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Covid-19 and Inflation Rate: An Evidence for OECD Countries

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Abstract

Covid-19 has affected the world's economy since 2019. The coronavirus pandemic is one of the most severe and dangerous problems that humanity has faced in the last century. Therefore, this paper aims to investigate the impact of Covid-19 on the inflation rate in the 36 OECD member countries. Monthly data on Covid-19 and the inflation rate from February 2020 to August 2021 and the quantile panel regression method have been used to achieve this purpose. The results show that new cases of Covid-19 decrease the inflation rate in all quantiles, which means that by increasing the number of Covid-19 cases, economic activities decrease because of the business restrictions. Moreover, the new deaths of Covid-19 have a dual impact on the inflation rate in OECD countries. With increasing in Covid-19 deaths, business restrictions have increased, the economy has entered a recession, and inflation has decreased. On the other hand, the growth of Covid-19 casualties could increase economic uncertainty and inflation. Furthermore, Covid-19 vaccinations have positive and significant effects on the inflation rate in OECD countries. Accordingly, policymakers are advised to include increasing vaccine injections, especially booster doses, to increase economic activity and prosperity in OECD and world economies. Furthermore, Covid-19 showed the necessity of preparing the world against infectious diseases in the future.

Highlights

- New cases of Covid-19 decrease the inflation rate in all quantiles in OECD member countries.
- New deaths of Covid-19 have a dual impact on the inflation rate in OECD countries.
- Covid-19 vaccinations have positive and significant effects on the inflation rate in OECD countries.

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1. Introduction

Infectious diseases are considered one of the leading causes of mortality, accounting for a quarter to a third of global mortality. Notwithstanding various significant advances that we see in the pharmaceutical industry every day, the prevalence of infectious diseases is increasing due to factors including globalization, increase in traveling and trade, urbanization, densely populated towns and cities, changing human behavior, resuscitation of pathogens and misuse of antibiotics (Verikios, 2020). The recent outbreak of the Covid-19 virus shows that open economies lead to the ease of spreading infectious diseases, which threatens every country's economic stability. The past infections have had to resemble economic effects worldwide, but the Covid-19 virus is more contagious and challenging due to its capability to retain on different surfaces. The virus is more infectious than the flu and swine flu because it is easily spread between people. The coronavirus pandemic caused different turbulences in all sectors of the country. In addition, this epidemic created widespread ambiguities in developed and developing countries, including stock market fluctuations, economic policy uncertainty, unemployment, rising inflation, and uncertainty in GDP growth. Uncertainties worsened during and after quarantine (Altig et al., 2020). According to the International Monetary Fund (IMF; imf.org), Covid-19 is the worst recession since the Great Depression. The epidemic had a negative impact on the local economies, and the risk is increasing in countries most influenced by the disease, such as the European Union and OECD countries. Inflation is considered one of the most significant indices since it may directly affect many macroeconomic variables, such as consumer spending, exchange rates, production costs, and interest rates. By definition, inflation is the general rise in the price of goods and services (excluding the price of assets) throughout the economy. Moreover, monetary shocks increase output and inflation (Keshavarz & Parsa, 2019; Kiaee,2017). When inflation occurs, people can buy fewer goods and services for the same amount of money, which can also be seen as a general devaluation. Inflation measures are applied to adjust financial figures to keep the purchasing power constant over time, allowing for more exact comparisons over different periods. Inflation could be calculated by observing variations in the average price of a fixed set of goods and services, called the market basket. Some reasons for the recent rise in inflation are related to supply disruptions caused by the Covid-19 epidemic and the consequent return of consumer spending in specific sectors. Thus, it is reasonable to believe that some price pressures are temporary. However, there are concerns that higher inflation may be sustainable if rapid GDP growth rates happen since the second half of 2020, causing the economy to overheat and inflation expectations to rise. Currently, the economy is performing below its full potential, but the Congressional Budget Office (CBO) predicts that production will exceed its potential by 2022 if the rapid growth continues. Overall employment is still lower than before the pandemic, and overall wages are not increasing faster than

inflation. Specific industries are facing labor shortages, which, if expanded, could indicate that the economy is overheating.

Inflation is not the only factor that must be carefully watched during the pandemic. Apart from the inflation rate, data obtained from the study of the effects of Covid-19 on economic growth, foreign commerce, borrowing, and monetary markets must be inserted into the policy-making procedures. During this period, it was found that the economic growth rate decreased as a result of the recession. This trend increased the unemployment rate. Many countries have launched expansionary monetary policies to mitigate the negative impacts of the recession. Thus, predicting the inflation rate trend in rising unemployment is essential to determine the policies to deal with the recession.

The Covid-19 crisis may exacerbate some of the long-standing pre-epidemic challenges while providing a chance to consider some. The economic landscape is highly uncertain, and recovery is more hesitant. The critical policy challenge is to curb the continued or new spread of the virus while minimizing economic failures. Many businesses in the service sector that are most exposed to these deterrents cannot survive, increasing the risk of job loss and bankruptcy, which will hit demand in the economy. Central banks and monetary authorities, especially in developed economies, have drastically facilitated monetary policy to support the economy and fulfilling their inflation goals by reducing interest rates and enhancing central bank reserves of government bonds. It has also significantly reduced the cost of government debt services. Due to the output and inflation's slow recovery, central banks and monetary authorities need an adaptive fiscal policy to achieve their goals regarding inflation. Dependence on short-run financial instruments has increased because of an increase in governmental cash requirements. Governments can gradually reduce their vulnerability to hedging risks by introducing long-maturing securities, helping to increase average debt maturities and manifolding the investor base. Financial support is considered a crucial factor in countries where fiscal policy has a narrow domain to drive private demands. Economies with low debt services costs concerning the economy’s growth and stable financial market conditions must continuously provide financial support to warrant a sustainable recovery. Financial support is significant in economies and countries where fiscal policies have a limited domain for driving and encouraging private demands. However, considering high initial deficits, public debt is not expected to decline spontaneously or rapidly after the crisis. In the long run, most economies have to deal with higher debts; otherwise, there will be limited financial space to address future crises and the long-run challenges associated with population aging, rising costs of healthcare, and climate change. A higher inflation rate and economic growth will reduce the debt-to-GDP ratio. For this purpose, the general fiscal mix must move toward growth. Governments must also implement effective structural reforms to reinforce growth in OECD member countries. Declining aggregate demand during the pandemic and a sharp drop in the price of consumer inputs in production are positive elements in controlling the inflation rate. However, it is worth noting that

the supply of intermediate and capital commodities has become very difficult. Interruptions in the supply chain reduce production. In normal circumstances, the contraction of demand reduces prices. Nevertheless, if supply decreases as demand decreases, the price may increase. So, due to the imbalance between supply and demand, it is not easy to control inflation trends. Therefore, some studies must be conducted, and measures must be taken to control the inflation rate.

The rest of this study is organized as follows: Section 2 shows a brief overview of the related literature, Section 3 explains the methodology of the study, Section 4 provides the results and discussion of research findings, and finally, Section 5 addresses the conclusion and policy recommendations.

2. A Review of the Related Literature

2. 1 Theoretical Background

Inflation is generally considered a disproportionate increase in the general price level. There are two main reasons for the formation of inflation: first, inflation due to demand-pull, and second, inflation due to cost-pull. Inflation due to demand-pull is the most common cause of rising prices. This type of inflation occurs when consumer demand exceeds supply. Meanwhile, manufacturers cannot adequately respond to demand. The inability to respond to existing demand can be due to various reasons, such as the need for time to increase production, shortage of raw materials, and shortage of skilled labor. In this case, if producers do not raise prices, they will suffer from a shortage of goods due to high demand. After the spread of the Covid-19 disease and the creation of trade restrictions, people's demand for goods and services decreased, and with the decrease in demand, prices also decreased, and consequently, inflation decreased. The second cause of inflation is due to cost-pull. This factor occurs when the economy has a steady demand and supply shortage, which allows producers to increase prices and consequently increase inflation. There are several factors in cost-pull inflation. For example, global supply chain disruptions, such as those caused by the Coronavirus epidemic in 2020 (Congressional Research Service, 2021; United States Congress, 2021; Board of Governors of the Federal Reserve System, 2021).

2. 2. Research Background

It is a fact that COVID-19 and the great lockdown changed consumption trends and increased uncertainties. The continued limited manufacturing and consumption may result in inflation. Several articles focused on uncertainty and expenditures, and others on the most influential sectors. However, few studies have been conducted on the relationship between Covid-19 and inflation. Eichenbaum et al. (2020) analyzed the effects of the pandemic on economic decisions in the United States using a conventional epidemiological model. They found that the disease reduced consumption, exacerbating the intensity of the Covid-19 recession. Also, Altig et al. (2020) compared the indicators of economic uncertainty, like stock market fluctuations, trade uncertainty, and uncertainty in

US and UK GDP growth before and after the Covid-19 crisis. They concluded that uncertainty would rise in response to the pandemic and its economic consequences. They found a35% increase in economic uncertainty in the US to a 20-fold increase in predicting the nonconformity over British economic growth. These researches illustrated a positive relationship between Covid-19 and the inflation rate. Likewise, researchers also concluded that fluctuations began to increase in late February and peaked in mid-March. It has been falling since late March, when stock prices began to recover. Also, the authors showed a sharp decrease between 12% and 19% in industrial production.

Anderson et al. (2020) studied the changes in consumer expenditures during the coronavirus pandemic in the Danish economy. They concluded that total non-pandemic costs were 27 percent lower than the actual level. The reduction in costs was related to goods and services that were directly limited during quarantine. This cost reduction was highest among those who lost their jobs and those who lost their money and properties during the Covid-19 crisis. The consumption reaction to Covid-19 was calculated by Baker et al. (2020). The authors found that household expenditure in retail, credit card, and food costs had risen sharply in the early days of the pandemic; however, restaurant and retail spending had fallen sharply in previous months.

Dunn et al. (2020) investigated the effects of Covid-19 on consumer expenditures. They found that the most significant effects were on the accommodation and restaurants, which were 80% and 70%, respectively. In contrast, a 100% increase was observed in food and beverage sales. They concluded that the total cost reduction was 13.7%. According to the measures taken, the impact of the pandemic was estimated at 27.8%. Coibion et al. (2020) examined household expenditure patterns and their macroeconomic expenditures and expectations by surveying more than 10,000 respondents. In their study, 50% of the respondents reported losing income and wealth due to the crisis. They also noted that they expected a lower inflation rate in the future, a higher level of uncertainties, and foreign stocks in the form of cash savings. Sharif et al. (2020) used the Granger causality test to study the correlation between Covid-19, oil price fluctuations, geopolitical risks, stock market, and economic uncertainty in the United States. The effects of Covid-19 on geopolitical risks outweighed the US economic uncertainty. The pandemic risk was different in the short and long term.

Pellegrino et al. (2020) examined the advantage of decreasing policy uncertainty on GDP by a nonlinear VAR estimate for the Euro region. The author showed that the impact of the pandemic on the economy of uncertainty shocks was too more significant in periods when there was a pessimistic vision for the future. Also, Cavallo (2020) studied variations in consumer spending patterns that affect CPI. Covid-19 inflation was higher than the official CPI in the United States for both headings and critical indicators. Similar findings were found for Covid-19 portfolios in 10 of the 16 countries. Also, it was found that social distance precautions and behaviors increase spending on food and other items as inflation

increases but also cause losses in transportation and related groups experiencing severe inflation. Using swap rates, Apergis & Apergis (2020) analyzed the effect of Covid-19 on inflation anticipations and their fluctuations in the US economy. They concluded that inflation anticipations and their volatility increased with the spread of Covid-19.

Jaravel & O'Connell (2020), in their analysis, studied the inflation dynamics during the pandemic in the UK. The researchers obtained the inflation rate in the first month of quarantine at 2.4 percent, which is ten times higher than in previous months. The loss can be described by less advertising and reduced consumer purchasing power. They found that 96% of households have experienced inflation, but 50% have experienced deflation in past years. They also indicated that there could be a risk of stagflation in the British economy. Seiler P. (2020) investigated the association between the coronavirus spread and the inflation rate in Switzerland. The study aimed to analyze shifts in consumer expenditures and the Swiss consumer price index using debit card transactions. Inflation during quarantine was found to be higher than proposed by CPI inflation.

Covid-19 reflectance in CPI was investigated by Blundell et al. (2020). The spread of this disease increased the consumption of imported goods and commodities such as medicine, rice, nappies, and pet food by 1.1 percent. The results indicated that profit margins and production costs increased due to supply chain disruption and production during the crisis.

Bresser-Pereira (2020) described government support during the coronavirus crisis. Governments cut spending to keep public debt from rising. The author also mentioned the involvement of central banks in purchasing securities from the Treasury to finance exceptional expenses. Also, he explained that although this policy did not conflict with inflation restrictions, it could conflict with financial restrictions. Nevertheless, it did not lead to an increase in public debt. Furthermore, it was described that financing Covid-19 would not result in excess demand, which could increase the imports and account deficits, enhance the value of the national currency, accelerate inflation, and trigger a currency crisis.

Ebrahimy et al. (2020) studied the inflation stimuli and dynamics during the Covid-19 pandemic. At the beginning of the pandemic, researchers obtained evidence of inflation in food costs. Nevertheless, there was no evidence of inflation in macro indicators. Finally, Armantier et al. (2020) assessed anticipations on consumer inflation during Covid-19 in the United States. Researchers found no steady upward or downward trend when finalizing the study. However, they described that the information showed an unprecedented increase in inflation uncertainty.

3. Methodology and Data

3. 1. Model and Variables

The present study investigates the effect of Covid-19 on the inflation rate in 36 OECD member countries from February 2020 to August 2021 using the

quantile panel regression method. The conditional quadratic function presented in this research is as follows:

$$INF_{it} = \alpha_i + \varphi_t + \beta_1 NC_{it} + \beta_2 ND_{it} + \beta_3 NV_{it} + \beta_4 INR_{it} + \beta_5 Un_{it} \quad (1)$$

Concerning Equation 1, the variables are described in Table (1):

Table 1. Definition of Variables

Variable	Definition	Source
INF	Inflation Rate (% monthly)	OECD.Stat
NC	new confirmed COVID-19 cases per million people	Our World in Data
ND	new death per million people	Our World in Data
NV	new vaccination per million people	Our World in Data
INR	Long-term Interest Rate (% annual)	OECD.Stat
Un	Unemployment Rate (% of the labor force)	OECD.Stat

***Source**: Research findings.*

Furthermore, to study the effect of factors impacting different quantiles (based on diagnostic tests in section 3.2) of the inflation rate, Equation 2 will be written as follows:

$$Q_{INF_{it}}(\tau|\alpha_i.\varphi_t x_{it}) = \alpha_i + \varphi_t + \beta_{1\tau} NC_{it} + \beta_{2\tau} ND_{it} + \beta_{3\tau} NV_{it} + \beta_{4\tau} INR_{it} + \beta_{5\tau} Un_{it} \quad (2)$$

In the above equation, Qτ represents the τth quantile regression parameter in the dependent variable. The coefficients $\beta_{1\tau}$, $\beta_{2\tau}$, $\beta_{3\tau}$, $\beta_{4\tau}$ and $\beta_{5\tau}$ show the τth quantile regression parameters in the explanatory variables. This model is estimated monthly for the group of OECD member countries from February 2020 to August 2021 in the form of panel data with fixed effects.

3. 2. Data Descriptive Review

This section presents a descriptive review of the variables used in this research before estimating the model. Tables (2) and (3) show the descriptive statistics and correlations between variables, respectively. Table (2) shows that all variables have an asymmetric distribution since the skew. and Kurt. statistics are almost high in all variables. Also, since the Jarque-Bera test probability statistic is below 5% for all variables, the null hypothesis that all data are standard is rejected.

Table 2. Descriptive Statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max	Skew.	Kurt.	Pr. (JB test)
INF	610	1.634	2.48	-2.3	17.14	3.03	16.33	0.000
NC	610	153446	504200.8	-70	6429552	8.44	90.42	0.000
ND	610	3097.49	8270.72	0.00	97187.00	6.09	53.37	0.000
NV	610	1814127	6838472	0.00	89886358	7.63	78.56	0.000
INR	610	1.04	1.99	-0.6	11.26	2.72	11.19	0.000
Un	610	7.40	3.96	1.80	22.91	1.37	4.60	0.000

***Source**: Research findings.*

Table (3) also indicates the correlation between the variables. As can be seen, except for the two variables NC and ND, whose correlation is close to 83%, none of the variables correlate with 70%. To justify the positive correlation between the number of patients with Covid-19 and the deaths from this disease, the higher the number of patients, the higher the number of casualties.

Table 3. Variables Correlation

	INF	NC	ND	NV	INR	Un
INF	1.000					
NC	0.90	1.000				
ND	0.055	0.836	1.000			
NV	0.139	0.345	0.330	1.000		
INR	0.229	0.027	0.117	0.026	1.000	
Un	0.051	0.035	0.49	-0.058	0.412	1.000

***Source**: Research findings.*

Moreover, Table 4 shows the results of the unit root test. As can be seen, the variables are stationary at the level I(0) and in the first difference I(1). The histogram related to inflation is illustrated in Figure (1). As can be seen from Figure (1), this graph is skewed to the right and have abnormal points. Due to the skewness in the inflation rate, the ordinary least square regression method is inappropriate for investigating the factors affecting the inflation rate. Considering the skewness in the dependent variable and considering all parts of the distribution by quantile regression; as a result, the research model has been estimated based on this method. Therefore, using the quantile regression method is acceptable

based on the result of the JB test and the trend of inflation rate in OECD countries.

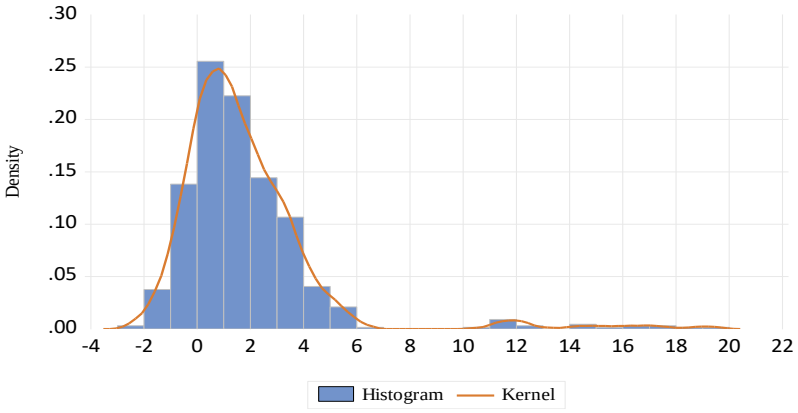

Figure 1. The Histogram of inflation rate in OECD countries
***Source**: Research findings.*

Table 4. Unit Root Test

	Level							
	C				C & T			
Variable	Levin[1]	Im[2]	ADF[3]	PP[4]	Levin	Im	ADF	PP
INF	3.70	4.49	27.39	25.00	-4.63*	-0.36	78.91	83.59
NC	-4.063*	-2.92*	101.45**	81.11	-3.94*	-2.23**	95.85**	53.40
ND	-7.48*	-6.93*	116.29*	113.38*	-5.64*	-3.93*	118.54*	58.36
NV	-5.08*	-1.91**	128.58*	255.87	-3.88*	-3.05**	119.29*	29.38
INR	-3.27*	-1.79**	83.68***	61.99	-1.52***	-0.31	63.12	70.90
UN	-8.68*	-7.82*	190.76*	128.25*	-11.59*	-8.33*	209.56*	82.31

***Note:** [1]Levin, Lin & Chu t, [2]Im, Pesaran and Shin W-stat, [3] ADF - Fisher Chi-square, [4] PP - Fisher Chi-square. Note: 1%, 5%, and 10% significance level is denoted by *, **, and ***.*
***Source**: Research findings.*

3. 3. Research Methodology

Quantile regression is on account of symmetric and asymmetric loss functions and is similar to the estimation of parameters in the ordinary least squares (OLS) regression. Unlike the OLS method, the quantile regression method introduced by Roger Koenker & Bassett Jr (1978) examines the final effect of descriptive variables on the dependent variable at different distribution points and not just the mean. In other words, the method for estimating OLS regression pattern parameters is based on minimizing the square of the pattern deviation residuals. In quantile regression, unlike OLS regression, the minimization of the absolute value of the weighted residuals is used to estimate the pattern parameter, which is called the Least Absolute Deviations (LAD) method (Roger Koenker & Bassett Jr, 1978; Powell, 1984). The LAD method has advantages over the conventional least-squares method, including being more resistant to outliers and less sensitive to them since, in this method, only the

residuals' signs are considered. In addition, the estimations are resistant to the abnormality, and quantile regression is more efficient than ordinary least squares regression when there is heterogeneity in observations (Khoshgooyan Fard, 2005; Mohammadzadeh Asl et al., 2017).

The general definition of quantile regression states that if the linear regression model is assumed as the following equation, we have:

$$y_i = {}'x_i\beta_\tau + u_{\tau i}.\ 0 < \tau < 1 \quad (3)$$

$$Quant_\tau(y_i|x_i) = x_i\beta_\tau \quad (4)$$

Equation (4) shows the τth conditional quantile function of the y distribution under the condition of random variables x in which the following condition holds:

$$Quant_\tau(u_{\tau i}|x_i) = 0 \quad (5)$$

In the quantile regression structure, the effect of observable features on the conditional distribution is estimated by minimizing the absolute value of the error element. To estimate the model coefficients, the absolute value of the errors with appropriate weighting is used:

$$Min\ \Sigma_{y_{i\geq {}'x_i\beta}}\tau|y_i - {}'x_i\beta| + \Sigma_{y_{i<{}'x_i\beta}}(1-\tau)|y_i - {}'x_i\beta| \quad (6)$$

As mentioned, quantile regression is resistant to outliers. However, this method is not intended to recognize the heterogeneity of a country. In this research, the quantile panel regression method with fixed effects is used, which makes it possible to estimate the effects of conditional heterogeneous covariance of inflation rate stimuli, thus controlling invisible individual heterogeneities. Consider the quantile panel regression model with the following fixed effects:

$$Q_{y_{it}}(\tau_k|\alpha_i.x_{it}) = \alpha_i + {}'x_{it}\beta(\tau_k) \quad (7)$$

The estimator will be inconsistent if several units are infinitely inclined, but some observations are constant for each cross-sectional unit. A suitable method has been suggested by Koenker (2004) for solving such problems. He considers invisible fixed effects parameters jointly estimated with auxiliary variables' effects for different quantiles. The unique feature of this method is that it introduces a penalty term in the minimization to address the computational problem of a set of parameters; The parameters are calculated as follows:

$$min_{(\alpha.\beta)}\Sigma_{k=1}^{K}\Sigma_{t=1}^{T}\Sigma_{i=1}^{N} w_k\rho_{\tau k}\left(y_{it} - \alpha_i - x_{it}^{T}\beta(\tau_k)\right) + \lambda\Sigma_i^N|\alpha_i| \quad (8)$$

In Equation (8), i represents the number of countries (N), T represents the index for the number of observations of each country, K represents the quantile index, x is the matrix of explanatory variables, and $\rho_{\tau k}$ is the quantile loss function. Also, W_k represents the relative weight for the kth quantile. λ is an adjustment parameter that reduces individual effects to zero to improve the performance of β estimates. If λ tends to zero, the penalty term is eliminated, and a conventional fixed effects estimator is obtained. Whereas if λ tends to infinity, an estimate of

the model is obtained without fixed effects. In this research, $\lambda = 1$ (Damette & Delacote, 2012).

4. Empirical Results

As mentioned in Section 3, the present research is based on the quantile panel regression model with fixed effects. Thus, before addressing the primary model, we examine the diagnostic tests of the ordinary least squares panel model. The Redundant Fixed Effects Test is the first test to determine if a model is fixed or pooled. Since the probability of this test is below 1% (Cross-section Chi-square = 126.672), the null hypothesis indicating that the model is pooled is rejected, and the model is confirmed with fixed effects. The second test to determine whether a model is random or pooled is the Lagrange Multiplier Test for Random Effects. The null hypothesis of this test, indicating that the model is pooled, is rejected at the level of 1% (Cross-section = 3019.181), and random effects confirm the model. We refer to the Hausman Test to determine whether the model is fixed or random. The null hypothesis of this test also indicates that the model is random at the 1% level, and finally, the model with fixed effects is confirmed (Cross-section random = 14.553). After proving the stability of the model in the ordinary least-squares method, we examine the effect of Covid-19 disease on the inflation rate in OECD member countries by quantile panel regression. The introduced model was estimated in different quantiles (0.90, 0.80, 0.70, 0.60, 0.50, 0.40, 0.30, 0.20, 0.10), and the results are presented in Table (5). Also, the results obtained from the OLS method estimation are reported in the last column of Table (5) for comparative analysis. The coronavirus outbreak caused the world economy to undergo many changes, including a significant reduction in GDP. Many activities were also curtailed, and passenger transport services suffered significant losses as travel was reduced.

NC at all quantile levels from 10% to 90% significantly negatively affects the inflation rate in OECD member countries. As shown in Figure (2), the effect of the number of new cases (NC) of Covid-19 on the inflation rate has an almost constant trend. The interpretation of the sizes of the coefficients per quantile is similar to the OLS regression. For example, in the 50% quantile, the inflation rate decreases by 0.339% for every 1% increase in the number of new cases of the Covid-19 virus. The problem can be analyzed so that with the increase in the number of patients and the consequent decrease in economic activities due to coronavirus restrictions, the economy will enter a recession, and the inflation rate will decrease. The number of new deaths (ND) due to Covid-19 has a dual effect on the inflation rate in OECD member countries. In quantiles of 10%, 20%, 30%, 40%, 80%, and 90%, ND has a significant negative effect on the inflation rate, but in quantiles of 40%, 50%, and 60%, new deaths from coronavirus have a significant positive effect on the inflation rate in OECD member countries. The

OLS model also confirms the significant negative effect of ND on the inflation rate.

Figure (2) shows the effect of ND on the inflation rate as almost constant as NC. The number of new vaccines (NV) injected at all levels of 10% to 90% significantly positively affects the inflation rate in OECD member countries. The OLS method confirms this significant positive effect. With the increase in the number of people vaccinated, business restrictions, which are more severe in European countries, have been removed, and the global economy can escape the recession and the Corona crisis; New investments are also happening, and employment rates are rising; Especially the global trade which has suffered a great deal is largely recovered. The distribution of corona vaccines also increases the demand for various industries. New investments are a form of demand in the factory industries and basic goods; production capacity increases, and the need for medical equipment such as masks, supplies, and equipment is reduced; and the resources used for this type of products can be used for other goods. Unemployment (UN) has also had a very significant negative effect on the inflation rate in the OECD member countries at all levels of the various quantiles and the OLS model. In the short term, inflation and unemployment have an inverse relation, so inflation decreases with increasing unemployment. Unemployment has also risen during the corona crisis due to the recession of the OECD member economies and has had a negative impact on inflation.

Figure (2) also shows that the effect of unemployment on inflation is constant. The interest rate (INR) has a significant positive effect on inflation at all levels. According to the theoretical foundations of economics, interest and inflation rates tend to be inversely correlated. This relationship is one of the main principles of current monetary policy. In general, with lower interest rates, more people can borrow more money; as a result, consumers have more money to spend. This will boost the economy and increase inflation. The reverse is true for rising interest rates. With increasing interest rates, consumers tend to save money because the returns on savings are higher. With the lower cost of disposable income, the economy enters a recession, and inflation decreases. Nevertheless, this research has a significant positive relationship between inflation and interest rates. That is, with the increase in interest rates, the inflation rate has also increased. In the economic literature, the most well-known relationship between interest and inflation rates in the long term is the Fisher relationship, which states that apparent interest rates are always related to inflation rates in the economy. Naturally, this relationship can have a bilateral cause, and therefore research on this issue has been one of the economists' concerns for many years. Interestingly, the vast majority of studies consider the causal relationship between inflation rate to interest rate and believe that people adjust interest rates and consider the effect of inflation by considering the past inflation rate and rational expectations from future inflation rates.

In other words, in the long term, inflation determines the interest rate, not the other way around. On the other hand, Taylor's rule in economics, proposed as a

simple rule of thumb formula for central banks, recommends using money market instruments, i.e., short-term interest rate changes are used to reduce inflation in the short term. This rule states that if inflation is higher than the target value, the interest rate should be "increased"; if it is below the target value, it should be "reduced" to increase inflation. In other words, Taylor's rule states that short-term interest and inflation rates move in opposite directions. It is not difficult to understand why lower interest rates do not have a decreasing effect on inflation. For this case, it is enough to look at the drawbacks of the argument in favor of this relationship. Those who advocate a policy of reducing interest rates to reduce inflation argue that since lowering interest rates increases production, it has an anti-inflationary effect. This argument is flawed both in the premise and the macro-output. The first mistake is that based on the supply and demand situation of financial resources, reducing interest rates to previous values does not have any positive effect on the increase of production, but also it reduces the production. Even at high-interest rates, banks lend their financial resources to companies applying for loans, indicating sufficient demand for industrial investment even at this rate. Reducing interest rates to lower levels will only force weaker companies to join loan applicants, thus reducing the average quality of loan recipients. With a fixed number of financial resources and a lower chance of success for the loan recipient, not only will the production not increase but also it is expected to decrease. The second mistake is that this policy aims to control inflation, a monetary phenomenon resulting from a significant injection of new liquidity into society by increasing industrial production by a few percent. The third mistake arises when the discussion of inflation, a persistent phenomenon in the economy and related to annual changes, is confused with the discussion of changing the cost price (due to changes in the cost of financial equipping of enterprises). Inflation is a phenomenon that shows an annual continuous growth of prices, while a decrease in interest rates (in the most optimistic case) causes a drop in the cost price of one year, and its effect stops in the same year. The final mistake is ignoring lower interest rates' effect on consumer behavior. Reducing interest rates encourages people to consume in the current period, increasing demand and pressure on the supply side. Suppose the economy's activity is below its capacity. In that case, this will increase production, and if the economy faces supply constraints, the pressure of demand will only increase the level of prices (inflation rate). Thus, the assumption of a rising inflation rate due to rising interest rates is neither causally valid in the long term nor suggests the right direction in the short term.

Table 5. Panel Quantile Regression

Variable	Quantiles									OLS
	10th	20th	30th	40th	50th	60th	70th	80th	90th	
NC	-0.035 (-3.33)**	-0.0096 (-4.31)*	-0.0012 (-5.67)*	-0.206 (-3.21)**	-0.339 (-4.40)*	-0.300 (-2.14)**	-0.297 (-3.069)*	-0.220 (-2.52)**	-0.104 (-2.05)**	-0.049 (2.517)**
ND	-0.130 (-4.71)*	-0.119 (-5.52)*	-0.139 (-1.053)	-0.023 (-2.53)**	0.029 (2.630)*	0.005 (2.836)*	0.022 (4.156)*	-0.011 (-3.413)*	-0.0012 (-3.078)*	-0.315 (-4.18)*
NV	0.221 (2.526)**	0.221 (4.023)*	0.219 (4.014)*	0.264 (4.618)*	0.267 (4.933)*	0.249 (4.166)*	0.231 (4.247)*	0.224 (5.028)*	0.363 (4.680)*	0.137 (3.818)*
INR	0.425 (2.971)**	0.456 (6.422)*	0.519 (10.637)*	0.508 (10.472)*	0.534 (10.443)*	0.533 (8.101)*	0.527 (6.660)*	0.602 (3.137)*	0.639 (5.485)*	0.042 (8.160)*
UN	-0.126 (-1.95)**	-0.121 (-2.72)*	-0.146 (-3.964)*	--0.130 (-3.538)*	-0.119 (-2.706)*	-0.097 (-2.05)**	-0.083 (-2.07)**	-0.020 (-3.232)*	-0.159 (-3.017)*	-0.244 (-4.80)*
C	-0.889 (-2.39)*	-0.858 (-4.58)*	-0.215 (-6.352)*	0.828 (10.423)*	2.037 (13.371)*	2.096 (17.107)*	2.373 (15.559)*	1.909 (10.852)*	-1.534 (10.852)*	3.576 (2.967)*
Obs.	610	610	610	610	610	610	610	610	610	610

Note: *1%, 5%, and 10% significance level is denoted by *, ** and ***. () shows the t-Statistic.*
Source*: Research findings.*

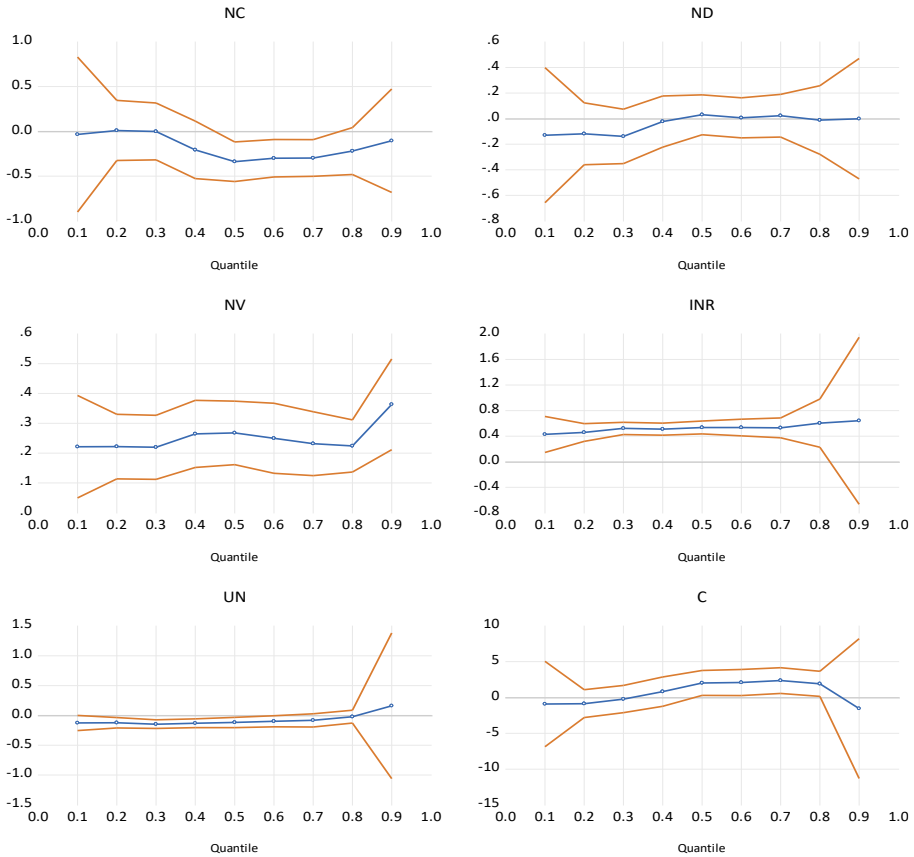

Figure 2. Panel quantile regression coefficients. Note:
Source*: Research findings.*

Finally, inter-quantile tests should be used to check the heterogeneity of parameters. Quantile tests have been developed to examine whether the estimated coefficients' differences are significant. According to the studies of Koenker & Bassett (1978), the Wald test is used to examine the equality of slopes between quantiles. The hypothesis of this test is whether the model in the lower quantiles (which is 25% in this study) is similar to that in the middle (50%) and upper (75%) ones. Table (6) shows the results of the coefficient equality test between the lower and upper quantiles. Given the probability value in the Wald test, the null hypothesis of symmetry of the results is confirmed except for NC and UN. In other words, the effect of NC and UN variables on the inflation rate was asymmetric, and the effect of other variables was symmetric.

Table 6. Wald test for the equality of slopes.

	0.25 against 0.50 quantile		0.75 against 0.50 quantile	
	Test statistic	p-value	Test statistic	p-value
NC	0.299**	0.027	-0.0175***	0.071
ND	-0.132	0.160	-0.037	0.665
NV	-0.030	0.547	0.041	0.385
INR	-0.039	0.428	0.027	0.711
UN	-0.0174***	0.056	-0.098**	0.048

Note: *1%, 5%, and 10% significance level is denoted by *, **, and ***.*
Source*: Research findings.*

5. Concluding Remarks

Covid-19 has changed various aspects of the world economy. One of the aspects which the Covid-19 pandemic affected is the inflation rate. As one of the most important macroeconomic variables, inflation affects all aspects of the economy, including consumer spending, trade investment, interest rates, employment rates, government programs, and monetary and fiscal policies. The coronavirus shocked the world in 2019. The virus has damaged all aspects of human life, including the economy. Therefore, this study investigates the effect of the Covid-19 pandemic on the inflation rate in 36 members of OECD countries. Monthly data from February 2020 to August 2021 and the quantile panel regression method have been employed. This study found that new confirmed COVID-19 cases and new vaccination positively affect the inflation rate in OECD. Increased uncertainty in the economy due to the prevalence of the Coronavirus and reducing the economic constraints caused by vaccine injection and consequently increasing demand, respectively, can be the causes of a positive impact of new confirmed COVID-19 cases and new vaccination on inflation. However, new death cases have a dual impact on the inflation rate. By increasing Covid-19 deaths, business restrictions have increased, the economy has entered a recession, and inflation has decreased. Conversely, the growth of Covid - 19 casualties could increase economic uncertainty and inflation. As is evident, the effect of Covid-19 on the inflation rate in OECD member countries is dual. This paper's result is in line with Eichenbaum et al. (2020), Altig et al. (2020),

Anderson et al. (2020), and Coibion et al. (2020) that belief during the Covid-19 pandemic inflation rate has fallen due to lower household spending and lower demand due to lower incomes and wealth. Moreover, the result of this study is in line with Jaravel & O'Connell (2020), Seiler P. (2020), and Blundell et al. (2020) that faith due to rising production costs, rising government spending, rising uncertainty about the future, the Covid-19 has had a positive impact on the inflation rate. Consequently, with respect, the following policy recommendation is advised to OECD policy-makers:

- Adopting combined fiscal-monetary policy to avoid turning the Covid-19 crisis into an even greater magnitude and severity economic recession.
- Utilized combined fiscal-monetary interventions that can mitigate the impact of the pandemic on inflation and help to establish a more rapid recovery to pre-crisis levels of activity.
- Increasing vaccine injections, especially booster doses, to increase economic activity and prosperity in the economies of OECD countries.

Author Contributions:

Conceptualization, all authors; R.A. prepared the introductory and methodological sections of the paper, performed the full empirical analysis of the paper, collected data, provided software and was a major contributor to writing the manuscript. S.G. provided a review of the empirical literature and a conclusion. K.A. interpreted the preliminary analysis and empirical analysis. All authors read and approved the final manuscript

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The authors declare no conflict of interest.

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