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The Effects of the COVID-19 Crisis on the Main Saudi Non-Petroleum Sectors

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Abstract
This study investigates the economic impact of the COVID-19 in Saudi Arabia by examining the decrease of non-petroleum sectors' GDP, and total GDP. These sectors had been in hibernation for more than four months. They have been directly affected, in particular tourism and transport. . Manufacturing and trade also have suffered during the lockdown. We use a two steps method with a simultaneous equation system for sectorial GDP growth and a linear model to estimate the negative effects of the COVID19 pandemic on Saudi GDP growth. rate. Our estimation are made for two scenarios: the first normal evolution of the crisis in a short period and the second a new wave with more long duration of the pandemic. Our results show that the most affected sector is of the pandemic. Our results show that the most affected sector is Services (from -6.7% to - 8.4%) followed by Whole and Retail Sales (-2 % to - 3.1%). The agriculture and manufacturing sectors are the less affected, respectively (-1.1% to -1.8%) and (-1.7% to -2.5%). Financial sector' GDP expected variation is between -1.3% and -2 %. The total impact of the health crisis on the main non-petroleum sectors varies between 12.6% and 17.8%. So Saudi GDP may decrease by -19.6% to -24.8 %.
Keywords: COVID-19, Economics effects, GDP, GDP growth, Saudi sectors.
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1. Introduction

In 2020, we are witnessing a worldwide pandemic and a global economic shutdown, which has spared no country. The COVID-19 consequences will far exceed those of all previous health crises and pandemics. This has prompted political and economic leaders as well as researchers to reflect and ask the question: What will be the impact of COVID-19 on the national (and international) economy?

In Saudi Arabia, the authorities reacted rapidly to the global pandemic to avoid its rapid spread in the kingdom. They have taken all strict measures to save lives by ensuring a strong health system, which has become an immediate priority. Between health and economy, the authorities were intransigent because the cost of human lives is incomparable with the economic cost. Consequently, both education and economic and social activities have come to a halt. These drastic and coercive decisions have had a significant impact on Saudi domestic economic activity.

The intensity of the shock is determined by the duration of the lockdown, the underlying properties of the COVID-19 pandemic, the behavior of firms, as well as consumers facing adversity from measures taken by public authorities. The degree to which economic activity is affected by the social distancing measures depends largely on the capacity of firms to maintain business processes from home. This type of work is not possible for agricultural, industrial, tourism, transport, commerce, and construction activities, which are Saudi sectors selected for our study

Bloom and Canning (2006) argue that epidemics of infectious diseases can have sizable economic impacts – both in the short and long term – and that their management and control require investment in national and international health systems They concluded that The links between epidemics and economics are broadly similar to those between health and wealth in general. Prosperous societies not only have better health; they are also at

In his study of the effects of the COVID-19 on the world economy, Fernandes (2020) estimated the decrease of Saudi GDP by approximately -4.4% with a confidence margin from -2.9 % to5.8% with assumption that the crisis is for short run (maximum 3 months) . He stated that all economic sectors will be affected but, the problems will be particularly bad in hospitality-related sectors in all countries over the world.

According to the IMF, the total shutdown of the activities of almost all economic sectors, mainly transport,

tourism, construction, and commerce was accompanied by a sharp drop in oil prices. As a result, GDP growth is now projected at –4.7% in 2020, or 2% less than in April 2020. The decline rates of Saudi GDP, estimated from the first month of the pandemic by several studies, do not seem to take into account the specific factors to this crisis: its duration, the speed of its expansion, the number of cases, the number of deaths and the drastic measures taken by the most affected countries.

Saudi economic has two main characteristics: It depends on oil exportation and on religious tourism (Hajj and Umrah). Any change in the level of revenues of those two sectors affects all other sectors and the global economic growth rate. In addition, Saudi Arabia has a strong financial and banking industry that enjoys high liquidity. However, its output is projected to contract in 2020 due to scaled-down oil production. However, even non-oil private sector activity will likely decline as the pandemic weighs on the tourism sector, the VAT rate increase and a weaker labor market depress private consumption.

The pessimistic scenario occurred when the state of the pandemic was declared and the return of economic activity was delayed to the month of June. So, the production returned to normal levels and the signs of controlling the virus began to appear by August. But, the resumption of Umrah and international flights was postponed. The occurrence of this scenario for more than eight months may greatly affect the Saudi economy, and there is a possibility of a decline in the GDP growth rate by approximately 20% to 30% mainly due:

(i) A decline of oil production.
(ii) A rise in the size of the public budget deficit.
(iii) A decline in consumer spending, and
(iv) A further decline in the performance of the services , retail and petrochemical sectors.

The aim of this paper is to develop a precise method of measurement in order to estimate the negative impact of this unprecedented health crisis on the GDP of the main non-oil sectors and on the total Saudi GDP. This precision can only be obtained by adopting an approach based on the interrelationships between the sectors selected for the study.

This study is structured as follows: The second section is devoted to the literature review. In section 3 will present the Saudi economy principle characteristics and in the fourth section we present our data and methodology. Section 5 presents the regression results and the discussion of our findings. The conclusion is the section 6.

2. Literature Review

Since March 2020, there are a plethora of ongoing studies that have tried to estimate the economic and financial impact of COVID-19 on economic growth, GDP, employment, firms' activities, firms' profits, and poverty level. With the widespread business closures, national economies, over the world, are expected to contract, leading to an important rise in loses, unemployment and poverty rates.

In 2004, Lee and McKibbin concluded that the most significant real costs of SARS have been generated by changes in spending behavior by households and firms in affected countries. They estimated the cost of the SARS outbreak by focusing on the impacts on consumption and investment behavior through changes in the cost and risk of doing business. Even thowgh SARS has limited effects, Lee and McKibbin stated that through increased economic interdependence, these changes in behavior have wide-ranging general equilibrium consequences for the world economy that can lead to economic losses well over the traditional estimates of the cost of disease."

Izvorski et al.(2020) stated that " severe global economic recession. foregone conclusion that the global economy will slip into a recession in 2020. What we don't know is how deep, long, and widespread the contraction in economic activity is going to be. As a result of the unprecedented sudden stop in global economic activity, 2020 is on track to witness the deepest global recession on a scale not seen since World War". So any country can be spared.

As pointed out by Elliot et al. (2020), the COVID-19 crisis has shown us that international cooperation easily breaks down during a crisis and that without global cooperation the costs for the poorer or less able countries may be very high. It is not the case in Saudi Arabia which has a solid financial system and the government can easily support firms, workers, and families. They also pointed out that a global crisis easily disrupts international supply chains which, among other effects, has already led to reductions in both the flows of trade as well as people around the world. We understand that, in the short term, the implications on Saudi economy of these reductions are inevitable.

Muellbauer (2020) estimated instantaneous declines and found a fall of quarterly consumption of 20%. This would translate to losses of annual GDP if the lockdown lasted for a year. His findings are in line with those of the OECD (2020) study based on aggregating industry-level shocks, which expected a drop in immediate GDP of around 25%.

Barrot et al. (2020) estimated industry-level shocks by considering the list of essential industries, the closure of schools, and an estimate of the ability to work from home. Using these shocks in a multisector input-

output model, they found that six weeks of social distancing would bring GDP down by 5.6%.

Baldwin (2020) has the same conclusions as Izvorski et al. (2020) and Elliot et al.(2020) for the impact of COVID-19 on the flows of income in the economy in one country or over the world. First, households do not get paid, so their consumption and savings levels are reduced. Second, households reduce their demand for imports, which in turn reduces income for the rest of the world, and hence the country's exports decreased Third, the demand/supply shocks cause disruption in domestic and international supply chains. Fourth, all of the previous shocks and disruptions lead to a fall in output, causing reductions in the usage of the factors of production. In this case, labor is more affected than capital through reduced working hours or layoffs and hence lower earnings.

For the first economy in the world (USA), Ludvigson et al. (2020) estimated a cumulative loss of 24 million jobs over 10 months, largely due to a 17% loss in service sector employment. They concluded that only 37% of jobs can be performed at home.

According to Dingel and Neiman (2020), lower-income countries have a lower share of jobs that can be performed remotely from home. We think that the overall work-from-home percentage is low even in some rich countries as Saudi Arabia in many sectors, except for banking, insurance, and administrative work.

Analyzing data from a personal finance website, Baker et al. (2020), found that consumer spending in the United States is highly dependent on the severity of the disease outbreak in the state and the strength of the local government's response.

Carlsson-Szlezak et al. (2020a) and Carlsson-Szlezak et al. (2020b) stated that there are three main transmission channels: direct impact, indirect impact, and supply-side disruptions. The direct impact is the reduction of consumption of goods and services. Prolonged lengths of the pandemic and the social distancing measures might reduce consumer confidence by keeping consumers at home. While the indirect impact of working through financial market shocks and their effects on the real economy. As a result, Household wealth will likely fall, savings will increase, and consumer spending will decrease further. Supply-side disruptions, as COVID-19 keeps production halted, will negatively impact supply chains, labor demand, and employment, leading to prolonged periods of lay-offs and rising unemployment.

Mckibbin and Fernando (2020) applied their G-Cubed economic model to estimate the economic impact of the current global COVID-19 crisis in seven scenarios. They demonstrated that even a contained outbreak could significantly impact the global economy in the short run. They stated that the economic losses caused by covid19 are measured in the trillions of dollars. Real-world GDP will fall by 2% compared to what was forecasted for 2020 before the pandemic.

Lewis et al. (2020) developed a weekly economic index (WEI) using ten different economic variables to track the economic impact of COVID-19 in the U.S. Their findings show that between March 21 and March 28, the WEI declined by 6.19%. This was driven by a decline in consumer confidence, a fall in fuel sales, a rise in unemployment insurance (UI) claims, and other variables.

Using a real business cycle (RBC) model, Baker et al. (2020b) found that a COVID-19 shock leads to year-on-year contraction of GDP by 11% in the 4th quarter of 2020. According to the authors, more than half of the contraction is caused by COVID-19 induced uncertainty

Assuming the coronavirus pandemic can last for several months, Eichenbaum et al.(2020a) used a SIR-Macro model and found that aggregate consumption fell by 9.3% over 32 weeks. On the other hand, labor supply or hours worked followed a U-shaped pattern, with a peak decline of 8.25% in the 32nd week from the start of the pandemic. However, long-run declines in hours worked are lower because a higher proportion of the population survives and returns to work compared to the counterfactual.

In their across countries study, Demirguc-Kunt et al. (2020) estimated the economic impact of social distancing measures via three high-frequency proxies (electricity consumption, nitrogen dioxide emissions, and mobility records). They found that social distancing measures led to a 10% decline in economic activity (as measured by electricity usage and emissions) for European and Central Asian countries between January and April.

Hassan et al. (2020) observed in their study a pattern of heterogeneity of firm resilience across industries in the United States and around the World. Based on earnings call reports, they provided evidence that some firms are expecting increased business opportunities amid the global disruption (e.g., firms which make medical supplies).

Bonadio et al. (2020) use a quantitative framework to simulate a global lockdown as a contraction in labor supply for 64 countries. They found that the average decline in real GDP constitutes a major contraction in economic activity, with a large share attributed to disruptions in global supply chains.

According to Estrada (2020), to cope with the effects of the pandemic and also to take the best anticipatory measures that reduce the impact of any other pandemic before they occur, there are needs to use a precise and useful measurement of the impact of COVID-19 on economic performance. Thus, we believe that the economic effects of the following waves will be less important even before the discovery of a vaccine. There will be less fear and the populations will live with the maximum of precautions. The large number of researches and the

many approaches adopted to measure the economic effects of COVID-19 across the world agree on the certainty of the decline of all economic indicators. But, there is uncertainty as to the magnitude of the effects. This is due to the methods of measurement applied, the strength of the economy, the degree of international interconnectivity of each country, and the measures taken to mitigate the negative effects of the scenarios planned.

3. Saudi economy characteristics

The Saudi authorities have focused on supporting the resumption of economic activities and reallocation of resources to mitigate the negative effects of the pandemic and help businesses to overcome these shocks. They have been able to ensure financial stability during the pandemic period by injecting sufficient funds to help businesses. In September 2020, Standards and Poors maintained the KSA ranking. It was a positive signal for financial stability.

The impact of COVID-19 on Saudi economic sectors growth may be substantial, but measuring such implications is subject to a great deal of uncertainty. In the second quarter of 2020, the Saudi economy shrank 7% year-on-year. It's the highest contraction rate since 1985.

Table 1: COVID-19 Effects on the second quarter of 2020

Saudi Sectors	Evolution rate 2020
Non-oil sector	-8.2%
Oil sector	-5.3%
wholesale and retail trade	-18.3%
Transport, storage, and communication	-16.3%
petroleum refining	-10.4%

Source: Saudi Agency of Statistics report

Table 1 shows the important negative effects of the pandemic on the Saudi sectors. The second quarter of 2020 marks the 4th consecutive quarterly decline in GDP, with the COVID-19 pandemic hurting an economy already battling with falling oil prices and fuel demand This happens during a big increase in VAT in July from 5% to 15%, aiming to increase non-oil revenues, is hurting domestic demand. At the same time, annual inflation rate increased to 6.2 % in August 2020 because the of the rise of the VAT rate. Indeed, it is the highest inflation rate since February 2009.

The Saudi tourism sector represents the second most important sector after petroleum. Indeed, the average number of Umrah visitors per year reached 19 million (about two-thirds from outside the Kingdom) and the number of pilgrims reached about 2.5 million, with an average income of $10 billion. The number of pilgrims in 2020 reached only 10,000 while the Umrah did not take place for 8 months. This means a decrease in revenues by about % for a sector that employs more than 300,000 employees and relies on 32,000 means of transportation. The contribution of this important sector to the GDP will inevitably decline by a large percentage.

Consequently, the gradual opening of international borders and the relaxation of travel restrictions in early November will certainly lead to a decline in the Saudi tourism sector's contribution to GDP. Forecasts are based on a single scenario: the total cessation of activity.

The total number of hotels in 2019 was 2354, 68% of which were in Mekkah and 17 % in Medina. The complete cessation of the Hajj and Umrah, means that their closure for more than 7 months will result in a drop in their added value by 100%. This will affect Saudi GDP and its growth rate in a significant way. Tourism is closely linked to international air transport which stopped completely for 8 months. Without added value, the inactivity cost of these airlines will be so high and the contribution of the transport sector to total GDP will decrease remarkably.

Table 2: Quarterly forecasted GDP growth rate

Period	Actual rate	Previous rate
Q4 2019	-0.5%	+0.5%
Q1 2020	-0.3%	-0.5%
Q2 2020	-1%	-0.3%
Q3 2020	-7%	-1%

Source: Saudi Agency of Statistics Reports

As we can see in Table 2, the actual negative decrease is higher than the forecasted one. This means that the coronavirus had an unexpected effect level at the beginning of the pandemic.

From 1996 to 2019 was a period of Saudi economy's high growth rate and performance as shown in Table 3 and figure 1.

Table 3: GDP (billion USD) and its annual growth rate 1996-2019

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GDP	594,19	621,53	550,41	606,44	710,68	690,52	711,02	809,28	970,28	1,230,7	1,411,4	1,558,8
growth rate (%)	10.69	4.60	-11.44	10.18	17.19	-2.84	2.97	13.82	19.89	26.85	14.68	10.44
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
GDP	1,949,2	1,609,1	528.2	671.2	736.	746.6	756.4	654.3	644.9	688.6	786.5	792.97
Growth rate (%)	25.05	-17.45	23.1	27.08	9.64	1.45	1.30	-13.5	-1.43	6.77	14.22	0.82

Source: Saudi Agency of Statistics Reports

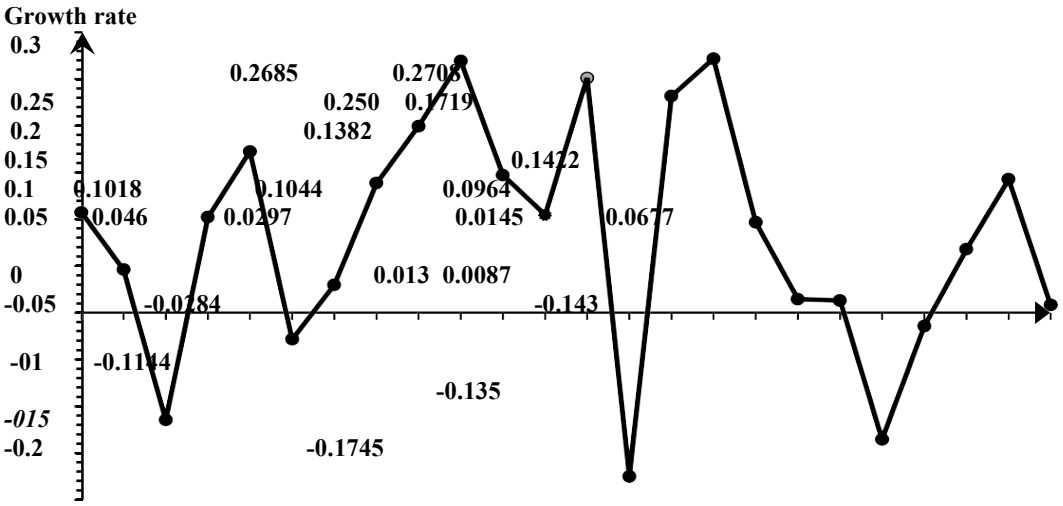

Figure 1:Saudi GDP VARIABLITY 1996-2019

Figure 1 shows that the Saudi GDP variability has been intense during the period 1996-2019. There is no trend, it declined strongly and became negative five times due to the decrease in the oil price: In 1998,2001, 2008, 2015, and 2016,although there was no pandemic or health crisis.

During the last twenty four years, the Saudi GDP has been unstable, it deceased ten time because it was strongly related to the variation in the price and export of oil. The contribution of oil's GDP varied between 24.02% and 29.5%, followed by manufacturing and financial sectors with an average contribution of 12.5% for each sector. And then, the commerce, hotel and restaurant sector with an average of 11 %.

Over the past five years, the other non-petroleum sectors (agriculture, transport, electricity, banking and financial services, and construction) contributed on average with about 40% to total GDP.

The overall quarantine in the whole kingdom, since March, resulted in a total stop in the economic activity and the chain of production, and international and domestic transportation. Certainly, these sectors were affected.

There are two transmission measures for the pandemic that will hit all Saudi sectors hard :

(i) First, international and national travel restrictions had reduced the flow of goods and services across the borders and inside the country.

(ii) Second, increased uncertainty will be translated into reduced spending by households and small businesses.

The most affected companies are those whose activities have ceased altogether. They have no more recipes and therefore no added value. Their inactivity costs are sometimes enormous, which inevitably leads to a drop in their contribution in total GPD. They need time to compensate these losses.

Saudi Air transport and religious tourism (Hajj and Umrah) are the most affected sectors by the COVID-19 pandemic. This is due to the precautionary measures applied and the decline in demand. The estimated loss of revenue is about $ 10 billion. Thus making Saudi Arabia the sixth most influenced country in terms of air transport in the Africa-Middle East region, as highlighted by the forecasts of the International Air Transport Association (IATA). It should be noted that road and rail transport are also widely affected, due to the ban on vehicle traffic and travel transport between cities since March 2020. SAPTCO (Saudi Public Transport Company) has lost 60% of its sales and more than 50% of its net unequal degrees.

For the Saudi economy, where GDP fell by 4.8% in the first quarter, it is expected that it will fall into recession in 2020, with a contraction of 5.0% in a likely scenario (McKibbin and Fernando 2020; Fernandes 2020). In developed countries, the estimated contraction rate for 2020 will be high, as in euro area where The European Commission estimated this rate by 7.25%.

The real impact and duration of the COVID-19 economic crisis on individual households are difficult to predict as many uncertainties surround this crisis duration, i.e. length of 'stay at home" orders, impacted industries, and the post-crisis consumption and recovery. As for Saudi Arabia, the curfew and the ban on travel between cities lasted only three months, after which domestic flights resumed, and shops were opened, which limited losses.

According to Buheji et al. (2020), 49 million individuals in four continents, will be driven into extreme poverty in 2020. This gives us an idea of the intensity of the health crisis's impact. But, the Saudi population will not be so affected because e of the rapid intervention of the authorities and the financial capacities of the households. Foreign workers will eventually be affected. For Kochhar and Barroso (2020), the highest risks of layoffs are in the accommodations, retail trade, transportation services, and arts entertainment and recreation services sector. This is indeed the case of the Saudi Arabia during the total curfew in the country.

Although ongoing research is assessing the economic ramifications of COVID-19, most of these studies are focusing on the macroeconomic and financial impact of the coronavirus pandemic. Impact on national economies is then translated into socio-economic impact on individuals, including consumption decrease and poverty rates increase. We will adopt macro-level analysis approach that can better capture the interaction across sectors.

The health direct impacts, due to illness and mortality, or indirect effects on the workforce are not modeled and are beyond the scope of this study. We focus on Saudi official economic data. So, the number of COVID-19 cases, Susceptible-Infected-Recovered (SIR) dynamic model, or other epidemiological models are not included in our study. Only the forecasted direct economic impact of the coronavirus on the main Saudi economic sectors is analyzed. But, The long-term intertemporal effects of consumption, savings, and income are neglected since many uncertainties surround the pandemic, lockdown, and subsequent recovery in Saudi Arabia at the time of this study. We develop models that can help authorities to make economic policies and strategies if they are able to foresee all the possible economic and monetary implications of health crises, like COVID-19.

4. Methodology and data

All necessary data for the study regressions were collected from SAMA (Saudi Arab Monetary Authority), quarterly and annual reports of the Saudi statistics agency from 1970 to 2019 for the Saudi total GDP and from 2010 to 2019 for sectorial GDP, added value, financial data and number of visitors. We also collected data for the first and second quarters of 2020.

For the financial sector, data are approximated by the available data for the banking sector from 2010 to 2019. As for the data relating to the added values of the various sectors, we approximated them on the basis of the data available from the large companies in each sector.

4.1. Methodology

Several approaches have been adopted to measure the economic effects of covid19, we mention among them the following: The computable general equilibrium model (CGE) and the macroeconomic and budgetary model "MFMOD" world Bank (2020), the G-Cubbed (Mckibbin and Fernando 2020), the EPM-Model (Estrada 2020), the cost of the COVID-19 model (Jordà et al. 2020), the multisector input-output model Barrot et al. (2020) to estimate industry-level shocks, econometric model (Muellbauer 2020). Some researchers used a variable vector autoregression model based on recent data in 2020.

In our study, and as stated by Gourinchas (2020), in a modern economy there is a complex web of several interconnected parties as firms, suppliers, consumers, workers and financial intermediaries, we have to consider that Saudi sectorial GDPs are interrelated and the variation of one of them affects all other sectors. Nhamo et al.(2020) focused on global tourism value chains and the linkages between COVID-19 and the Sustainable Development Goals (SDGs) by measuring the impacts of COVID-19 on various industries within the global tourism value chain including aviation, airports, cruise ships, car rentals hotels, restaurants, sporting, pilgrimage and religious tourism, gaming and entertainment, and the stock market. the realities reported by their study and their direct effects are the same as those observed in Saudi Arabia.

Due to the very high degrees of inter-connectedness activities, a breakdown in the transport flows and the supply chains will have cascading effects on the firms' added values that vary from a sector to another. This is how we consider that agriculture, tourism, some services, and manufacturing, are closely linked to transport. We focus only on main non-petroleum sectors that are directly affected by the COVID-19.

To calculate the change in total GDP, we adopt a two-step approach. We start by estimating the change in sector GDP and then determine the expected change in total GDP on the basis of a linear model. To measure the

real contribution of each sector to GDP, we integrate seven sectors into the GDP forecasting model. But for the sectorial model, only the five main sectors are retained (agriculture, whole and retail sales, services, manufacturing and the financial sector). We assume that the electricity and construction sectors are not severely affected by COVID-19 and therefore their contribution to the Total GDP will almost be constant.

Then, we propose two possible scenarios depending on the magnitude of the effects of the COVID-19:medium and high with assumption that the variations of oil sector and electricity sector GDP are constant. Using these two scenarios, we will obtain two sets of Total GDP and sectorial GDP growth rate estimations.

Usually, the economic impact of financial price variability or pandemics shocks is measured with aggregate time-series data, such as financial services, industrial production, GDP growth, unemployment rate, Added value variations, and others.

Our study aims to measure both the COVID-19 effects on the Saudi economic sectors and the overall impact on the economy by estimating the forecast decline in GDP. We propose a simultaneous equations model to estimate the pandemic effects on sectorial GDP variation in 2020 and at the same time the negative effects on global Saudi GDP.

4.2. Model specifications

4.2.1. Sectorial model

The ten main sectors contributing to the Saudi GDP are: Agriculture, Mining and Quarrying Crude Petroleum & Natural Gas, (Petroleum Refining, electricity), Gas and Water, Construction, Manufacturing, Wholesale and Retail Trade, Restaurants and hotels, transport, and Storage and Communication, Finance and Insurance, Real estate activities, and Business Services.

The oil price decline after the fall in international consumption, due to the COVID-19 pandemic, has certainly affected the Saudi economy. But it is not the first time. So, in this study we will focus only on the effects of the pandemic on five main economic sectors: manufacturing, Agriculture, Services (mainly transport and tourism), Wholesale and Retail Trade, and banking and Financial services. These sectors are closely related and they contribute for more than 50% to total GDP. The Saudi banking industry did not cease its activities during the first four months of the pandemic. All financial transactions were carried out online. The volume of deposits has certainly decreased due to the slowdown in economic activities but, without having serious consequences on commercial banks' financial intermediation level. Its relative contribution to total GDP is not less important than those of other sectors such as services, manufacturing and wholesale and retail trade.

To forecast the annual variations of the sectorial GDP, we propose a simultaneous equation system based on sample relationships and interconnectivity between the retained sectors.

$$\Delta GDPagr_t = \Delta GDPman_t + \Delta GPDserv_t + \Delta AVagr_t + \varepsilon_t \quad (1)$$

$$\Delta GDPman_t = \Delta GDPagr_t + \Delta GDPserv_t + \Delta AVman_t + \varepsilon_t \quad (2)$$

$$\Delta GDPserv_t = \Delta GDPman_t + \Delta GDPwrt_t + \Delta AVserv_t + \Delta UV_t + \varepsilon_t \quad (3)$$

$$\Delta GDPwrt_t = \Delta GDPman_t + \Delta AVagr_t + \Delta AVserv_t + \Delta UV_t + \varepsilon_t \quad (4)$$

$$\Delta GDPfin_t = \Delta AVman_t + \Delta AVserv_t + \Delta AVagr_t + \Delta AVfin_t + \varepsilon t \quad (5)$$

Where:

$\Delta GDPagr_t$: annual GDP growth of the agriculture sector.
$\Delta GDsev_t$: annual GDP growth of services sector.
$\Delta GDwrt_t$: annual GDP growth of the whole and retail sales sector.
$\Delta GDPfin_{ft}$: annual GDP growth of the financial sector.
$\Delta AVagr_t$: annual growth of the added value of agriculture sector.
$AVwrt_t$: annual growth of the added value of whole and retail sales sector.
$\Delta AVserv_t$: annual growth in the added value of services sector.
ΔUV_t: annual growth of number of Umrah and Haj visitors.

4.2.2. Total GDP Model

The main variable of the model is the change in total GDP as a dependent variable. It is based on the annual variations of eight non-petroleum sectorial GDP.

$$\Delta TGDP_t = \beta_1 \Delta GDPagr_t + \beta_2 \Delta GDPserv_t + \beta_3 \Delta GDPwrt_t + \beta_4 \Delta GDfin_t + \beta_5 \Delta GDPman_t + \beta_6 \Delta GDPcon_t + \beta_7 \Delta GDPelec_t + \varepsilon_t \quad (6)$$

Where:

$\Delta TGDP_t$:annual Saudi total GDP growth
$\Delta GDPagr_t$; annual GDP growth of the agriculture sector.
$\Delta GDPserv_t$: annual GDP growth of services sector.
$\Delta GDPwrt_t$: annual GDP growth of the whole and retail sales sector.
$\Delta GDPfin_t$: annual GDP growth of financial sector.

$\Delta GDPman_t$: annual GDP growth of the manufacturing sector
$\Delta GDPcon_t$: annual GDP growth of construction sector.
$\Delta GDPelec_t$: annual GDP growth of electricity sector.

5. Models' results and discussion

5.1. Sectorial GDPs' growth model

Certainly, there is a positive relationships between the different sectorial GDP variations. and direct correlations between added values and these variations. Table 4 displays the coefficients of the simultaneous equations system.

Table4: Regressions' results

Independent variables	Dependent variables				
	$\Delta GDPagr_t$	$\Delta GDPman_t$	$\Delta GDPwrt_t$	$\Delta GDPserv_t$	$\Delta GDPfin_t$
$\Delta GDPagr_t$		0.0210274* (4.28249)	0.021574* (2.03142)		
$\Delta GDPman_t$	0.064526* (1.64159)			0.097632* (1.20147)	
$\Delta GDPwrt_t$	0.112176* (2.014856)	0.049522* (1.79587)			
$\Delta GDPwrt_t$				0.139463* (1.087152)	
$\Delta AVagr_t$	0.297642* (2. 70875				0.083796* (1.021869)
$\Delta AVman_t$		0.094831* (2.205821)			0.121973 (0.89316)
$\Delta AVwrt_t$			0.327454* (2.15785)		0.204135* (1.93148)
$\Delta AVser_t$			0.126153* (1.75361)	0.398236* (2. 06048)	0.128953* (1.40785)
ΔUV_t			0.174502* (2.61509)	0.32482* (2.25648)	
R2	0.8282	0.8781	0.9247	0.8624	0.7823
R^2ajusted	0.8057	0.8529	0.9075	0.8413	0.7584
F-statistic	128.364	239.607	315.598	214.125	183.426

* significant at 0.05 level

Table 4 shows the connectedness of non-petroleum sectors and the relationships between sectorial GDP growth and added value and number of visitors.

All the sectorial GDP are strongly correlated with their own added values. The cut off of activities laid immediately to a decrease of the GDP. More long is the duration of lockdown, more are the decline of the added values. Based on the estimated rates of decease of added values for each sector and the number of visitors, the partial adjacent equilibrium between the five non-oil sectors of our simultaneous equations system results i the following variations for each scenario:

Table 5: estimated GDP variations with partial equilibrium

Sectors / Scenarios	Agriculture	Services	Whole and retail sales	Manufacturing	Financial sector
1	-5.161%	-22.472%	-10.294%	-6.164%	-12.014%
2	-8.445%	-28.173%	-15.954%	-9.065%	-21.844%

Services GDP is impacted by the drop in added value of the sector which was considerable and never seen (-75%). The main cause is the absence of travelers and pilgrims following the complete suspension of international flights. It is also affected by the stoppage of catering, coffee, hairdressing, taxi services, etc…The rate of decline in the services GDP could be higher than that of the oil sector unless there unless there will be a further fall in the oil price.

The second sector affected by the shutdown is the whole and retail trade whose added value decreased as it is strongly correlated with the services and the international visitors number.

The manufacturing sector is slightly affected because large Saudi industrial firms (and even some medium sized firms) have managed to maintain almost the same rate of production. The expected decrease of its added value is around 15%.

With regard to the financial sector, mainly commercial banks, the slowdown in the activities of the main sectors resulted in a reduction of the intermediation and stock market transactions. During a period of recession, the financial sector is certainly affected, mainly after the oil prices decrease but, the Saudi banking sector is solid and its liquidity level is high, so it can withstand short-term crises.

The variation of the agricultural sector's GDP is correlated with the variation of the services' GDP and, at the same time, the variation of its own added value which is around 5% during the crisis period . This added value is not affected by the health crisis because its activities have never been interrupted.

The combined effect of these decreases of sectorial GDP on Saudi total GDP will be of the order of 20% in 2020 and could continue in 2021 in the case of a second wave with a curfew and ban on inter-regional travel.

The number of pilgrims has affected negatively the added values of services, trade and financial sectors. It reached 2.5 million for the hajj and 19 million for Umrah (including 7 million home visitors) during the last few years. This number has fallen to 10,000 haj and zero for Umrah during the period March to September. So, the immediate result is the total restriction of the activity of approximately hotels (1650 in Makah and Medina), restaurants, shops, transport firms, and religious tourism companies.

Religious tourism is the second-largest source of income and foreign exchange after oil, it serves all other Saudi sectors and is a growing sector. These unprecedent crisis' effects may be an alert for the Saudi authorities who must reorient some strategic economic choices concerning the non-petroleum sectors and their ambitious program to develop the religious tourism' s reception capacities. In fact, the fall in tourism and services GDP risks to sustainable in the medium term as long as the fear of COVID-19 and its rapid spread may persist.

Sectorial GDP levels for 2019 may not be reached during the years 2021 and 2022. The resumption of normal activities is dependent on the withdrawal of foreign pilgrims and the use of Saudi authorities of economic and monetary measures to save jobs and to avoid small and medium sized firms solvencies.

5.2.Model GDP

The regression's results are presented in Tables 6 , 7and 8 below.

Table 6: Descriptive Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
ΔTGDP	50	12.85322	29.8227	-17.44891	190.9807
ΔGDPAGR	50	9.304161	11.99285	.4884455	71.47651
ΔGDPSER	50	11.01674	20.2232	-21.67066	100.9496
ΔGDPWSRS	50	12.95271	15.4618	-4.385663	63.73486
ΔGDPCONST	50	13.6237	28.66267	-14.32001	137.9202
ΔGDPELEC	50	10.08831	30.86374	-68.46867	164.8252
ΔGDPMAN	50	16.84622	49.28303	46.86018	287.5179
ΔGDPFIN	50	16.37915	38.4407	1.47772	222.4138

Table 6 shows that manufacturing's GDP has a higher growth rate and the GDP electricity is second. Followed by construction GDP and services GDP growth rate. The agriculture's GDP rate is the last. These rates of increase reflect the developments of the various non-petroleum sectors over 50 years and so, the economic development strategy.

The electricity sector is neither directly nor seriously affected by the COVID-19 pandemic, so we do not retain it in the sectorial model. We will assume that its GDP' s variation is very low to affect total GDP.

Table 7: Correlation Matrix

variables	ΔTGDP	ΔGDPAGR	ΔGBSER	ΔGDPWSR	ΔGDPCON	ΔGDPELEC	ΔGDPMAN	ΔGDPFIN
ΔTGDP	1.0000							
ΔGDPAGR	0.0074	1.0000						
ΔGDPSER	0.9699	0.3750	1.0000					
ΔGDPWSR	0.6079	0.0959	0.1625	1.0000				
ΔGDPCON	0.6212	0.2580	0.3365	0.8455	1.0000			
ΔGDPELEC	0.1426	0.6619	0.2098	0.2335	0.5499	1.0000		
ΔGDPMAN	0.2594	0.0188	0.3961	0.1697	0.0978	0.1377	1.0000	
ΔGDPFIN	0.7159	0.2189	0.0798	0.4716	0.7662	0.6162	0.1256	1.0000

The correlation matrix shows the contribution of each sector to the GDPs of other sectors as well as the degrees of interdependence of the Saudi sectors.

Table 8 : Model's Tests

Source	SS	Df	MS	Number of obs = 50
Model	42937.631	10	4293.7631	F(10, 39) = 260.57
Residual	642.64601	39	16.4781028	Prob > F = 0.000
Total	43580.277	49	889.393408	R-squared = 0.9853
				Adj R-squared = 0.9815
				Root MSE = 4.0593
				Durbin-Watson statistic 2.131967

Table 8 highlights the strong relationship between non-petroleum sector GDP and total GDP (98.5%). This helps us to predict future changes in Saudi GDP, with a small margin o error. Overall, all tests of the model are acceptable.

Table 9: Regression Coefficients of Model 2

Variables	Coef.	Std.	Err. T P>|t|	[95% Conf. Interval]
ΔTGDP	.2353264	.1326946	-1.77 0084	-.5037266 .2830738
ΔGDPAG	.2131462	.0853261	0.37 0716	-.1412722 .2539046
ΔGDPSER	.298149	.0642909	4.64 0530	.1681084 .4281896
ΔGPDWSR	.1942975	.1530866	1.27 0212	-.1153494 .5039444
ΔGDPCON	.0816499	.0880789	0.93 0360	-.0965065 .2598064
ΔGDPELEC	.0195789	.0237995	0.82 0416	-.0285603 .0677186
ΔGDPMAN	.2757875	.0266776	4.84 0000	.2418271 .4497481
ΔGDPFIN	.0915547	.0554997	1.65 0107	-.0207041 .2038135
Cons	-1.035289	1.0290743	-1.01 0321	-3.116788 1.0462093

Table 9 displays the correlations between the variations of sectorial GDP and Saudi annual GDP variation. It is that services and manufacturing and whole and retail sales ar the first to affect the change in total GDP and then Financial sector. The effect of the agriculture is the least during the 24 last years.

According to these coefficients and the estimated sectorial GDP variations (model 1), we can estimate the total GDP variation. We will estimate the sectorial GDP variation in in two situations as we have indicated in section 3. and although a gradual recovery in commercial and domestic air and land transport activity since July, Sectorial GDPs are expected to continue to decline in 2020. A mechanical rebound would then follow in 2021, unless there would be a second severe wave. This would allow the investment to gain momentum. Despite this probable rebound, the return to pre-crisis GDP levels will not occur before the end of 2021, or after, due to several international and national economic and health crisis factors.

5.3 GDP variations and Discussion

The results of our model 1 (table 5) and model 2 (table 9) above, allow us to estimate the expectedin both scenarios the oil sector GDP variation is -7% and that the GDP variations for Electricity and Construction will be insignificant.

Table 10: Saudi Sectorial GDP and global GDP estimated variations in 2020

Sector GDP growth	Scenario 1	Scenario 2
ΔGDP services	-6.7%	-8.4%
ΔGDP whole and retail sales	-2.0%	-3.1%
ΔGDP manufacturing	-1.7%	-2.5%
ΔGDP Finance	-1.1%	-2.0%
ΔGDP	-1.1%	-1.8%
Total	12.6%	17.8%
ΔGDP	-7.0%	-7.0%
ΔTGDP	-19.6%	-24.8 %

Table 10 shows the forecasted short-run decline of the non-petroleum GDP in 2020, it may vary between 12.6% and 17.8%. Services sector (essentially Transport an tourism) is the most affected by the pandemic. The sales and consequently, the added values of the services firms have decreased remarkably because of the total cessation of their activities.

6. Conclusion

Undoubtedly, the negative effects of COVID-19 on Saudi GDP growth , sectorial GDP and firms added value are inevitable and could be of an unprecedented magnitude but measuring such effects is subject to a great deal of uncertainty.

For Saudi Arabia, Services sector (essentially Tourism and transport) is the most affected and the drop in their added values, and by the same, their GDP decrease is the most important (-6.7% to -8.4%) in all scenarios of crisis. They are also related to the evolution of the COVID-19 spreading over the world. It is expected that the GDP of Whole and retail sales sector decrease by -2% to -3.1%.

The agriculture sector has not been seriously affected by the health crisis, but a slowdown of 1.1% is estimated and it can reach 1.8% in case of a second wave. Saudi financial sector is less impacted with a GDP decrease of -1.1% and a maximum of -2%. Other sectors' GDP rate will also decrease. First-degree interpenetration of the economic and financial sectors increased the decline in sectorial value added (and in particular those of large firms), which was reflected by inactivity costs and losses. It is difficult to compensate for these losses, depending on the revenues of the coming years.

The total impact of the health crisis on non-petroleum sectors varies between 12.6% and 17.8%. Consequently, Saudi 2020 GDP may decrease by -19.6 % but, in case of a second coronavirus wave, the rate of decrease will reach -24.8%.

Therefore, unless successive new waves spread in several countries around the world, economic activities are expected to return to their usual level, but gradually in some sectors whose activities contribute to the spread of the virus. But, a lasting recession could be avoided.

Our results do not mean that this pandemic will be followed by prolonged periods of recession, unless there are several successive waves of COVID-19. If the GDP decrease will be more important, the 2020 recession can't be caught rapidly. It takes time to retrieve the past GDP levels. These results should make it possible to predict the economic effects of a future pandemic similar to the pandemic of 2020 and pave the way for a significant reduction in its impact on Saudi vulnerable sectors. Besides, these estimates can be exploited for a potential reorientation of economic strategies in Saudi Arabia, to have less vulnerable sectors in the event of more new severe pandemics. Globally, the high vulnerability of some sectors to epidemics, such as COVID-19, lowers economic development standards. So, Saudi authorities have to reduce vulnerability by reinforcing he preventive health services in all regions of the Kingdom. They can prevent a short recession from becoming a long-lasting depression and can avoid large losses for businesses. New investment opportunities will appear and may substitute some services activities which are dependent on outside. In Saudi Arabia, it is time to orient new investments to agriculture and local manufacturing, particularly the anti-epidemic manufacturing. This will ensure independence and self-sufficiency.

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