International Business Research; Vol. 16, No. 2; 2023
ISSN 1913-9004 E-ISSN 1913-9012
Published by Canadian Center of Science and Education

COVID-19 Vaccinations: Efficacy and Financial Benefits (The Case of the Pharmaceutical Companies)

Nader Alber[1], Mansour Abdelrhim[2], & Mahmoud Farouh[3]

[1] Professor of Finance, Faculty of Business, Ain Shams University, Cairo, Egypt

[2] Ph.D. from Ain Shams University, Cairo, Egypt

[3] Lecturer in Business Administration, School of Business, Nile University, Egypt

Correspondence: Nader Alber, Professor of Finance, Faculty of Business, Ain Shams University, Cairo, Egypt.

Received: October 28, 2022 Accepted: January 25, 2023 Online Published: January 31, 2023

doi:10.5539/ibr.v16n2p54 URL: https://doi.org/10.5539/ibr.v16n2p54

Abstract

This paper empirically investigates two sides of the COVID-19 vaccinations. The first part is a study of the vaccination efficacy and its impact on the number of new cases and new deaths, using the daily doses data of Eight different COVID-19 vaccination for a sample of 30 countries around the world. The second part is a study of the financial benefits for the same eight vaccines producers' companies. The event study method is adopted in this research to explore the abnormal returns and their accumulations, where the event date is January 30, 2020.

The Vaccine's efficacy results show that (Moderna, Oxford/Astrazeneca, and Novavax V) have proved effi-cacy in reducing new cases and new deaths. Meanwhile, Cansino's vaccine has been effective in reducing the number of new cases only. On the other hand, vaccines like (Pfizer/ Biontech, Sinovac, Johnson & Johnson, and Sinopharm/ Beijing) haven't proved efficacy in reducing the number of new cases and new deaths.

The Financial benefits results show that the vaccine manufacturers who have achieved the benefits of abnor-mal returns in the presence of vaccine efficacy are (Oxford/AstraZeneca and Novavax), while other manufacturers haven't achieved the benefits of abnormal returns. The results also show that the pharmaceutical companies that have achieved benefits on the cumulative abnormal returns in the presence of the vaccine efficacy are (Ox-ford/AstraZeneca, Novavax, Moderna, and CanSino). Meanwhile, the rest of manufacturers have achieved cumulative abnormal returns but they are not effective in reducing the numbers of neither new cases nor new deaths.

Keywords: Coronavirus, COVID-19, Vaccinations, stock market return, event study, OLS

JEL Classification: D53, E44, G15, I15, L65.

1. Introduction

During the unprecedented COVID-19 Pandemic, the scene was extremely dramatic as fear hanged over the entire world. The number of new cases were exponentially increasing on a daily basis and the smell of death was too close to every soul. Streets were empty of people and life almost stopped. The only hope was survival and not to lose any beloved person. The investing opportunities were disrupting and too heavy for brains to think at that miserable time. The safe heavens were used by some investors to save their capital's values. But as usual, there is an opportunity at each adversity time and few investors understood that the vaccination production investment will lead the situation and there will be benefits behind the catastrophe. Thus, the situation stood between vaccine nationalism or human solidarity.

At the time of the pandemic, the entire world got affected at many aspects economically, socially, and environmentally, the world economy inflation rates increased due to supply shortage and supply chains were severely impacted by worker fear. Ninety percent of the world's countries GDP per capita markedly declined in 2020, for the first time since the year 1900 (Olaberria and Reinhart, 2022). All the sectors and industries were badly affected such as tourism, agriculture, trade, and the health sector (OECD, 2020). On the other sides, some sectors flourished such as the online trade and the pharmaceutical industry and especially the companies that managed to developed the vaccination (Nicola et al., 2020).

After the first cases were documented in Wuhan, Hubei Province, China, on December 19, 2019, the number of cases has risen quickly and the list of countries that declared having positive cases kept growing. The World Health Organization (WHO) announced a global pandemic declaration on March 11, 2020. With more than 40% of all cases that had been officially confirmed worldwide by mid-March 2020, the WHO at European Region has emerged as the epidemic's focal point. As of 28 April 2020, the Region accounted for 63% of all viral death globally (WHO, 2022a).

Since the WHO declared that COVID-19 is a pandemic and getting vaccinated can help improve people's health and well-being. It can stimulate the immune system and reduce containment efforts. thus, develop the immunity against the virus (CDC report, 2022a). The WHO stated that no one is safe until everyone is safe and everyone has to get vaccinated for the entire world to overcome this pandemic. The government's priority was to vaccinate their populations against the Coronavirus with the availability of vaccinations with respect to old and sick people in addition to the heath sector workers, in an effort to control the situation, therefore assisting their economies in recovering (Carvalho et al., 2020; Coibion, Gorodnichenko, and Weber, 2020).

Accordingly, the big pharmaceutical companies tried to participate in the auction of the vaccine manufacturing process. This has helped society and provided a financial benefit to the producing companies. Humanism and solidarity were too essential values for saving people's lives around the world. The knowledge produced by vaccine research and development is a global public good and rising vaccination rates coincided with better health care, job prospects, and future education plans (Bloom, David, Cadarette, and Tortorice, 2020).

In some respects, during the Pandemic the lack of attention to vaccination costs are unsurprising. Saving lives should always come first, no matter the costs. Furthermore, the International Monetary Fund (IMF) has stated that the expenses of vaccinating the globe fade into insignificance in relation to the economic repercussions of not doing so (Ruchir and Gita, 2021). The International Monetary Fund estimates that if COVID-19 became pandemic, global economic losses could exceed US$5.3 trillion by 2026 (WHO report, April, 2021b).

The COVID-19 pandemic has had a major and widespread impact on humanity worldwide. The death cases reached 6,459,684, including 596,873,121 confirmed cases, which have been reported to WHO as of 26th of August, 2022. And a total of 12,449,443,718 doses of vaccine have been given as of August 24, 2022 (WHO, Aug, 2022c).

This paper tries to shed a light for the health sector, governments, investors, and academic organizations to see how COVID-19 vaccines may affect the number of new cases and new deaths, and how manufacturers got financial benefit over the production process, this has been conducted on 30 countries and 8 vaccine's types. This analysis significance is relevant to the impact of vaccine, which may help the above-mentioned organizations in dealing and rationalizing such catastrophe.

This paper addresses three main questions about COVID-19 vaccine efficacy and financial benefits.

1) Do COVID-19 vaccines affect the total daily new cases and new deaths?

2) Do COVID-19 vaccines manufacturers make a financial benefit of the vaccine's production?

3) Do the vaccine manufacturing companies make the financial benefits based on efficacy?

2. Literature Review

This section tries to present the theoretical framework of the research topic, illustrating an overview about the Covid19 vaccine efficacy, which discusses the issues of herd immunity, public vaccine faith, approvals and production process. After that, the financial benefits of the pharmaceutical companies, which illustrate the vaccine equity equality on distributions, following by the vaccine monopolistic pricing policies and affordability.

Vaccination appears to deliver value for money at any cost and its stated that the expenses of vaccinating the globe fade into insignificance in relation to the economic repercussions of not doing so. Rich and poor nations alike, on the other hand, have experienced decades of massively exorbitant and exploitative pricing at the hands of pharmaceutical firms, which has put lifesaving and life-improving drugs out of reach of millions of people. This was the situation with HIV medications two decades ago, when generic competition drove down prices by up to 99 percent (Berwick, Sykes, and Achmat, 2002). On the other hand, rich and poor nations alike have experienced decades of massively exorbitant and exploitative pricing at the hands of pharmaceutical firms, which has put lifesaving and life-improving drugs out of reach for millions of people (Mariana et.al., 2018).

2.1 Vaccines Efficacy

COVID-19 vaccinations are important for mitigating the pandemic's devastation. The vaccination strategies can promote individual immunity and herd immunity without infecting a substantial proportion of the population (Anderson, Vegvari, Truscott, and Collyer, 2020; Omer, Yildirim, and Forman, 2020). The Vaccine has antigen parts of a specific organism that cause an immunological reaction. Instead of the actual antigen, more recent vaccinations contain the recipe for making them and this will boost their immune system to respond (WHO, 2021d). The epidemiological literature has previously demonstrated the efficacy of COVID-19 vaccinations in decreasing viral transmission, severe illnesses, hospitalizations, and mortality (Dagan et al., 2021; Voysey et al., 2021). Vaccines have been proven in clinical studies to reduce the risk of developing and spreading COVID-19, as well as the severity of virus (Abu-Raddad, Chemaitelly and Butt, 2021; Pritchard et al., 2021).

2.1.1 Herd Immunity and Public Vaccine Faith

The term "herd immunity" refers to the immune ratio of people in a population, the limit at which infection occurrence will reduce, and the pattern of immunity that will protect a population from the new case (Fine, Eame, and Heymann, 2011). Herd immunity does not totally protect those who cannot be properly vaccinated as no vaccine provides 100% protection, but it will help the individuals to have a significant protection since those close to them have received vaccinations (Kadkhoda, 2021). If the immune system is strong, it will be extremely likely to be resistant to the targeted virus. Meanwhile, not everyone can receive a vaccination because there is a certain vaccination may not be suitable for the people with underlying medical conditions that impair their immune systems like infant, cancer or HIV or who have severe sensitivities to particular vaccine components. The mimic infection can occasionally result in minor side effects following vaccination, such as fever. As the body develops immunity, such minor symptoms are normal and should be anticipated (CDC, 2020b). This is crucial for those who cannot only get vaccinations but may also be more vulnerable to the diseases we immunize against (Kadkhoda, 2021).

If these people live with other immunized individuals, they can still be protected. Thus, it has a difficult spreading when a large portion of the population in a community is immunized. Therefore, the more individuals who can be protected by vaccinations get vaccinated, the less probable it is that those who cannot be protected by vaccines are in danger of even being exposed to harmful microorganisms (WHO, 2021d). Also, getting vaccinated not only protects you but helps those in the community who cannot get vaccinated (Fine et.al, 2011). In the meantime, increasing people awareness about the power of vaccines and closing immunization gaps could protect millions of people worldwide from vaccine-preventable diseases, including polio, according to the World Health Organization (WHO, 2021d).

Skepticism and reluctance to the vaccine that can safeguard public health and limit viral transmission persisted as a controversial issue but at that time it was the only hope to decrease the new cases (Machingaidze and Wiysonge, 2021; Troiano and Nardi, 2021). Meanwhile, the public anxiety and acceptance have been influenced by misinformation (Bonnevie et al, 2021). Attitudes regarding vaccination are also influenced by psychological factors and many adults strongly expressed their willingness to receive the vaccination (Hill, 2021). Most discrepancies in vaccination probability were explained by a lack of faith in the vaccine approval and development procedures (Szilagyi, Thomas, Shah, Vizueta, and Vangala, 2021). Behavioral nudges could also assist overcome vaccination skepticism and increase vaccine uptake (Dai et al, 2021).

Previous studies have found that a range of sociodemographic characteristics including political beliefs, age, race, and education, may affect people's intentions to get the COVID-19 vaccine. (Salmon, et.al, 2021). Furthermore, another study was conducted to investigate the Immunization attitudes as regards the reasons might lead you to get the vaccine, and the results were as follows: to avoid catching the virus (55%), to reclaim their social lives (10%), to get back to work (9%) and to protect others (10%), on the other hand, is the possibility of undiscovered adverse effects (11%) of the respondents (Bagues and Dimitrova, 2021).

2.1.2 Vaccine Approvals, Development and Production

A proposed vaccination enters human testing if it passes its target product profile in animal studies. Such clinical trials adhere to pre-established standards from the Food and Drug Administration agency (FDA), WHO, and other national and supranational organizations. Clinical trials evaluate the vaccine's safety and effectiveness while causing the fewest possible side effects (Iserson, 2021).

A small (20–100) sample of healthy individuals participate in the initial tests (Phase I). Scientists assess the safety of the vaccine during this phase, as well as the impact of various vaccination doses on side effects and efficacy, which typically lasts many months (antibody and T-cell production). Phase one trials have only lasted few weeks in the present race to develop a vaccine before being hurried into significantly larger Phase II trials on hundreds to thousands of the volunteering humans. According to (Liu, 2020), This time period is obviously too short to determine whether the target Product Profile (TPPs) have been met. Since only around 10% of all medications undergoing Phase I trials ultimately received FDA approval in recent years, it is logical to predict that many of these Phase II vaccinations will be harmful or useless (Friede, Reid, and Ory, 1993).

After the Successful Phase, two trials are followed by considerably larger Phase three trials, which frequently run for several years. Scientific authorities may approve the marketing of a vaccine if the test findings meet all prerequisites, and this is what happened in COVID – 19 vaccination (Iserson, 2021).

The same procedures must be followed to assure safety and efficacy when creating a vaccine for a new disease or for a disease for which there isn't already a vaccine (i.e., a new vaccine). The preclinical (laboratory and animal testing) stages, clinical development (three distinct human testing processes), regulatory review and approval, manufacturing, and quality control are the typical stages of vaccine development. Each phase of the production process must be successful for a vaccine to be effective, and the final product must be safe (CDC report, 2020a).

When around 70% of the world's population get the immunity towards the pandemic due to either natural immunity or vaccination, the epidemic will have reached its medical end. People will feel confident that they can engage in their jobs and leisure pursuits without concern about getting the disease if the social impacts of the pandemic are to be reversed. Producers should address any shortcomings by increasing public and professional transparency across the entire process. This requires giving regular, accurate updates on the status of vaccine development, communicating in-depth pro-vaccine information, and creating a fair distribution system (Iserson, 2021).

2.1.3 Vaccine Equity and Pharmaceutical Companies Financial Benefits

There are several ways of purchasing COVID-19 vaccines, some countries made a vaccines group purchasing, like joining COVAX or maybe it's a country's direct purchasing of vaccines from vaccine producers and purchase of surplus stocks from other holding countries' surplus doses (The World Bank, 2022)

The global reliance on a few pharmaceutical firms to produce an effective vaccination gives them a lot of incentives and monopoly actions and let them decide who can get the vaccine, and at what price due to the short time constraints and the severity of the virus, this led to unacceptable COVID-19 vaccine inequality. The big countries and companies tried to get into the production auction in order to get rid of the effects of COVID-19 virus and get financial benefits. Corporations generate billions of dollars in sales and profits as COVID-19 vaccines quickly become one of the best-selling pharmaceutical items in history (OXFAM, Feb, 2021).

2.1.4 Inequitable Vaccine Distribution and the Intellectual Property Rights

The unequal distribution of the vaccine supplies in the world was too obvious as the developed countries has taken the big share of the vaccines. As reported, 47.5% of European population, and 41.6% of the North American population have been fully vaccinated, while only 2.63% of the African population have been fully vaccinated. Also, on the country level, 51.3% of the US population and 62.6% of the UK population have been fully vaccinated. On the other side, the developing countries have only 0.7% of the Nigerian population and 1.5% of the Kenyan populations are fully vaccinated (Altindis, 2022).

The World Trade Organization (WTO), India and South Africa proposed temporarily suspending intellectual property rights, and they received support from more than two-thirds of the member nations, including the USA. The European Union purchased 6.9 doses of vaccination for every resident, as well as the UK and Canada, which purchased 8.2 and 10.1 doses of vaccine for each resident, respectively, and they continue to reject this idea (APnews, 2021).

Intellectual property holders claim that other pharmaceutical companies are unable to develop these novel vaccines because they are very hard to develop, particularly mRNA vaccines. This grossly undervalues the scientific and production capabilities of some Low- and medium-income countries that have manufactured complicated vaccines (Erfani et.al, 2021). Afterwards, the (WHO) established an mRNA transfer of technology hub, and out of the 25 Low- and medium-income countries that expressed an interest, this ability and expertise might easily be used to significantly increase COVID-19 vaccine manufacturing in these countries by (i) waiving the intellectual property rights, (ii) using technology transfer for the recipes, (iii) transferring technological know to these skilled manufacturers, and (iv) teaching these countries how to produce it (Hotez et.al, 2021).

The American programs have declared their desire to distribute their vaccines to Americans before everyone else. Through the Access to COVID-19 Tools Accelerator program, the World Health Organization (WHO) and other organizations are coordinating vaccine production and ensuring fair access worldwide. Other pharmaceutical firms are making their way on their own, particularly in China and India (Cohen, 2020). The World Health Organization (WHO) is the leader of COVAX, a worldwide alliance that intends to distribute two billion doses of COVID-19 vaccine across the world. With aims of up to 20% of these nations' populations, 93 low and lower middle-income countries are estimated to consume 1.3 billion of these resources. However, the alliance requires more than $20 billion, which is an astronomical sum of money, to help COVAX achieve their objective of two billion doses. Furthermore, transmission within and across communities cannot be stopped by immunizing 20% of the people in these nations (Altindis, 2022).

Due to limited vaccine supplies and logistical constraints, two main population groups were prioritized: I front-line health and social workers to prevent the virus from spreading and protect health systems, and ii) elderly and clinically extremely vulnerable populations, who face the highest mortality risk (Paloyo, et.al, 2022). There have been substantial decreases in serious disease, hospitalization, and mortality in places with high vaccination coverage, but vaccine availability is highly inequitable internationally, with coverage varying from 1% to over 70%, depending primarily on a country's wealth. As a result, SARS CoV-2 variations continue to arise, triggering disease outbreaks and delaying, if not halting, the reopening of society and economy (WHO report, 2022).

In the United States, Pharmaceutical companies have received nearly $12 billion in taxpayer money as part of a USA federal government endeavor to produce vaccines. Particularly, the OWS gave Moderna $2.5 billion to aid in the production of the vaccine (Kavanagh, Gostin, and Sunder, 2021). While Pfizer's partner BioNTech got $445 million from the German government to speed up the development of the vaccine, Pfizer received $1.95 billion in public subsidies to produce and distribute 100 million doses of its vaccine. China has directly supported the development of vaccines by backing the businesses Sinovac and Sinopharm, in addition to taxpayer investments in the financing of these vaccinations in the USA and Europe. The Gamaleya Research Institute, a government-run research facility in Russia, was also where Sputnik V was created (Wouters et.al, 2021).

Without the billions of dollars expended by public institutions all around the world, these vaccinations could not have been manufactured so quickly and successfully. Coincidentally, Moderna and Pfizer anticipate sales growth of nearly $60 billion between 2021 and 2022. Pfizer raised vaccine pricing from $18.30 to $23 and Moderna raised prices from $22.60 to $25.50 despite these already record-breaking earnings. The COVID-19 vaccine patents should have been denied and the production technology should be shared to ensure the manufacture of generic vaccines as well as the equitable wide availability of vaccinations due to the use of public funding in the development and manufacturing of COVID-19 vaccines (Altindis, 2022).

As 85% of the world's population lives in low- and middle-income nations, which may not have the money to purchase sufficient quantities of COVID-19 vaccines, mechanisms are required to secure the accessibility and long-term financing of these vaccines. It is critical to provide low-income and disadvantaged communities with access to COVID-19 vaccinations, even in high-income nations. Companies have gradually revealed the costs they are charging for goods and services to nations with various income levels, with the lowest price per unit of instruction showing the most variety. AstraZeneca and Johnson & Johnson, two businesses that greatly profit from public sector investments, have committed to selling their vaccines at reasonable prices all around the world. Both businesses have pledged to keep these costs the same throughout the pandemic. Although there has to be greater clarification on post-pandemic pricing mechanisms and how the pandemic will be judged to be over (Wouters et.al, 2021).

2.1.5 Vaccine Monopolistic Pricing, Affordability and Financial Benefits

Although demand for medications is one of the factors that affects pharmaceutical spending, health system administrators are most concerned about growing pricing since medications are increasingly being priced at amounts that seem "unfair." drug prices often exceed the value for money and reasonable compensation for firms' investment. Pharmaceutical pricing is a growing challenge for all countries, calling into question the sustainability of the systems that are supposed to drive pharmaceutical innovation (Morgan, Bathula, and Moon, 2020).

Many of the COVID-19 vaccinations are priced unjustifiably high, according to evidence gathered and reviewed by the People's Vaccine Alliance. Governments are paying more than they should, implying that the CEOs and owners of these firms are squandering domestic budgets and foreign assistance funds that are desperately required for hospitals and health professionals. The inability of wealthy nation governments to bring costs down by breaking up vaccine monopolies and insisting on cost transparency has left pharmaceutical firms totally free to prioritize profit-maximizing contracts with them despite the knowledge that this would lead to many more fatalities. Pharmaceutical companies are rumored to be contemplating even more aggressive pricing for COVID-19 vaccines in the future (Marriott and Maitlan, 2021).

The COVAX Facility is a risk-sharing mechanism: it reduces the risk for manufacturers who invest without being sure about future demand, and it reduces the risk that countries would fail to secure access to a viable vaccine. Vaccines will be procured and delivered to countries by the UNICEF Supply Division and the PAHO's Revolving Fund for Access to Vaccines. The fast arrival of safe and effective COVID-19 vaccines has shown that multilateralism and multi-actor partnerships work to solve the most pressing problems of our time (Wouters et.al, 2021).

The average cost per dosage of the COVID-19 vaccine, according to data from UNICEF and Gavi, the Vaccine Alliance, is between US$ 2 and $ 40. After deducting vaccine waste, the anticipated distribution cost is US$ 3.70 for each individual receiving two doses of the vaccine. For low-income nations, where the average yearly per capita health expenditure is US$41, this represents a considerable financial burden. High-income countries must increase their health care spending by 0.8% on average to pay for the cost of immunizing 70% of the population. Comparing with low-income nations must increase their healthcare spending by an average of 56.6%. (UNDP, 2022).

China's significant manufacturing capacity for the COVID-19 vaccines not only satisfied domestic demand, but also allowed for export. China's government authorized the sale of four Chinese vaccinations on June 22, 2021. China has shipped 1.3 billion doses of COVID-19 vaccine and contributed 71.9 million doses to 112 nations, with 946 million doses delivered by 1 October 2021. Sino-pharm and Sinovac are China's two major COVID-19 vaccine exporters, accounting for 36.65 percent and 60.15 percent of Chinese vaccine exports, respectively (bridge, 2021).

Vaccine sales have significantly boosted the financial performance of Chinese pharmaceutical businesses. For example, Sinopharm's semi-annual performance report for 2021 revealed that its operational income climbed by 22% year on year, while its net profit increased by 25.51 percent (Sinopharm Group, 2021) Similarly, Sinovac's sales and gross profit reached RMB 69.6 billion (US $11 billion) and RMB 368.04 million (US $58.2 million) in the first half of 2021, up from RMB 428.6 billion (US $67.7 million) and RMB 65.1 billion (US $10.3 billion) in the same period the previous year (Sinovac, 2021).

According to the aforementioned literature, this research attempts to empirically examine the vaccine's efficacy and its impact on numbers of new deaths and new cases, using a daily doses data of eight vaccine types conducting on a sample of 30 countries. Furthermore, the research investigates the financial benefits made by the same eight pharmaceutical companies after and before Jan 30,2020. On the meantime, this research is attempting to determine whether the businesses that have benefited financially have an efficient vaccine that lowers the number of new cases and deaths, or they just made it to get gains and produced more of the vaccine without avail.

3. Sample and Data Description

COVID-19 virus outreached to 228 countries, where the list of countries and their regional classification is based on the United Nations geographical scheme, 30 countries were randomly selected to be the research sample due to the data availability, and the population of the 30 countries was estimated at 802,404,053 million people out of a total of 7.7 billion people in the world by (10.42%), and the countries are as follows:

Table 1. The Countries Sample

N.	Country	Population	N.	Country	Population
1	Austria	9,006,400	16	Italy	60,461,828
2	Belgium	11,589,616	17	Latvia	1,886,202
3	Chile	19,116,209	18	Lithuania	2,722,291
4	Croatia	4,105,268	19	Luxembourg	625,976
5	Cyprus	875,899	20	Malta	441,539
6	Czechia	10,708,982	21	Netherlands	17,134,873
7	Denmark	5,792,203	22	Norway	5,421,242
8	Ecuador	17,643,060	23	Poland	37,846,605
9	Estonia	1,326,539	24	Romania	19,237,682
10	Finland	5,540,718	25	Slovakia	5,459,643
11	France	68,147,687	26	Slovenia	2,078,932
12	Germany	83,783,945	27	Spain	46,754,783
13	Hungary	9,660,350	28	Sweden	10,099,270
14	Iceland	341,250	29	Switzerland	8,654,618
15	Ireland	4,937,796	30	United States	331,002,647
Total Population of the sample				**802,404,053**	

Sources: https://www.worldometers.info/coronavirus/#countries

Vaccine efficacy is a measure of the effectiveness of vaccination in protecting people from new cases and new deaths, the vaccine boosts the immune system to fight the COVID-19 virus, which will eventually decrease and end the spread around the world. Thus, the sample is chosen according to the most widely distributed vaccines which count eight vaccine types due to the data availability, and the pharmaceutical companies that manufacture those vaccines were as follows:

Table 2. Pharmaceutical Companies that Manufacture Vaccines

N	Vaccines	Anticipated decision date	Country approvals	Manufacturers
1	CanSino	25/02/2021	10	CanSino Biologics Inc. (6185.HK)
2	Johnson&Johnson	12/03/2021	111	Johnson & Johnson (JNJ)
3	Moderna	30/04/2021	85	Moderna Inc. (MRNA)
4	Oxford/AstraZeneca	15/02/2021	138	AstraZeneca PLC (AZN)
5	Pfizer/BioNTech	31/12/2020	144	BioNTech SE (BNTX)
6	Sinopharm/Beijing	30/04/2021	91	Sinopharm Group Co. Ltd.
7	Sinovac	30/05/2021	55	Sino Biopharmaceutical Limited
8	Novavax	15/02/2021	37	Novavax Inc. (NVAX)

Sources: https://www.who.int/ar , https://finance.yahoo.com/

4. Measuring Variables and Developing Hypotheses

4.1 Measuring Variables

The types of vaccines are represented as an independent variable, and the dependent variable is the number of new cases and new death, which is measured to test the first and second hypotheses through the following:

- **Vaccinations:** The total number of daily vaccinations for all countries was collected and the result was divided by the total population of the research sample countries from 01/01/2021 to 08/11/2021 with a number of 312 days.

- **Number of new cases and new deaths:** The data of the new cases and new deaths were collected for the sample of all countries and the result was divided by the total population of the research sample countries, from 01/02/2021 to 31/12/2021 (334) days, where a month of vaccine doses data was delayed to show the effectiveness of vaccination on the number of new cases and new deaths.

The third and fourth hypotheses were tested using the event study technique, through the following steps (Alber, 2013).

1. Calculate the actual return for pharmaceutical companies that manufacture vaccines as follows:

$$R_{i,t} = \left(P_{i,t} - P_{i,t-1}\right)/P_{i,t-1}$$

2. Calculate the return on the main market index of the vaccine-manufacturing country as follows:

$$R_{m,t} = \left(M_{m,t} - M_{m,t-1}\right)/M_{m,t-1}$$

3. Calculate the estimated revenue of the pharmaceutical companies that manufactures vaccines *i* at time *t* using the “market model” as follows:

$$\acute{R}_{i,t} = \alpha_i + \beta_i R_{m,t}$$

4. Estimate the abnormal return (and the abnormal cumulative return) for pharmaceutical companies manufacturing vaccines i at time t, as follows:

$$AR_{i,t} = R_{i,t} - \acute{R}_{i,t}$$

$$AR_{i,t} = \sum_{t=1}^{n} \acute{A}R_{i,t}$$

5. Significance testing between abnormal returns (and abnormal cumulative returns) within a different weekly event window.

Where,

$R_{i,t}$: Price of share i at the end of period t.

$\boldsymbol{P_{i,t-1}}$: Price of share i at the end of period t-1.

$\boldsymbol{M_{m,t}}$: Market index at the end of period t.

$\boldsymbol{M_{m,t-1}}$: Market index at the end of period t-1.

$\boldsymbol{\acute{R}_{i,t}}$: Normal return of stock i at time t (predicted using the market model).

$\boldsymbol{AR_{i,t}}$: Abnormal return of stock i at time t.

4.2 Research Hypotheses

This paper aims to test the following four hypotheses:

1. There is no significant effect of the efficacy of COVID-19 vaccines on the number of COVID-19 new cases around the world.
2. There is no significant effect of the effectiveness of COVID-19 vaccines on the number of COVID-19 new deaths around the world.
3. There are no significant differences between the abnormal returns of pharmaceutical companies that manufacture vaccines before and after the spread of the COVID-19 pandemic.
4. There are no significant differences between the cumulative abnormal returns of pharmaceutical companies that manufacture vaccines before and after the spread of the COVID-19 pandemic.

5. Data Analysis and Results

5.1 Diagnostic and Descriptive Statistics

In the first part of the research, which aims to study the effectiveness and impact of COVID-19 vaccines to reduce the number of COVID-19 new cases and new death around the world, the results of the descriptive analysis of the variables of new cases and death and types of vaccines from the date of 02/01/2021 to 31/12/2021 are as follows:

Table 3. Descriptive Statistics of Efficacy Variables

variables	Mean	Max	Min	S.D	J-Bera	Prob.	Obs.
New_cases	0.000	0.001	0.000	0.000	46.247	0.000	312
New_deaths	0.000	0.000	0.000	0.000	100.711	0.000	312
Pfizer/BioNTech	0.629	1.446	0.001	0.449	29.841	0.000	312
Sinovac	0.027	0.060	0.000	0.019	24.109	0.000	312
Moderna	0.186	0.375	0.000	0.115	25.887	0.000	312
Oxford/AstraZeneca	0.091	0.203	0.000	0.066	29.820	0.000	312
Novavax V	0.002	0.005	0.000	0.001	6.462	0.040	312
Johnson&Johnson	0.024	0.062	0.000	0.020	31.250	0.000	312
Sinopharm/Beijing	0.002	0.005	0.000	0.001	8.360	0.015	312
CanSino	0.000	0.001	0.000	0.000	38.842	0.000	312

In the second part of the research, which aims to study the abnormal and cumulative returns of pharmaceutical companies that produce the vaccines, the day of the event is stated as 01/30/2020, where the dates of the events used in the study were clarified separately for each company before and after the day of the event in weekly periods (- 10...+10), (-20... + 20), (-30... +30), (-40... +40). The results of the descriptive analysis were as follows:

Table 4. Descriptive Statistics of Abnormal Returns of Manufacturers

Manufacturers	**Vaccines**	**Event period 30/01/2020**	**10 weeks**		**20 weeks**		**30 weeks**		**40 weeks**	
			Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
CanSino Biologics Inc. (6185.HK)	CanSino	Min	-0.072	-0.072	-0.070	-0.130	-0.090	-0.170	-0.090	-0.220
		Max	0.150	0.388	0.150	0.390	0.150	0.390	0.150	0.390
		Mean	**0.050**	**0.103**	**0.036**	**0.068**	**0.026**	**0.042**	**0.018**	**0.031**
		S.D	0.071	0.143	0.060	0.141	0.059	0.143	0.063	0.133
Johnson & Johnson (JNJ)	Johnson&Johnson	Min	-0.010	-0.090	-0.020	-0.090	-0.040	-0.090	-0.050	-0.090
		Max	0.030	0.100	0.030	0.100	0.030	0.100	0.050	0.100
		Mean	**0.009**	**-0.002**	**0.007**	**0.000**	**0.001**	**0.002**	**0.0020**	**0.0015**
		S.D	0.012	0.061	0.014	0.050	0.018	0.042	0.020	0.040
Moderna Inc. (MRNA)	Moderna	Min	-0.050	-0.210	-0.110	-0.220	-0.110	-0.220	-0.210	-0.220
		Max	0.120	0.610	0.120	0.610	0.120	0.610	0.120	0.610
		Mean	**0.018**	**0.060**	**0.021**	**0.073**	**0.019**	**0.051**	**-0.001**	**0.051**
		S.D	0.063	0.237	0.072	0.227	0.068	0.194	0.080	0.174
AstraZeneca PLC (AZN)	Oxford/ AstraZeneca	Min	-0.020	-0.160	-0.030	-0.160	-0.030	-0.160	-0.030	-0.160
		Max	0.030	0.150	0.090	0.150	0.100	0.150	0.100	0.150
		Mean	**0.002**	**0.001**	**0.0055**	**0.0060**	**0.006**	**0.004**	**0.005**	**0.004**
		S.D	0.015	0.081	0.028	0.060	0.030	0.054	0.029	0.050
BioNTech SE (BNTX)	BioNTech	Min	-0.070	-0.110	-0.090	-0.110	-0.160	-0.120	-0.160	-0.360
		Max	0.100	0.130	0.110	0.130	0.190	0.290	0.190	0.660
		Mean	**-0.009**	**0.009**	**-0.013**	**0.014**	**-0.006**	**0.014**	**0.011**	**0.030**
		S.D	0.060	0.073	0.060	0.056	0.075	0.080	0.079	0.159
Sinopharm Group Co. Ltd. (1099.HK)	Sinopharm/ Beijing	Min	-0.020	-0.190	-0.100	-0.190	-0.100	-0.190	-0.100	-0.190
		Max	0.040	0.090	0.050	0.090	0.080	0.090	0.080	0.110
		Mean	**0.006**	**-0.041**	**0.002**	**-0.017**	**0.001**	**-0.011**	**-0.003**	**-0.008**
		S.D	0.021	0.079	0.033	0.069	0.035	0.061	0.035	0.061
Sino Biopharmaceutical Limited (1177.HK)	Sinovac	Min	-0.090	-0.100	-0.090	-0.100	-0.090	-0.100	-0.270	-0.100
		Max	0.070	0.080	0.120	0.130	0.120	0.130	0.120	0.130
		Mean	**0.000**	**0.000**	**-0.003**	**0.015**	**0.015**	**0.008**	**0.006**	**0.003**
		S.D	0.045	0.056	0.051	0.061	0.056	0.055	0.071	0.051
Novavax Inc. (NVAX)	Novavax	Min	-0.200	-0.310	-0.210	-0.310	-0.210	-0.310	-0.370	-0.310
		Max	0.380	0.600	0.390	1.320	0.810	1.320	0.810	1.320
		Mean	**0.022**	**0.190**	**-0.001**	**0.208**	**0.008**	**0.152**	**-0.010**	**0.112**
		S.D	0.160	0.302	0.160	0.367	0.205	0.324	0.189	0.290

Table 5. Descriptive Statistics of CARs of Manufacturers

Manufacturers	Vaccines	Event period 30/01/2020	10 weeks		20 weeks		30 weeks		40 weeks	
			Pre	Post	Pre	Post	Pre	Post	Pre	Post
CanSino Biologics Inc. (6185.HK)	CanSino	Min	0.022	0.133	0.240	-0.120	0.050	-0.290	0.030	-0.400
		Max	0.429	0.888	2.300	1.280	0.850	1.380	0.610	1.360
		Mean	**0.218**	**0.577**	**1.318**	**0.586**	**0.559**	**0.421**	**0.424**	**0.251**
		S.D	0.143	0.209	0.660	0.480	0.227	0.539	0.151	0.516
Johnson & Johnson (JNJ)	Johnson&Johnson	Min	0.010	0.020	-3.870	-0.070	-0.420	-0.010	-0.020	-0.110
		Max	0.080	0.200	-0.380	0.220	-0.010	0.280	0.110	0.160
		Mean	**0.043**	**0.091**	**-2.116**	**0.021**	**-0.155**	**0.072**	**0.044**	**-0.026**
		S.D	0.028	0.058	1.088	0.076	0.126	0.069	0.043	0.055
Moderna Inc. (MRNA)	Moderna	Min	0.130	0.150	0.400	-0.170	0.370	-0.240	-0.140	0.220
		Max	0.240	0.890	1.980	1.650	2.520	1.690	0.630	2.090
		Mean	**0.177**	**0.526**	**1.165**	**0.763**	**1.443**	**0.488**	**0.264**	**0.797**
		S.D	0.035	0.283	0.533	0.605	0.705	0.640	0.214	0.589
AstraZeneca PLC (AZN)	Oxford/ AstraZeneca	Min	-0.020	0.020	0.050	-0.030	0.110	-0.050	0.040	-0.060
		Max	0.020	0.250	0.860	0.360	2.070	0.420	1.290	0.400
		Mean	**0.000**	**0.132**	**0.463**	**0.116**	**1.098**	**0.112**	**0.705**	**0.079**
		S.D	0.018	0.065	0.264	0.111	0.605	0.119	0.402	0.110
BioNTech SE (BNTX)	BioNTech	Min	-0.400	0.120	-0.250	0.950	-0.170	0.780	-0.420	-0.270
		Max	-0.080	0.260	0.410	1.260	0.630	1.140	0.430	1.160
		Mean	**-0.263**	**0.183**	**0.010**	**1.113**	**0.367**	**0.981**	**-0.104**	**0.414**
		S.D	0.107	0.050	0.198	0.081	0.224	0.099	0.203	0.389
Sinopharm Group Co. Ltd. (1099.HK)	Sinopharm/ Beijing	Min	0.000	-0.460	-0.070	-0.230	-0.090	-0.200	-0.150	-0.250
		Max	0.100	0.090	0.060	0.260	0.120	0.310	0.140	0.280
		Mean	**0.054**	**-0.264**	**-0.007**	**-0.024**	**0.012**	**0.034**	**0.005**	**0.041**
		S.D	0.038	0.203	0.039	0.137	0.047	0.119	0.069	0.119
Sino Biopharmaceutical Limited (1177.HK)	Sinovac	Min	-0.100	-0.010	-0.180	-0.010	-0.130	-0.060	-0.100	-0.220
		Max	0.030	0.160	0.040	0.420	0.390	0.460	0.520	0.260
		Mean	**-0.028**	**0.073**	**-0.064**	**0.268**	**0.062**	**0.204**	**0.183**	**-0.004**
		S.D	0.052	0.058	0.071	0.116	0.137	0.177	0.192	0.145
Novavax Inc. (NVAX)	Novavax	Min	-0.170	0.140	-0.420	0.210	-0.460	-0.440	-0.480	-0.610
		Max	0.210	1.940	0.220	3.880	0.470	4.540	0.470	4.340
		Mean	**0.068**	**0.968**	**-0.004**	**2.041**	**0.056**	**1.782**	**-0.007**	**1.171**
		S.D	0.126	0.534	0.150	1.114	0.225	1.589	0.264	1.546

5.2 Testing Hypotheses

5.2.1 Testing the First Hypothesis

The first and second hypotheses can be tested using Ordinary least squares (OLS) regression multiple analyses, the estimated equation are as follows:

$$\textbf{H1: Coronavirus New Case} = \boldsymbol{a} + \boldsymbol{b1}\, Pfizer/Biontech + \boldsymbol{b2}\, Sinovac + \boldsymbol{b3}\, Moderna + \boldsymbol{b4}\, Oxford/Astrazeneca + \boldsymbol{b5}\, Novavax + \boldsymbol{b6}\, Johnson\&Johnson + \boldsymbol{b7}\, Sinopharm/Beijing + \boldsymbol{b8}\, Cansino + \boldsymbol{u}$$

$$\textbf{H2: Coronavirus New Deaths} = \boldsymbol{a} + \boldsymbol{b1}\, Pfizer/Biontech + \boldsymbol{b2}\, Sinovac + \boldsymbol{b3}\, Moderna + \boldsymbol{b4}\, Oxford/Astrazeneca + \boldsymbol{b5}\, Novavax + \boldsymbol{b6}\, Johnson\&Johnson + \boldsymbol{b7}\, Sinopharm/Beijing + \boldsymbol{b8}\, Cansino + \boldsymbol{u}$$

Where,

a : the intercept coefficient or constant term.

b: the function coefficient of the linear regression equation.

U: the standard error or random error of the estimated model.

This means that alternative hypothesis Ha: β # 0 versus null hypothesis Hb: β = 0. The results of testing the first and second hypotheses were as follows:

Table 6. Effects of Vaccines on Coronavirus New Cases

Variable	Coefficient	Prob.	R^2	Durbin-Watson	Prob.	Obs.
Constant	0.000	0.000	**71.37%**	1.0023	0.000	312
Pfizer/Biontech	0.002	0.000				
Sinovac	0.002	**0.178**				
Moderna	**-0.003**	0.000				
Oxford/Astrazeneca	**-0.008**	0.000				
Novavax V	**-0.109**	0.000				
Johnson&Johnson	0.001	**0.762**				
Sinopharm/Beijing	0.082	0.000				
Cansino	**-0.122**	0.005				

Results support the significance impact of COVID-19 vaccines on the number of new cases with an interpretation of (71.37%), and the model coefficients of negative signs interpret the influence of (Moderna, Oxford/Astrazeneca, Novavax V, and Cansino) on the number of new cases, that has an effectiveness of vaccination in protecting people from the virus. It has the effect of reducing the number of new cases, as the higher the number of vaccinations, the lower the number of new cases, and thus the vaccines have an efficacy.

The model coefficients positively affecting the number of new cases are (Pfizer/Biontech and Sinopharm/Beijing), but the effectiveness of vaccination in protecting people from the virus does not have an impact on reducing the number of new cases, as the higher the number of vaccinations, the higher the number of new cases, and thus the vaccines are not effective.

The independent variables of vaccines (Sinovac and Johnson & Johnson) did not have an effect or effectiveness on the number of new cases at a significant level (0.05), and with regard to the problem of autocorrelation, the Durbin-Watson test indicates that the problem of autocorrelation does not exist among the independent variables, where it reached (1.0023) , where the value of DW is between 1 and 3, therefore, for the first hypothesis, the null hypothesis is rejected and the alternative hypothesis can be accepted.

5.2.2 Testing the Second Hypothesis

This section is to investigate the efficacy of each of the eight vaccine types of Coronavirus vaccines on the new deaths to show how vaccines are affecting and protecting people, using Ordinary least squares (OLS) regression multiple analyses.

Table 7. Effects of Vaccines on Coronavirus New Deaths

Variable	Coefficient	Prob.	R^2	Durbin-Watson	Prob.	Obs.
Constant	0.0000	0.0000	**65.09%**	1.4225	0.000	312
Pfizer/BioNTech	0.00000	**0.4374**				
Sinovac	0.00007	0.0099				
Moderna	**-0.00003**	0.0000				
Oxford/AstraZeneca	**-0.00007**	0.0000				
Novavax V	**-0.00057**	0.0529				
Johnson&Johnson	0.00031	0.0000				
Sinopharm/Beijing	0.00044	**0.1120**				
CanSino	-0.00073	**0.3292**				

Results support the significance impact of COVID-19 vaccines on the number of new deaths with an interpretation of (65.09%), and the model coefficients that has negative signs interpret the influence of (Moderna, Oxford/Astrazeneca, and Novavax V) on the number of new deaths, and the effectiveness of vaccination in protecting people from virus has an effect to reduce the number of new deaths, as the higher the number of vaccinations, the lower the number of death and thus the vaccines have an efficacy.

The model coefficients that has a positive influence on the number of new deaths are vaccines (Sinovac and Johnson & Johnson), and the effectiveness of vaccination in protecting people from virus does not has any effects on reducing the number of new deaths, as the number of new vaccinations increases, the number of new deaths increases, and thus the vaccines has no efficacy to new deaths.

The independent variables of vaccines (Pfizer/BioNTech, Sinopharm/Beijing, and CanSino) had no effect on the number of new deaths at the level of significance (0.05).

With regard to the autocorrelation problem, the Durbin-Watson test indicates that the autocorrelation problem does not exist among the independent variables where it reached (1.4225), where the DW value ranges between 1 and 3, therefore, for the second hypothesis, the null hypothesis is rejected and the alternative hypothesis can be accepted.

5.2.3 Testing the Third Hypothesis

The third and fourth hypotheses can be tested using the event study methodology, where all levels of significance associated with the normality of the data for different weekly periods indicate that the abnormal and cumulative returns deviate from normality, so Non-Parametric tests should be used using the Wilcoxon Signed-Rank test which is a non-parametric procedure used to test the hypothesis It says that two related variables have the same distribution. This test provides a Z-value which is calculated as:

$$\boldsymbol{Z = W \,/\, \sqrt{\frac{N\,(N+1)(2N+1)}{6}}}$$

Where:

W = sum of ranks for all observations

N = number of observations for each group.

According to the significance level (associated with Z value), research hypotheses could be accepted or rejected. The results of testing the third and fourth hypotheses were as follows:

Table 8. Testing Significance of Differences among Abnormal Returns

Manufacturers	**Vaccines**	**Event period 30/01/2020**	**weeks -10, +10**	**weeks -20, +20**	**weeks -30, +30**	**weeks -40, +40**
CanSino Biologics Inc.	CanSino	Z	-1.172-[b]	-1.552-[c]	-.185-[b]	-.489-[b]
		Sig.	0.241	0.121	0.853	0.625
Johnson & Johnson (JNJ)	Johnson&Johnson	Z	-1.172-[b]	-1.552-[c]	-.185-[b]	-.489-[b]
		Sig.	0.241	0.121	0.853	0.625
Moderna Inc. (MRNA)	Moderna	Z	-.358-[b]	-.896-[c]	-1.687-[c]	-1.193-[b]
		Sig.	0.720	0.370	0.092	0.233
AstraZeneca PLC (AZN)	Oxford/AstraZeneca	Z	-1.248-[b]	-2.623-[c]	-4.147-[c]	-3.432-[c]
		Sig.	0.212	**0.009**	**0.000**	**0.001**
BioNTech SE (BNTX)	BioNTech- Pfizer	Z	-.918-[b]	-.393-[c]	.000 [d]	-.168-[b]
		Sig.	0.359	0.695	1.000	0.867
Sinopharm Group Co. Ltd.	Sinopharm/Beijing	Z	-1.685-[c]	-.081-[b]	-.433-[c]	-.491-[c]
		Sig.	0.092	0.936	0.665	0.623
Sino Biopharmaceutical Limited	Sinovac	Z	-1.073-[b]	-1.611-[b]	-.237-[c]	-.334-[c]
		Sig.	0.283	0.107	0.813	0.738
Novavax Inc. (NVAX)	Novavax	Z	-1.326-[b]	-1.904-[b]	-2.044-[b]	-2.360-[b]
		Sig.	0.185	0.057	**0.041**	**0.018**

Denotes a. Wilcoxon Signed Ranks Test, denotes b. Based on negative ranks, denotes c. Based on positive ranks.

The Wilcoxon Signed-Rank test shows that there are statistically significant differences between the average changes in abnormal returns for only two companies that manufacture vaccines, the first is AstraZeneca PLC (AZN) that manufactures the Oxford/AstraZeneca vaccine, and the differences for the weekly periods were (-20, +20) , (-30, +30), (-40, +40), and the second Novavax Inc. manufacturer of Novavax vaccine, and the differences for the weekly periods were (-30, +30), (-40, +40) and there were no statistically significant differences between the average changes in the abnormal returns of the rest of the pharmaceutical companies that manufacture vaccines during the different weekly periods.

Therefore, for the third hypothesis, the null hypothesis is partially rejected, and the alternative hypothesis is partially accepted.

5.2.4 Testing the Fourth Hypothesis

This section shows the cumulative abnormal return of the vaccines manufacturing companies for the 4 periods before and after the event day which is 30/01/2020 using event study window.

Table 9. Testing Significance of Differences among CARs

Manufacturers	Vaccines	Event period 30/01/2020	weeks -10, +10	weeks -20, +20	weeks -30, +30	weeks -40, +40
CanSino Biologics Inc. (6185.HK)	CanSino	Z **Sig.**	-2.666-[b] **0.008**	-3.825-[c] **0.000**	-1.103-[c] **0.270**	-2.081-[c] **0.037**
Johnson & Johnson (JNJ)	Johnson&Johnson	Z **Sig.**	-1.680-[b] **0.093**	-3.823-[b] **0.000**	-4.707-[b] **0.000**	-4.184-[c] **0.000**
Moderna Inc. (MRNA)	Moderna	Z **Sig.**	-2.429-[b] **0.015**	-3.784-[c] **0.000**	-4.703-[c] **0.000**	-4.300-[b] **0.000**
AstraZeneca PLC (AZN)	Oxford/AstraZeneca	Z **Sig.**	-2.670-[b] **0.008**	-3.825-[c] **0.000**	-4.704-[c] **0.000**	-5.429-[c] **0.000**
BioNTech SE (BNTX)	BioNTech- Pfizer	Z **Sig.**	-2.805-[b] **0.005**	-3.921-[b] **0.000**	-4.784-[b] **0.000**	-5.415-[b] **0.000**
Sinopharm Group Co. Ltd. (1099.HK)	Sinopharm/Beijing	Z **Sig.**	-2.429-[c] **0.015**	-.743-[c] **0.458**	-3.738-[b] **0.000**	-1.738-[b] **0.082**
Sino Biopharmaceutical Limited (1177.HK)	Sinovac	Z **Sig.**	-2.371-[b] **0.018**	-3.784-[b] **0.000**	-3.817-[b] **0.000**	-5.374-[c] **0.000**
Novavax Inc. (NVAX)	Novavax	Z **Sig.**	-2.666-[b] **0.008**	-3.824-[b] **0.000**	-4.008-[b] **0.000**	-3.415-[b] **0.001**

Denotes a. Wilcoxon Signed Ranks Test, denotes b. Based on negative ranks, denotes c. Based on positive ranks.

The Wilcoxon Signed-Rank test shows that there are statistically significant differences between the average changes in the cumulative abnormal returns of the pharmaceutical companies manufacturing vaccines, according to the different weekly periods as follows:

- **For weeks (-10, +10):** There are differences for all vaccine manufacturers, except for Johnson & Johnson (JNJ), which produces the Johnson & Johnson vaccine.
- **For weeks (-20, +20):** There are differences for all vaccine manufacturers, except for Sinopharm Group Co. Ltd. which produces (Sinopharm/Beijing).
- **For weeks (-30, +30):** There are differences for all vaccine manufacturers, except for CanSino Biologics Inc., which produces the vaccine CanSino.
- **For weeks (-40, +40):** There are differences for all vaccine manufacturers.

Based on the previous analysis for the third hypothesis, the null hypothesis is rejected and the alternative hypothesis can be accepted, which shows that there are differences in the cumulative abnormal returns of pharmaceutical companies that manufacture vaccines with different weekly periods for each company.

6. Conclusion

This research examines the impact of the COVID-19 vaccine's efficacy on the number of new cases and death cases since the pharmaceutical companies announced their production, where vaccines used on January 1, 2021. The types of vaccines are measured by the total vaccines for daily vaccinations for all countries divided by the total population of the research sample from 01/01/2021 to 08/11/2021 in a total of (312) days. The number of new cases and death cases was measured by dividing them on the total population of the research countries sample from the date 02/01/2021 to 12/31/2021 in a total of (334) days. The data on the vaccines are delayed for one month to show more the impact of the vaccine reflection on new cases and death cases. The results show the vaccines are effective in reducing the new cases and death cases are (Moderna, Oxford/Astrazeneca, Novavax V, and Cansino), but the vaccines that has no efficacy in reducing the number of new cases and death cases are (Pfizer/Biontech, Sinovac, Johnson & Johnson, and Sinopharm/Beijing).

The second part of the study is the financial benefits of the pharmaceutical companies that manufactured the vaccines since the WHO declared a public health emergency of international concern on 30 January 2020. The abnormal returns and abnormal cumulative returns for pharmaceutical companies manufacturing vaccines is measured by using different weekly event study methodology. The results show that vaccine manufacturers achieved benefits from abnormal return in the presence of vaccination efficacy from new cases that reduces the number of new cases and new deaths, the vaccine manufacturers (Oxford/AstraZeneca and Novavax), while the pharmaceutical companies that manufacture the rest of the vaccines have not achieved benefits from abnormal returns even though some are effective. The results also show that the pharmaceutical companies that manufactured the vaccines achieved cumulative abnormal returns in the presence of the vaccine efficacy against virus that reduces the number of new cases and new deaths are (Oxford / AstraZeneca, Novavax, Moderna, and CanSino), while the vaccine manufacturers that achieved the cumulative returns that were not effective in reducing the number of new cases and death cases are (Pfizer/Biontech, Sinovac, Johnson & Johnson and Sinopharm/Beijing).

Based on the previous results of measuring the efficacy and financial benefits of vaccine manufacturers, it's concluded that some vaccines have achieved efficacy and furthermore achieved financial benefits, unlike Moderna vaccine which achieved efficacy and did not achieve financial benefits. It's also concluded that some vaccines did not achieve efficacy but achieved financial benefits.

References

Abu-Raddad, L. J., Chemaitelly, H., & Butt, A. A. (2021). Effectiveness of the BNT162b2 COVID-19 Vaccine against the B. 1.1. 7 and B. 1.351 Variants. *New England Journal of Medicine*, *385*(2), 187-189. https://doi.org/10.1056/NEJMc2104974

Alber, N. (2013). Competitive advantages and performance of stock market: The case of Egypt. *International Journal of Economics and Finance, 5*(11). https://doi.org/10.5539/ijef.v5n11p133

Altindis, E. (2022). Inequitable COVID-19 vaccine distribution and the intellectual property rights prolong the pandemic. *Expert review of vaccines*, *21*(4), 427-430. https://doi.org/10.1080/14760584.2022.2014819

Anderson, R. M., Vegvari, C., Truscott, J., & Collyer, B. S. (2020). Challenges in creating herd immunity to SARS-CoV-2 infection by mass vaccination. *The Lancet*, *396*(10263), 1614-1616. https://doi.org/10.1016/S0140-6736(20)32318-7

APnews (2021). Vaccine inequity: Inside the cutthroat race to secure doses. Retrieved July 18, 2021, from https://apnews.com/article/coronavirus-vaccine-inequality-dac9c07b324e29d3597037b8dc1d908a

Bagues, M., & Dimitrova, V. (2021). The psychological gains from COVID-19 vaccination: who benefits the most? *arXiv preprint arXiv:2111.02197*. https://doi.org/10.2139/ssrn.3954601

Berwick, D., Sykes, R., & Achmat, Z. (2002). "We all have AIDS": case for reducing the cost of HIV drugs to zero Commentary: The reality of treating HIV and AIDS in poor countries Commentary: Most South Africans cannot afford anti-HIV drugs. *BMJ*, *324*(7331), 214-218. https://doi.org/10.1136/bmj.324.7331.214

Bloom, D. E., David E. B., Daniel, C., & Daniel, L. T. (2020). *(IMF report).* Retrieved from https://www.imf.org/en/Publications/fandd/issues/2020/09/vaccine-finance-epidemics-and-prevention-bloom

Bonnevie, E., Gallegos-Jeffrey, A., Goldbarg, J., Byrd, B., & Smyser, J. (2021). Quantifying the rise of vaccine opposition on Twitter during the COVID-19 pandemic. *Journal of communication in healthcare*, *14*(1), 12-19. https://doi.org/10.1080/17538068.2020.1858222

Bridge. China (2021). COVID-19 Vaccine Tracker [Internet]. Beijing (CN): *bridge Consulting;* 2021 [updated 2021 Jul 20; cited 2021 Jul 28]. Retrieved from https://bridgebeijing.com/our-publications/our-publications-1/china-COVID-19-vaccines-tracker/

Carvalho, V. M., Garcia, J. R., Hansen, S., Ortiz, Á., Rodrigo, T., Rodríguez, M. J. V., & Ruiz, P. (2021). Tracking the COVID-19 crisis with high-resolution transaction data. *Royal Society Open Science*, *8*(8), 210218. https://doi.org/10.1098/rsos.210218

CDC report (2020). *Centers for Disease Control and Prevention.* Vaccine testing approval process. Retrieved July 29, 2022, from https://www.cdc.gov/vaccines/basics/test-approve.html

CDC report. (2022,a). Centers for Disease Control and Prevention. Benefits of Getting A COVID-19 Vaccine. Retrieved from https://www.cdc.gov/coronavirus/2019-ncov/vaccines/vaccine-benefits.html

CDC website, (2022b). Understanding How Vaccines Work. National Center for Immunization and Respiratory Diseases, https://www.cdc.gov/vaccines/hcp/conversations/understanding-vacc-work.html#print

Cohen, J. (2020). Unveiling "Warp Speed," the White House's America-first push for a coronavirus vaccine. *Science Magazine* 2020 May 12. https://doi.org/10.1126/science.abc7056

Coibion, O., Gorodnichenko, Y., & Weber, M. (2020). The cost of the COVID-19 crisis: Lockdowns, macroeconomic expectations, and consumer spending (No. w27141). *National Bureau of Economic Research.* https://doi.org/10.3386/w27141

Dagan, N., Barda, N., Kepten, E., Miron, O., Perchik, S., Katz, M. A., ... Balicer, R. D. (2021). BNT162b2 mRNA COVID-19 vaccine in a nationwide mass vaccination setting. *New England Journal of Medicine*. https://doi.org/10.1056/NEJMoa2101765

Dai, H., Saccardo, S., Han, M. A., Roh, L., Raja, N., Vangala, S., ... Croymans, D. M. (2021). Behavioural nudges increase COVID-19 vaccinations. *Nature*, *597*(7876), 404-409. https://doi.org/10.1038/s41586-021-03843-2

Erfani, P., Binagwaho, A., Jalloh, M. J., Yunus, M., Farmer, P., & Kerry, V. (2021). Intellectual property waiver for COVID-19 vaccines will advance global health equity. *bmj*, *374*. https://doi.org/10.1136/bmj.n1837

Fine, P., Eames, K., & Heymann, D. L. (2011). “Herd immunity”: a rough guide. *Clinical infectious diseases*, *52*(7), 911-916. https://doi.org/10.1093/cid/cir007

Friede, A., Reid, J. A., & Ory, H. W. (1993). CDC WONDER: a comprehensive on-line public health information system of the Centers for Disease Control and Prevention. *American Journal of Public Health*, *83*(9), 1289-1294. https://doi.org/10.2105/AJPH.83.9.1289

Hao, F., & Shao, W. (2021). Understanding the effects of individual and state-level factors on American public response to COVID-19. *American Journal of Health Promotion*, *35*(8), 1078-1083. https://doi.org/10.1177/08901171211017286

Hill, P. L., Burrow, A. L., & Strecher, V. J. (2021). Sense of purpose in life predicts greater willingness for COVID-19 vaccination. *Social Science & Medicine*, *284*, 114193. https://doi.org/10.1016/j.socscimed.2021.114193

Hotez, P. J., Batista, C., Amor, Y. B., Ergonul, O., Figueroa, J. P., Gilbert, S., ... Bottazzi, M. E. (2021). Global public health security and justice for vaccines and therapeutics in the COVID-19 pandemic. *EClinical Medicine*, *39*, 101053. https://doi.org/10.1016/j.eclinm.2021.101053

Iserson, K. V. (2021). SARS-CoV-2 (COVID-19) vaccine development and production: an ethical way forward. *Cambridge Quarterly of Healthcare Ethics*, *30*(1), 59-68. https://doi.org/10.1017/S096318012000047X

Kadkhoda, K. (2021). Herd immunity to COVID-19: alluring and elusive. *American Journal of Clinical Pathology*, *155*(4), 471-472. https://doi.org/10.1093/ajcp/aqaa272

Kavanagh, M. M., Gostin, L. O., & Sunder, M. (2021). Sharing technology and vaccine doses to address global vaccine inequity and end the COVID-19 pandemic. *Jama*, *326*(3), 219-220. https://doi.org/10.1001/jama.2021.10823

Liu, A. (2020). China’s CanSino Bio advances COVID-19 vaccine into phase 2 on preliminary safety data. *Fierce Pharma*.

Machingaidze, S., & Wiysonge, C. S. (2021). Understanding COVID-19 vaccine hesitancy. *Nature Medicine*, *27*(8), 1338-1339. https://doi.org/10.1038/s41591-021-01459-7

Mariana et.al. (2018). The people’s prescription: Re-imagining health innovation to deliver public value, *UCL Institute for Innovation and Public Purpose*. Retrieved from https://www.ucl.ac.uk/bartlett/public-purpose/sites/public-purpose/files/peoples_prescription_report_final_online.pdf

Marriott, A., & Maitland, A. (2021). The Great Vaccine Robbery. Pharmaceutical corporations charge excessive prices for COVID-19 vaccines while rich countries block faster and cheaper routes to global vaccination. *The People's Vaccine Policy Brief*, *29*.

Morgan, S. G., Bathula, H. S., & Moon, S. (2020). Pricing of pharmaceuticals is becoming a major challenge for health systems. *bmj*, *368*. https://doi.org/10.1136/bmj.l4627

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., ... Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): *A review. International journal of surgery*, *78*, 185-193. https://doi.org/10.1016/j.ijsu.2020.04.018

OECD. (2020). Coronavirus (COVID-19): SME policy responses. *OECD Policy* Responses to Coronavirus (COVID-19). Retrieved from https://www.oecd.org/coronavirus/policy-responses/coronavirus-COVID-19-sme-policy-responses-04440101/

Olaberria, E., & Reinhart, C. (2022). The Reversal Problem: Development Going Backwards. *World Bank Bolgs*.

Retrieved April 15, 2022, from https://blogs.worldbank.org/developmenttalk/reversal-problem-development-going-backwards

Omer, S. B., Yildirim, I., & Forman, H. P. (2020). Herd immunity and implications for SARS-CoV-2 control. *Jama*, *324*(20), 2095-2096. https://doi.org/10.1001/jama.2020.20892

OXFAM International, Feb, (2021). *Monopolies causing "artificial rationing" in COVID-19 crisis as 3 biggest global vaccine giants sit on sidelines.* Retrieved from https://www.oxfam.org/en/press-releases/monopolies-causing-artificial-rationing-COVID-19-crisis-3-biggest-global-vaccine

Paloyo, S. R., Caballes, A. B., Hilvano-Cabungcal, A. M., & De Castro, L. (2022). Prioritizing the vulnerable over the susceptible for COVID-19 vaccination. *Developing World Bioethics*, *22*(3), 162-169. https://doi.org/10.1111/dewb.12327

Pragyan, D., Davide, F., Jimenez, D., Siddharth, K., Ostry, J. D., & Nour, T. (2022). The effects of COVID-19 vaccines on economic activity. *Swiss Journal of Economics and Statistics*, *158*(1). https://doi.org/10.1186/s41937-021-00082-0

Pritchard, E., Matthews, P. C., Stoesser, N., Eyre, D. W., Gethings, O., Vihta, K. D., ... Pouwels, K. B. (2021). Impact of vaccination on new SARS-CoV-2 infections in the United Kingdom. *Nature medicine*, *27*(8), 1370-1378. https://doi.org/10.1038/s41591-021-01410-w

Ruchir, A., & Gita, G. (2021). A Proposal to End of the COVID-19 Pandemic. *IMF Staff Discussion note 3*. https://doi.org/10.5089/9781513577609.006

Salmon, D. A., Dudley, M. Z., Brewer, J., Kan, L., Gerber, J. E., Budigan, H., ... Schwartz, B. (2021). COVID-19 vaccination attitudes, values and intentions among United States adults prior to emergency use authorization. *Vaccine*, *39*(19), 2698-2711. https://doi.org/10.1016/j.vaccine.2021.03.034

Sinopharm Group. (2021) Interim Report [Internet]. 2021 [cited 2022 Mar 10]. Retrieved from http://ir.sinopharmgroup.com.cn/html/report.php?type=interim

Sinovac reports (2021). First half of 2021 financial results [Internet]. 2021 Dec 31 [cited 2022 Mar 10]. Retrieved from http://www.sinovac.com/news /shownews.php

Szilagyi, P. G., Thomas, K., Shah, M. D., Vizueta, N., Cui, Y., & Vangala, S. et al. (2021). The role of trust in the likelihood of receiving a COVID-19 vaccine: Results from a national survey. *PrevMed*, 153, 106727. https://doi.org/10.1016/j. ypmed.2021.106727 .

The world Bank. (2022). The World Bank Group's Response to the COVID-19 (coronavirus) Pandemic. Website: https://www.worldbank.org/en/who-we-are/news/coronavirus-covid19 . Accessed on 2, august, 2022.

Troiano, G., & Nardi, A. (2021). Vaccine hesitancy in the era of COVID-19. *Public Health*, *194,* 245-51. https://doi.org/10.1016/j.puhe.2021.02.025

UNDP. (2022). *Vaccine Affordability.* Retrieved August 1, 2022, from https://data.undp.org/vaccine-equity/affordability/

Voysey, M., Clemens, S. A. C., Madhi, S. A., Weckx, L. Y., Folegatti, P. M., Aley, P. K., ... Bijker, E. (2021). Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (AZD1222) against SARS-CoV-2: an interim analysis of four randomized controlled trials in Brazil, South Africa, and the UK. *The Lancet*, *397*(10269), 99-111. https://doi.org/10.1016/S0140-6736(20)32661-1

WHO (2022a). Rolling updates on coronavirus disease (COVID-19) Updated 31 July 2020. Retrieved September 12, 2022, from https://www.who.int/europe/emergencies/situations/COVID-19

WHO (2022c). *WHO Coronavirus (COVID-19) Dashboard.* Retrieved August 24, 2022, from https://covid19.who.int/

WHO report. (April, 2021b). *Strategy to Achieve Global COVID-19 Vaccination by mid-2022.* Retrieved August 1, 2022, from https://cdn.who.int/media/docs/default-source/immunization/COVID-19/strategy-to-achieve-global-COVID-19-vaccination-by-mid-2022.pdf

WHO. (2021d). How do vaccines work. Retrieved August 20, 2022, from https://www.who.int/news-room/feature-stories/detail/how-do-vaccines-work?adgroupsurvey={adgroupsurvey}&gclid=CjwKCAjwsfuYBhAZEiwA5a6CDPNDaV1aMPEW6Odsdz7ciNwQ_yNEKvA454nvGhBkA

rYQeOj1DK0JzxoCtGMQAvD_BwE

Wouters, O. J., Shadlen, K. C., Salcher-Konrad, M., Pollard, A. J., Larson, H. J., Teerawattananon, Y., & Jit, M. (2021). Challenges in ensuring global access to COVID-19 vaccines: production, affordability, allocation, and deployment. *The Lancet*, *397*(10278), 1023-1034. https://doi.org/10.1016/S0140-6736(21)00306-8