy and transportation. Stability or fluctuations in oil prices can impact overall inflation rates.
- The recovery of global economies and trade relations can affect the prices of imported goods and services in Saudi Arabia, contributing to CPI trends. Changes in global market dynamics can impact the cost of imports and subsequently influence local prices.

Considering these factors, the CPI trends in Saudi Arabia might exhibit a mix of dynamics post-pandemic. Certain sectors may experience price increases due to continued high demand or supply chain constraints, while others may see stabilization or even decreases as supply chains improve and demand patterns normalize. Moreover, government interventions and policies aimed at stabilizing prices, ensuring the availability of essential goods, and supporting economic recovery will also play crucial roles in shaping CPI trends. Fig. 16 illustrates the forecasted values for Saudi Crude Oil Production (COP) post-COVID-19, presenting a steady trend from 2023Q4 to 2028Q4, maintaining a range of 10.3 to 10.7 million barrels per day (MBPD).
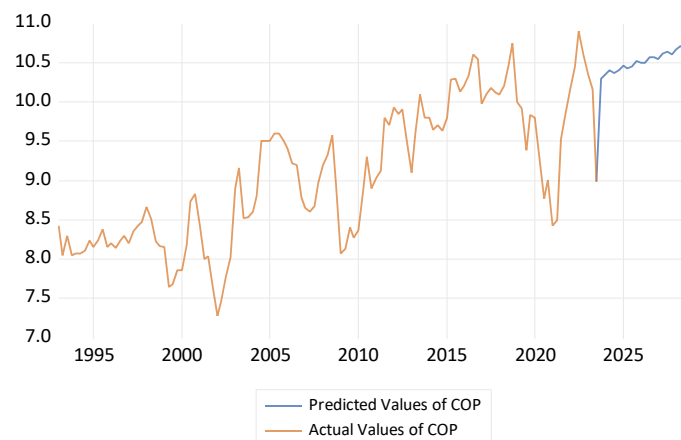

Fig. 16: Actual and predicted values of COP

These projections indicate a deliberate effort to sustain a consistent output, reflecting Saudi Arabia's strategic approach amidst varying global factors.

The stability observed in crude oil production signals a cautious and deliberate strategy to balance output in response to anticipated demand,

prevailing market conditions, and broader economic influences. This steadiness suggests a concerted effort to uphold production levels while navigating market stability. It is crucial to acknowledge the dynamic nature of the global oil landscape, where geopolitical shifts, alterations in oil demand, and international agreements can significantly impact Saudi Arabia's future production decisions. In summary, these forecasts imply an intention to maintain stable crude oil production, highlighting a strategic emphasis on stability in response to evolving market dynamics post-COVID-19 period.

The stable and reliable nature of the ARIMA models, as revealed in previous literature, indicates their effectiveness as a robust forecasting method for evaluating the impact of COVID-19 on Saudi economic indicators. This coherence with the findings of Abuhasel et al. (2022) affirmed the accuracy of ARIMA models. Consequently, there is an urgent need for a proposed strategy to mitigate the consequences and impacts of COVID-19 on the Saudi economy.

8. Comparative assessment: Saudi Arabia's pandemic response in context

When comparing the impact of COVID-19 on Saudi Arabia's economy with similar economies, especially those in the Gulf Cooperation Council (GCC) region, several parallels and distinctions emerge:

- Oil-dependent economies: Saudi Arabia, along with other GCC countries like Kuwait, Qatar, and the UAE, faced a significant challenge due to plummeting oil prices. These nations heavily rely on oil revenues, and the sharp decline in global demand impacted their fiscal health and economic stability.
- Diversification efforts: Similar economies have been pursuing diversification strategies to reduce dependence on oil revenues. Saudi Arabia's Vision 2030 aligns with the diversification efforts of other GCC nations, aiming to develop non-oil sectors like tourism, technology, and renewable energy.
- Tourism and hospitality: The pandemic had a severe impact on the tourism and hospitality sectors across the region due to travel restrictions and lockdowns. The suspension of religious tourism in Mecca and Medina affected revenue streams in Saudi Arabia and comparable GCC nations.
- Government response: GCC nations implemented stimulus packages and economic support measures to mitigate the pandemic's economic fallout. The response strategies varied, focusing on protecting businesses, supporting affected sectors, and preserving employment.
- Financial services: Financial markets in similar economies experienced volatility, responding to global economic uncertainties. Efforts to stabilize

financial markets and sustain investor confidence were common across these nations.
- Labor market and expat workers: The pandemic affected the labor market, especially the expatriate workforce prevalent in GCC countries. Layoffs and job losses were observed across sectors, impacting both local and expatriate populations.
- Healthcare investments: Increased healthcare spending and investments in healthcare infrastructure were observed across GCC countries to manage the crisis and strengthen healthcare systems.
- Global trade and economic partnerships: Similar economies faced disruptions in global trade, impacting export-oriented sectors and economic partnerships. Efforts to reconfigure trade strategies and diversify economic linkages were evident.

While these economies shared some common challenges due to their economic structures and reliance on oil, variations in responses, sectoral impacts, and diversification strategies existed based on individual country policies, economic diversification progress, and financial reserves. The severity of the impact varied depending on the degree of economic diversification and the effectiveness of pandemic response measures undertaken by each country.

9. Proposed strategy to mitigate the consequences and impacts of COVID-19 on the Saudi economy

The proposed strategy is outlined as follows.

9.1. Objectives of the proposed strategy

The strategy aims to mitigate the consequences of COVID-19 on the Saudi economy, improve economic indicators affected by the outbreak, and implement measures to strengthen the country's capacity to combat the virus.

9.2. Premises of the proposed strategy

The strategy is built upon several premises: analysis of the COVID-19 outbreak's real impact on the Saudi economy, aligning with the Saudi government's efforts to curb the virus spread, and understanding the economic impacts of the pandemic. Additionally, it draws insights from the experiences of developed nations in handling the economic effects of COVID-19.

9.3. Requirements for implementing the strategy

To address the impacts of the COVID-19 outbreak, the following requirements are necessary:

1. Preventive requirements: Implement long-term preventive actions by the government. Establish

strategic alliances with universities and international organizations to create awareness programs regarding the negative impacts of the COVID-19 pandemic. Conduct systematic awareness campaigns on the economic risks posed by the pandemic and develop strategies to address them. Create diverse mechanisms to manage economic risks and strengthen the institutional capacity of economic organizations and specialized companies to mitigate the impacts of the COVID-19 outbreak.

2. Economic requirements: Provide cash transfers, wage endowments, and duty discounts to the most affected households and businesses by policymakers. Support projects and programs that aim to increase the annual economic growth rate and verify economic foundations. Implement and enhance unemployment insurance programs. Offer training for administrative specialists who regulate banks and monetary institutions to mitigate the negative effects of the economic shock.

3. Financial requirements: Provide tax breaks and loans for firms to assist them in coping with a decline in revenue. This includes injecting liquidity by the central bank and reducing interest rates for banks and non-bank financial institutions. Additionally, it involves ensuring transparency and regulatory oversight in monitoring the allocation of financial resources.

9.4. Mechanisms for implementing the strategy

Several mechanisms can aid in reducing the impacts and consequences of COVID-19 on the Saudi economy, including:

- Monitoring economic indicators and taking corrective actions to enhance their values; establishing a national policy to control the COVID-19 pandemic; developing an integrated and appropriate economic plan to manage the challenges posed by the pandemic; collaborating with relevant authorities to implement the proposed strategy effectively.
- Maximizing investment capacities.
- Boosting non-oil revenue.
- Implementing strategies to alleviate the economic and social repercussions of national public health measures.
- Supporting oil revenue and petrochemicals.
- Increasing GDP and investments by improving the business environment.
- Implementing diverse mechanisms to mitigate economic risks.
- Developing institutional capacity and qualifying specialized companies to manage the impacts of the pandemic.
- Strengthening the private sector's capabilities.
- Promoting both oil and non-oil industries.
- Enhancing the rate of exports and encouraging economic activities.

- Establishing fiscal policies to encourage domestic and international investments for economic sustainability.
- Ensuring the integrity of the banking system and governance of the financial sector.
- Supporting the development of small and medium-sized enterprises.
- Enhancing the responsibility of the Saudi Central Bank in maintaining price stability and labor market balance.
- Elevating investment expenditure and managing inflationary pressures in the national economy.
- Reducing the deficit in the balance of payments and achieving financial sustainability.

10. Policy recommendations

Addressing the complexities of the COVID-19 pandemic demanded an unprecedented range of policy interventions by governments worldwide. These policies were crafted in response to the immediate and varying impacts, considering the available resources and the distinct risks faced by each country. Consequently, the research strategy emphasizes delving deeper into economic policies that aggravated the health crisis while integrating monetary and industrial facets to tackle global financial market concerns. These strategies involve bolstering cross-sector financial advancements, instituting social and public health protection measures, and directing targeted funding towards robust social security programs.

Moreover, recognizing the urgency for fundamental fiscal policy reform emerged as a crucial pillar for social investment and economic revitalization. This necessitates an exhaustive evaluation of current policies, identifying requisite fiscal policy alterations, implementing measures to stimulate economic growth, augment revenue generation, create fiscal space, and foster sustainable investments in human development.

Immediate and resolute policy measures hold paramount importance, encompassing equitable access to social protection, closing the digital divide through strategic infrastructure investments, maintaining a well-balanced approach to healthcare priorities, and enacting pivotal policies that bolster macroeconomics and development. Such policies span from tax deferrals to temporary labor subsidies, direct income assistance, and mortgage moratoriums.

The exigency for accurate, real-time data has been underscored by the pandemic's impact on human development and economic progress. Employing rapid data collection techniques becomes imperative to grasp the nuanced impacts of the COVID-19 crisis on the Saudi economy. Additionally, continual improvements in data collection for economic indicators should be an annual commitment to accurately measure economic progress. Mitigating the pandemic's impact on the Saudi economy necessitates a multi-pronged

approach that extends beyond immediate health measures.

10.1. Public health measures

Firstly, reinforcing public health initiatives entails not only augmenting vaccination campaigns across all segments of the population but also introducing innovative approaches such as mobile vaccination units and intensifying awareness programs to combat vaccine hesitancy. Concurrently, enhancing the healthcare infrastructure requires substantial investments in capacity, supplies, and a robust healthcare workforce.

10.2. Economic policies

On the economic front, pivotal policies involve targeted financial aid, assistance programs, grants, low-interest loans, and tailored tax relief for affected sectors and Small and Medium Enterprises (SMEs). Moreover, ensuring job protection and creation demands a multifaceted approach, entailing job retention schemes, promoting job-skill matching programs, and incentivizing growth in sectors like technology and renewable energy. Strengthening welfare systems, expanding benefits, and ensuring access to essential services for vulnerable populations are integral components of comprehensive social safety nets.

10.3. Structural reforms

Lastly, embarking on structural reforms includes an accelerated digital transformation across sectors, substantial investments in digital infrastructure, promoting e-commerce, and facilitating the transition to remote work setups. Simultaneously, supporting Vision 2030 initiatives, reducing dependence on oil revenues, and bolstering non-oil sectors such as tourism, entertainment, and renewable energy sources contribute significantly to fostering economic diversification and resilience.

Implementing these interconnected policy recommendations holistically will aid in effectively mitigating the pandemic's adverse effects on the Saudi economy. Such concerted efforts are crucial for fostering resilience and establishing a sturdy foundation for sustained recovery and growth in the wake of the COVID-19 crisis.

11. Conclusions

The emergence of the novel coronavirus, COVID-19, has presented a global economic challenge, posing a threat to both economic and social stability. To understand the ramifications on the Saudi economy, this study delved into the consequences and impacts of the COVID-19 outbreak by modeling and forecasting key economic indicators: GDP, exports, imports, Gross Capital Formation (GCF),

Consumption Expenditure (CE), Unemployment Rate (UR), Consumer Price Index (CPI), and Crude Oil Production (COP).

The study gathered quarterly GDP, exports, imports, GCF, and CE data from 2003Q1 to 2023Q2. UR data covered the period from 1999Q1 to 2023Q2, while COP data spanned from 1993Q1 to 2023Q3. Monthly CPI data was collected from January 1995 to September 2023.

Employing the Box-Jenkins approach, the study developed the best-fit ARIMA models for each indicator. Multiple testing procedures were implemented, including time series and correlogram plot analyses to test data stationarity, Maximum Likelihood Estimation (MLE) testing for model estimations, AIC and BIC testing for goodness-of-fit measures, and tests for various autoregressive and moving average ARIMA models to determine the most appropriate models.

The findings revealed the optimal fit models for each indicator, such as ARIMA (2,1,1) for GDP, ARIMA (0,1,1) for exports, SARIMA $(1,1,0)(1,1,0)_4$ for imports, ARIMA (2,1,2) for GCF, ARIMA (2,1,2) for CE, ARIMA (4,1,4) for UR, ARIMA (1,1,1) for CPI, and ARIMA (4,1,3) for COP. These models were then used to forecast economic indicators up to 2028.

The results pointed out the negative impacts of COVID-19 on several economic indicators, including GDP, export and imports rates, unemployment rate, and the consumer price index. However, measures adopted by the Saudi government contributed significantly to pandemic control. Forecasts derived from the ARIMA models suggest a positive trajectory marked by consistent growth and economic recovery.

This positive outlook owes its credence to the proactive measures undertaken by the Saudi government, demonstrating resilience in the face of the pandemic's challenges. The models project a promising growth trajectory, primarily attributed to the effective implementation of government programs and economic initiatives. These proactive steps are pivotal in steering the economy towards stability and development.

It is essential for regulators to consider these pandemic-driven consequences while formulating economic decisions to mitigate severe fluctuations. Urgent steps are needed to protect the Saudi economy, promote an investment-friendly environment, manage economic inflation, support individual purchasing power, and develop an integrated economic policy to navigate the challenges posed by COVID-19.

However, the study acknowledges its limitations. Forecasting models perform better for shorter periods than longer ones. The predictive strength could be enhanced with shorter-term predictions, especially in complex and unpredictable indicators like consumption expenditure and the consumer price index.

Future research should delve into the potential for economic sector development, improvements in the oil industry, and enhanced investment

opportunities to boost the Saudi economy during and after the pandemic. Structural models and simulations should be explored to better evaluate the impact of COVID-19. Additionally, the study calls for a deeper understanding of practical implications by empirically showcasing the restrictive effects of COVID-19 on Saudi economic performance and proposes various mechanisms to bolster economic progress.

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Compliance with ethical standards

Institutional review board statement

The research was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the University of Ha'il (protocol code 46123541 and 19941).

Informed consent

Informed consent was obtained from all subjects involved in the study.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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