The Impact of COVID-19 Vaccination on Countries' Economic Recovery: Taking the OECD as an Example

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Abstract. In 2019, the worldwide health system was significantly impacted by the COVID-19 pandemic which caused a chain reaction to all aspects of society. The epidemic has raised concerns about the upcoming economic crisis and recession. Despite public choice, budget constraints and many other factors, the formation of social immune barriers through mass vaccination is still one of the most effective measures to prevent and control the epidemic. Taking countries in Organization for Economic Co-operation and Development (OECD) for example, this paper aims to explore the relationship between vaccination rate and national economic growth. In 2020, almost all major economies in the world will have negative GDP growth. After countries took strict prevention and control measures and financial remedies, the economy began to improve. Using Difference-in-Difference (DID) method, qualitative and quantitative research helps us intuitively understand the impact of vaccination on national economic, and the regression results confirm the positive effect of vaccines on economic recovery. This conclusion provides some theoretical support for the policies of countries to promote COVID-19 vaccination.

Keywords: COVID-19; Vaccine; GDP; Economic Recovery; Difference-in-Difference.

1. Introduction

A new coronavirus was first observed in Wuhan, Hubei, China in late 2019. As of January 27, 2020, 14411 confirmed cases have appeared in the mainland, with a weekly growth rate of 625.99%. The new coronavirus was given the official name COVID-19, and the World Health Organization (hereinafter referred to as WHO) declared it a worldwide emergency in January 2020. in February 11, 2020. The outbreak of COVID-19 pneumonia has brought uncertainty and haze to the world. According to the latest data from WHO, as of August 05, 2022, at least 579,092,623 cases were diagnosed globally and 6,407,556 people died. The negative effects of COVID-19 also include short-term and long-term social, economic and political effects. As early as the early stage of the epidemic, OECD (2020) predicted that the longer and more intense COVID-19 epidemic may reduce the global economic growth rate to 1.5% in 2020, half of the expected growth rate before the epidemic, which will have a negative impact on most industries of the world. Nicola et al. (2020) report that measures such as travel restrictions and self-isolation have had a serious impact especially on labor-driven industries, resulting in the reduction of jobs and the unemployment of workers [1]. The recovery plan of the global economy may be a period of several years, and the future economic situation is not optimistic.

In order to save the world economy, all countries have actively taken measures to remedy the economy and issued a rescue package. Since the worst period of the financial crisis in 2008, the Federal Reserve has taken emergency measures for the first time. On March 5, 2020, it announced that it would reduce borrowing costs by 0.5 basis points to deal with the threat of COVID-19. Meanwhile, Baker's (2021) research points out that regarding financial markets, countries must take strong measures to stop the virus from spreading further, such as actively promoting vaccination, otherwise central banks will have to face the choice of continuing to reduce interest rates and expand bond purchase plans [2]. In fact, after the first shock of the unexpected epidemic, some countries have paid attention to both vaccination and fiscal policies, and achieved good economic results. Naisbitt et al. (2021) suggest that the United States has learned from the experience of the first wave of epidemic in dealing with the second wave of virus and adopting blockade restrictions [3]. At the same time, it has vigorously promoted vaccination and taken a lot of fiscal stimulus policies. Due to the economic

status of the United States, this will also bring a positive and clear prospect to the global economy. This has raised the forecast for global GDP growth.

2. Literature Review

2.1 The Impact of COVID-19 on the Global Economy

The COVID-19 is reminiscent of another major public health event due to the initial epidemic area, disease transmission mode, public response and government response measures. The Severe Acute Respiratory Syndrome (SARS) epidemic that had a negative impact on the economy of some countries of 2002-2004. A research by Nippani and Washer (2004) demonstrates that, with the exception of Vietnam and China, SARS had no adverse effects on the affected countries' financial markets within their sample. [4]. However, the research of Abiad, A. et al. (2020) points out that the COVID-19 epidemic was much more severe than SARS, and estimates the negative impact of the epidemic on Asian economies, including China [5].

The impact of the epidemic was not limited to Asia. The economies of many countries in the world have been negatively affected by the epidemic and it also created uncertainty in the global financial industry. Liu, et al. (2020) they evaluate 21 important stock market indicators for the short-term effects of the COVID-19 outbreak, and conclude that from the direct market performance, after the virus outbreak, the stock market of the countries studied fell rapidly [6]. The first reason is that the deepening of globalization in the past decade has made the economic ties of various countries closer; Second, China's integration into the world is increasing [7]. In order to deal with this economic and financial crisis, the central banks around the world promised to save the global economy "at all costs". Europe promised to provide a €1.7tn euro rescue package [1]. In the medium and long run, it is crucial to consider how much negative consequences can cause a slowdown in global economic growth. The impact of high unemployment on human capital and the adverse impact of the long-term epidemic on health will slow down the growth of global GDP due to the loss of investment in order to increase the capital stock [3]. With the outbreak of COVID-19 in the United States, global financial markets have become more pessimistic. The research results of Gunay and Can (2022) show that like the 2008 global financial crisis, the source of volatility spillover is the US stock market during the epidemic [8].

2.2 Economic and Social Impact of Vaccine

Since there is minimal research on the new crown vaccine's economic effects, previous papers on the impact of other vaccines on the economy and society have been consulted. The effectiveness of a vaccine in a population is based on its coverage. Since the establishment of a social immunization guarantee is of great importance in epidemic prevention, in terms of cost and benefit, giving priority to vaccinating the groups most in need of protection is a more economic and social benefit choice. A paper on Transnational analysis by Lugnér, et al. (2012) also involves research on similar contents. The paper explores the effectiveness of influenza immunization situation of the Netherlands, Germany, and the UK and discusses which kind of people should be vaccinated first in order to achieve the best economic benefits under different circumstances [9].

Although previous literature has analyzed the economic cost of vaccination when the epidemic broke out, the positive effect of vaccination will be more important if studies focus on a longer-term perspective. A paper by Bloom (2010) provides a long-term economic perspective on vaccination and proves that vaccination can help achieve national economic goals. Studies show that the national vaccination program for children can reduce the incidence rate and mortality rate of a country, and it is also conducive to poverty alleviation and national economic growth in the long run [10]. Based on the strong link between population health and economic well-being, the study discusses the value of health economic benefits and vaccination. These values may be long-term and intangible, such as the improvement of work efficiency caused by the improvement of health. This is particularly evident in the covid-19 epidemic. Not only are infected people unable to work, but healthy people must work from home or suffer layoffs in order to remain uninfected, and infected people are at risk of sequelae.

Masia, et al. (2018) analyze how the change of immunization coverage affects the GDP growth of countries over different time lengths by econometric means, and expressed a similar view. Evidence was found that the GDP growth rate associated with the lagging growth of vaccination rate was statistically and economically significant and continued to grow. In addition, the study found that these effects will increase over time [11]. Brenzel (2015) reports the poverty limits vaccine promotion. The burden of vaccines may hinder the sustainable growth of poorer countries, according to the paper, which analyses 40 extensive multi-year immunization regimens. [12]. The scope of the COVID-19 and the severity of its impact on the global supply chain have made it more difficult for an economy to recover under the low vaccination rate. The Wall Street Journal showed that in mid-2021, the International Monetary Fund also lowered its forecast for dealing with the latest wave of new pneumonia epidemics, namely Vietnam, Indonesia, Thailand, the Philippines and Vietnam and other Southeast Asian economies [13].

This paper chooses OECD member countries as the research object. They are 38 market economy countries that assist each other. According to a statistical data released by the OECD on October 25, 2021, the average proportion of the relatively poor population in its member countries is 11.1% from 2018 to 2019. Therefore, the promotion of COVID-19 vaccine in these member countries is relatively smooth, and the member countries have a certain regional representation.

3. Methodology

3.1 DID Model

In the empirical part, this dissertation refers to the research method of Batool, et al. (2021) and Brodeur, et al. (2020) to adopt the difference-in-difference (DID) model for analysis, which can avoid endogeneity and other problems [14,15]. DID model is a widely used technique in applied economics. It is suitable to process panel data and is often used to analysis the effect of a policy intervention on economic variables. Difference-in-difference model is becoming more and more popular as a cutting-edge tool in the policy effect evaluation method. It can be distilled into the following points: First, in comparison to economic issues, policies are typically exogenous; therefore there is no reverse causality problem. This can greatly reduce the difficulty of endogenous problems. Additionally, the adoption of fixed effect estimation somewhat reduces the issue of missing variables and inaccuracies. Second, the traditional approach mostly uses regression after setting a dummy variable to indicate whether the policy is implemented or not in order to assess the policy effect. In contrast, setting of DID model is more exact and is able to assess the policy influence more precisely. A critical hypothesis of this model is the parallel trend hypothesis, which means that the treatment group and the control group will follow the parallel path without intervention. Therefore, DID is used in this study, because in the absence of vaccine promotion, the GDP growth rate in the adjacent two years should not change much and should maintain a similar trend. Specifically, a standard difference-in-difference model is formed as follows:

$$Y_{it} = \alpha_0 + \alpha_1 \cdot du + \alpha_2 \cdot dt + \alpha_3 \cdot du \cdot dt + \varepsilon_{it} \quad (1)$$

du is a grouping dummy variable among them. It is used to distinguish whether the target will be affected by the policy. If it is received, du is equal to 1; otherwise, du is equal to 0, and these two cases belong to the treatment group and the control group respectively. DID generally uses dt as a dummy variable to measure the implementation of policies. dt is 0 prior to the execution of the policy and 1 following it. The term du*dt, whose coefficient indicates the influence of vaccination implementation, is an interactive item of the two variables related to policy implementation.

3.2 Data Selection and Sources

The OECD takes the first quarter of 2021 as the beginning of statistics for its member countries to start vaccinating against COVID-19. Here, the model takes the data of 2021 as the processing group, and its du value is 1. In 2020, it was not popularized by the vaccine. As a result, it is a member of the

control group and has a du value of 0. Before vaccine promotion, dt equals to 0, and after, it equals to 1. du*dt reflects the net effect of vaccine promotion in the world.

The data of this article comes from the official website of OECD, which mainly collects the information of OECD member countries.

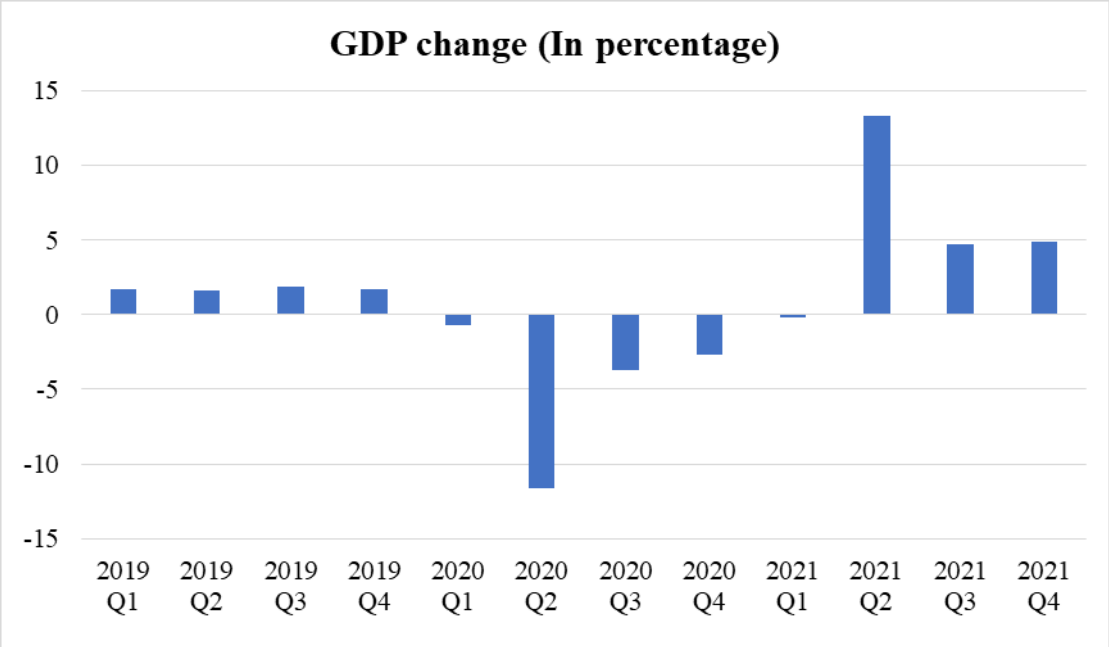

Fig. 1 Economic growth in OECD member countries
(Source: OECD (2022), https://www.oecd.org/)

Next, this article use Stata software to process the data. The first quarter of 2020 through the last quarter of 2021 make up the data's sample range. Table 1 is the result of descriptive statistics:

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
q	8	2.5	1.195229	1	4
year	8	2020.5	0.5345225	2020	2021
change	8	0.50125	7.334372	-11.59	13.3

Where q represents different quarters, year represents different years, and change represents the changes in economic growth of OECD member countries. The average value of economic growth is 0.50, and its standard deviation is 7.33. There is no obvious abnormality in the data, which can be analyzed in the next step. This paper then makes a correlation analysis of the samples.

3.3 Correlation Analysis

The results of the following analysis, which is done to determine the correlation between variables, are displayed in Table 2.

Table 2. Correlation analysis

	year	*change*
year	1.0000	
change	0.7530 *	1.0000

Note: ***, ** and * indicate that the estimated coefficients are significant respectively at the 1%, 5% and 10% levels.

It can be seen from the Table 2 that the year and economic growth rate are significant at the level of 0.1, and there is a certain correlation between the two.

3.4 Regression Results Analysis

Next, the analysis takes 2020 as the control group and 2021 as the treatment group, use DID as the interactive item and analyze it with the DID model.

Table 3. DID analysis results for 2020 and 2021

Variable	Regression results
DID	11.406**
	(3.433424)
Constant	-3.776
	(2.102534)
R-squared	0.6478
Observations	8

Note: robust standard errors in parentheses; ***, ** and * indicate that the estimated coefficient is significant respectively at the level of 1%, 5% and 10%.

The regression shows that the net effect of vaccination policy is significant at the level of 5%. The exam of R-squared also shows that the model can explain the 0.65 of economic growth of the OECD member countries. The coefficient of the interaction term is positive, indicating that the promotion of vaccination is indeed conducive to economic recovery. Finally, it is necessary to conduct robustness test. The study selects the quarterly data of economic growth of OECD member states in 2019 and 2021, take the data in 2019 as the control group and the data in 2021 as the processing group, and conduct the regression analysis of DID model again. The results are as follows:

Table 4. DID analysis results for 2019 and 2021: Robustness test

Variable	Regression results
DID	6.29**
	(2.13589)
Constant	1.34
	(1.30796)
R-squared	0.5911
Observations	8

Note: robust standard errors in parentheses; ***, ** and * indicate that the estimated coefficient is significant respectively at the level of 1%, 5% and 10%.

The regression is similar with those in 2020 and 2021. The economic effect of vaccination policy is significant at the level of 5%. The number of R-square also shows that it can explain the 0.59 of economic growth of OECD member countries in the model. Although the value of some data is not as good as the previous regression result, this is still a convincing result. The coefficient of the interaction term is positive, indicating that the promotion of vaccination is indeed conducive to economic recovery, but the coefficient is less than the regression results in 2020 and 2021. This may be that there is no large-scale outbreak in 2019, while the outbreak of COVID-19 in 2020, as mentioned above, has a detrimental effect on the world economy. In conclusion, the model passed the robustness test.

4. Conclusion

The results of this analysis are broadly consistent with previous research on vaccines and COVID-19. Almost all the literatures agree on the positive role of the economic role of vaccines. The only argument may lie in the economic cost of high coverage required for the establishment of social immune barriers and the economic benefits of vaccination. But even at this point, most of the literature believes that vaccination is worth it, and the only concern is insufficient budget. The analysis results of this paper show that from a quarterly perspective, COVID-19 vaccine as a policy has positive economic benefits as soon as it is launched, and this is explained to a great extent. Compared with 2019, the launch of COVID-19 vaccine in 2021 will have higher economic benefits for 2020. This may be because the economy in 2020 was severely suppressed by the epidemic, and the economic growth potential was released after vaccination and open policies. There are also some limitations in this paper, such as small sample size because there are only quarterly OECD economic data but this defect can be made up by DID to a certain extent. However, follow up studies can be further carried out from the perspective of more representative samples.

Over the past two decades, vaccination has made great efforts to prevent the onset of life-threatening and crippling diseases in tens of millions of people. These efforts have laid the foundation for many economic achievements of future generations. Many previous scholars have made numerous attempts to identify the advantages of vaccination from the perspective of cost-effectiveness, productivity and many other research perspectives. This paper also hopes to contribute to the research on the economic role of COVID-19 vaccine, and it draws a conclusion by taking the OECD as a case. Considering the high economic return of COVID-19 vaccination program in the current quarter, decision makers should have more reason to give priority to and maintain the vaccination program for countries with adequate budgets.

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