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The Fight Against COVID-19 in Europe: The Effects of Vaccination on the Economy

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Avrupa'da Kovid-19 ile Mücadele: Aşılamanın Ekonomiye Etkileri

Öz

COVID-19, 2019 yılı sonlarında ortaya çıkan ve 2023 yılı Eylül ayı itibarıyla dünya çapında yaklaşık 6,9 milyon insanın ölümüne neden olan bir salgındır. Pandeminin ekonomiye de olumsuz etkileri olmuştur. Çalışmanın amacı COVID-19 aşılarının ekonomik göstergeler üzerindeki etkisini belirlemektir. Çalışmada, ARDL modeli ve PMG tahmincisi kullanılarak 2021:01-2022:01 dönemi için 28 Avrupa ülkesinin aylık COVID-19 aşı sayıları ile ihracat, ithalat, enflasyon ve işsizlik değişkenleri arasındaki ilişki incelenmiştir. Analiz bulgularına göre, ihracat ve ithalatın aşılanan kişi sayısıyla istatistiksel olarak anlamlı bir ilişkisi olmadığı görülmüştür. Ancak aşılanan kişi sayısı artıkça enflasyonun arttığı, işsizlik oranının ise azaldığı belirlenmiştir. Sonuç olarak, aşılamanın ekonomik göstergeleri olumlu etkilediği belirlenmiştir.

Anahtar Kelimeler: Uluslararası İktisat, Uluslararası Ticaret, Enflasyon, COVID-19, İstihdam

Makale Türü: Araştırma Makalesi

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Abstract

COVID-19 is an epidemic that emerged in late 2019 and has killed approximately 6.9 million people worldwide as of September 2023. The pandemic also had negative effects on the economy. The aim of the study is to determine the impact of COVID-19 vaccines on economic indicators. In the study, the relationship between monthly COVID-19 vaccination numbers and export, import, inflation and unemployment variables of 28 European countries for the period 2021:01-2022:01 was examined using the ARDL model and PMG estimator. According to the analysis findings, it was seen that exports and imports did not have a statistically significant relationship with the number of vaccinated people. However, it has been determined that as the number of vaccinated people increases, inflation increases and the unemployment rate decreases. As a result, it has been determined that vaccination positively affects economic indicators.

Keywords: International Economics, International Trade, Inflation, COVID-19, Employment

Paper Type: Research Article

1. Introduction

The COVID-19 epidemic emerged in late 2019 and became a global pandemic in 2020. The tools for combating this epidemic included quarantine, masks, social distancing, travel restrictions, etc. Although precautions were taken, the spread could not be prevented (Pieroni et al., 2021: 1). With the emergence of the epidemic, many scientists started vaccine studies. At the end of the studies, the vaccine produced by Pfizer-BioNTech became the first COVID-19 vaccine to be approved (FDA, 2021). Today, there are 50 approved vaccines approved worldwide, but only 11 of them have been approved for emergency use by the World Health Organization. (VIPER, 2023; Chi, et al. 2022: 2). The Vaccination

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process started rapidly, and a visible decrease in the number of cases, deaths, and hospitalizations occurred in a short time (Antonini et al., 2022: 1). With the influence of globalization, vaccines have rapidly spread around the world, and as a result, the decrease in the number of cases and deaths has brought about normalization (Lupu and Tiganasu, 2022: 6). Strict quarantine and closure measures implemented around the world have been relaxed, and travel restrictions have begun to be lifted. As a result of vaccination, community immunity has begun to be gained, and with the restrictions being lifted, economic activities have begun to be carried out as they were in the pre-epidemic period.

A limited number of studies have examined the economic effects of vaccination. However, there has been no study which specifically measures the effect of vaccination policy on economic variables. This study's purpose is to enrich the literature about the vaccination policy's effect on economic variables and contribute to this literature. The study of Khalfaoui et al., (2021) examined the relationship between the daily number of COVID-19 patients, deaths, and vaccinations and the daily US stock market index return. Their study concluded that there is a positive relationship between the number of COVID-19 vaccinations, deaths, and cases and the return of the S&P 500 index. Antonini et al. (2022) which examined the effects of the COVID-19 vaccination policy in France, Israel, Italy, and Spain demonstrated that the number of administered vaccines has caused to decreased unemployment rates in these countries. In the study of Guo et al. (2022) the relationship between the USA's per capita national income and unemployment rate and the COVID-19 vaccination rate was examined at national level for the period between January 2021 and July 2021. Their study found out that both per capita income and unemployment rates had a positive relationship with the COVID-19 vaccination rate. Similarly, Ren and Zheng (2023) examined the relationship between household savings and the number of COVID-19 vaccinations in the USA. The result of their study shows that there is a negative relationship between the number of COVID-19 vaccinations and household savings, and thus the COVID-19 vaccination policy affects expenditures positively and unemployment negatively. The study of Hansen and Mano (2023) examined the relationship between the COVID-19 vaccination rate and expenditures and unemployment rates in the USA. they study illustrates that when the first dose COVID-19 vaccination rate increased by 1 percent, expenditures increased by 1.3 percent. It was observed that the unemployment rate decreased by 0.09 percent. Similarly, Ahangar and Prybutok (2023) examined the relationship between the economic effects of the epidemic and the vaccination rate for 85 countries. Their paper manifest that countries with high gross domestic product growth rates and competitiveness indexes have low inflation/vaccine rates. In short, their results emphasize that the negative economic effects of the epidemic decreased as the vaccination rate increased. Therefore, this study can be considered a novel contribution as to the effect of vaccination policy on selected economic variables.

This study aims to provide an answer as to how the vaccination policy affects economic variables in the short and long terms. In related literature, there are a few papers that consider this question. Nevertheless, there is no paper which directly deals with the effects of vaccination policy on selected economic variables. Due to this reason, this paper aims to make a novel contribution in this regard. This article is an exploratory research because it examines a new topic which has not been studied before, thus the results of this study can be a pioneer for further research in this field. (Neuman, 2014: 38). The basic hypothesis of this paper is that the progress of vaccination effect on positively on economic variables.

This study primarily examines whether the vaccination process affects economic variables using a sample of 28 European countries. For this purpose, the panel ARDL model PMG estimator was used to determine whether the number of vaccine doses administered in 28 countries impacted inflation, export, import, and unemployment variables. The hypothesis of the study is the expectation that vaccine administration will positively affect economic variables. In the first part of the study, the concise information is given about the emergence of the COVID-19 epidemic and its economic effects. The second section introduces the data set and method used, and then the analysis results are explained. Research questions are answered in the last part of the study, and policy recommendations are suggested in light of the findings.

2. COVID-19 Outbreak and Its Economic Effects

The COVID-19 pandemic emerged in Wuhan Province, China, towards the end of December 2020. The epidemic, which initially emerged around Wuhan's seafood and animal market, Spread to the world from there at an unpredictable pace. The epidemic, which spread with significant momentum quickly, was named COVID-19 by the World Health Organization (WHO) on 12 February 2020 and was accepted as an epidemic on 11 March 2020 (Zhou et al., 2020:2-3).

The virus constantly mutated and initially spread rapidly throughout the world. However, the epidemic has lost its speed due to the closing of borders, lockdowns, mask and distance practices implemented by countries, and especially the effect of vaccination. As of 6 May 2023, the epidemic has ceased to be a global emergency (WHO, 2023). While the total number of cases worldwide is approximately 770 million as of 6 September 2023, this figure is approximately 18 million in Turkey, 90 million in America, 30 million in France, and around 28 million in Germany and England. The number of people who died due to COVID-19 worldwide is 6.9 million.

In the early period of the pandemic, when the effective treatment method was not yet known, countries took various measures and imposed restrictions to prevent the spread of the virus (Ahsan et al., 2022: 2). In order to ensure social isolation and thus reduce the spread of the virus, some measures have been implemented such as curfews, interruption of education, limitation of entry and exit from countries and international trade, closure of factories, restaurants, restaurants and markets, suspension of workplace activities, etc. Measures such as these have profoundly affected every aspect of life and economic activities. The pandemic's effects on the economy are so significant that a report published in cooperation with the World Trade Organization (WTO) stated that the effects are more profound than the 2008-2009 Global Economic Crisis (WHO, 2021). Thus, in addition to creating a global health crisis, COVID-19 has also caused an economic crisis.

The economic crisis that emerged with the COVID-19 pandemic was sudden and unexpected. This situation experienced in the economy in the early period of the epidemic was generally caused by the contraction of supply and demand together. Due to the imposed restrictions, the functioning of the global supply chain has been negatively affected. Considering the impact of globalization, it would not be inaccurate to say that this negativity in the global supply chain is observed in the economies of almost every country (Cinel, 2020: 5). In this context, world trade in goods shrank by 5.3 percent in quantity in 2020 and decreased from 18.35 trillion dollars to 17.0 trillion dollars (Gürlesel, 2020).

Again, in the early period of the epidemic, many global organizations suspended their production which caused a contraction in supply and an increase in unemployment rates. The job loss in 2020 was 114 million compared to 2019 before the crisis, and the global labor force participation rate decreased by 2.2. With this increase in unemployment rates, global working hours decreased by 8.8% in 2020. This reduction is equivalent to 255 million full-time jobs and is four times greater than the loss experienced in the 2008-2009 Global Crisis. (WHO, 2021: 20).

During the epidemic, an increase far beyond the estimates made for the number of low-paid people in the world was observed and between 119-124 million people became low-paid (WHO, 2021: 3). As a result of all these developments, a contraction in demand was inevitable and losses in the country's revenues occurred that cannot be ignored (Özatay and Sak, 2020: 2). Governments have developed various policies and support packages to alleviate the effects of the economic crisis and prevent more remarkable collapses. These practices have caused budget deficits to increase, and therefore, there have been significant increases in inflation rates, especially in developing and underdeveloped countries (WHO, 2021: 66).

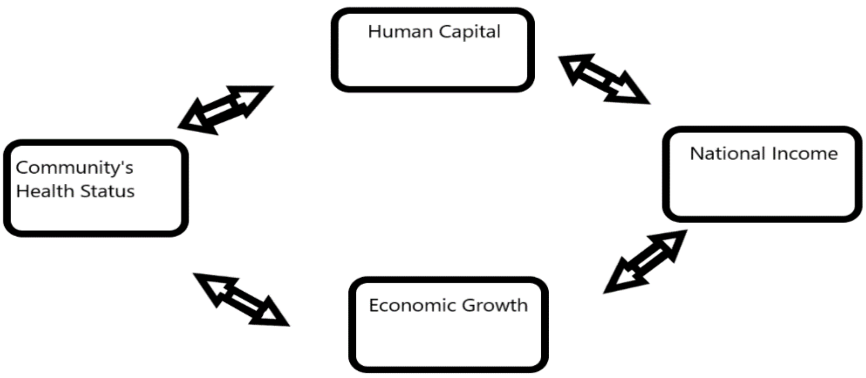
Effective treatment methods were researched soon after the start of the COVID-19 pandemic, and vaccine studies were launched. Restrictions have been gradually reduced with the implementation of vaccines that have been successful and authorized for use. With life being integrated into the new normal, economic activities have also entered the recovery process. The health crisis is resolved as vaccination rates increase and societies gains immunity. However, the economic effects have been observed to continue for a while.

As can be seen, the COVID-19 pandemic has caused a significant economic crisis. Vaccination is the most effective known way to combat the epidemic (Mohanty et al., 2021: 238; Chen et al., 2022: 386). Therefore, it can be safely claimed that the vaccine also has a healing effect on the economic crisis.

3. Theoretical Framework

The health and the economy have complex and two-way relationships (R. J. Barro, 2013: 329). In the literature, there is a consensus that not only the health affects the economy, but also the economy affects the health. Economic growth is frequently boosted by better health in various ways (Mayer, 2001: 1025). Economic growth also drives additional investments in health capital. The overall relationship scheme can be seen in Figure 1. However, in this study the only one part of these relationships, which is the way the health status affects the selected economic variables, will be examined in accordance with the research question of this study.

Figure 1. The Relationships between the Selected Health-Related and Economy-Related Variables



Adapted from D. Bloom & Canning, 2003; D. E. Bloom et al., 2018; Smith et al., 2020

According to Figure 1, when the community's health status increases, human capital quality also increase. When the quality of human capital increases, capital becomes more productive (Erçelik, 2018: 1). As a result of this, the national product increases, and national income also rises. Raises in national income levels also bring about raises in economic growth. With rising economic growth, unemployment and inflation rates will be expected to fall, and export and import volumes will rise. Lastly, high economic growth can bring about the ability of more spending levels in the health sector. This cycle can determine which country could be affluent or less affluent. Improving health status can help to create economic growth and economic development. For example, in some low-income areas, particularly in sub-Saharan Africa, the prevalence of disease presents a significant obstacle to economic development (Malik, 2006: 1).

Health status affects economic relations through two basic elements which are increases in productivity (R. J. Barro, 2013; Costa, 2015) and life expectancy (Preston, 1975; Smith et al., 2020). Additionally, better health affects economic relations through three different mechanisms: 1) Healthier workers are more productive because they are stronger and better able to perform physically demanding occupations (D. Bloom & Canning, 2003: 305; Wu et al., 2021: 1); 2) Healthier students benefit more from their time in school and students desire to spend more time in school (Bleakley et al., 2014: 128); 3) Governments can save more money when their citizens have excellent health conditions which results in rises in the country's savings (Suhrcke et al., 2006: 997). The first mechanism is defined as a direct effect on health on output, and the second and third ones are defined as an indirect effect on output (Malik, 2006: 2).

According to neoclassical theories, capital works with diminishing returns. The neoclassical model's definition of capital can be expanded to include human capital in the forms of education, experience, health, and physical products. Notably, endogenous growth theories focus on advancements in productivity under the favor of technological progress and increased human capital with education Therefore, in the related literature the impact of the health has been neglected so far. However, mainly, the emergence of the pandemic and the lack of health services in countries with low economic growth performances highlighted the importance of relationships between the health and the economy and the subsequent literature. In the study of R. Barro and Barro (1996), it was proven empirically that health status affects economic growth. According to their findings, early developments in the health sector may even be a more significant indicator of future economic growth than initial investments in the education sector. (R. Barro & Barro, 1996: 114).

The pandemic or diseases and their economic effect have been taken attention, especially with the emergence of COVID-19 pandemic. In the relevant literature, studies examining the effects of epidemics on the economy, such as those of the 1918 Spanish Flu (Beach et al., 2022; Correia et al., 2022), the 1968 H3N2 Influenza (Jinjarak et al., 2022), the HIV/AIDS pandemic (Gaffeo, 2003; Malik, 2006; Zinyemba et al., 2020) and examined different pandemics (Jordà et al., 2022) have been discussed. Pandemics could affect the aggregation of demand, supply, and production growth. Due to these affections, unemployment and inflation could rise, and exports and imports could decrease. The strength of these effects varies widely among nations, labor markets, and sectors (Buheji et al., 2020: 221). For instance, pandemics have an impact on investments and physical capital through intricate, interconnected, and frequently conflicting mechanisms, leaving long-term consequences unclear and typically marginal and non-linear (Callegari & Feder, 2022: 185).

One of the main effects of the pandemic on economics can be traced on labor supply. The fraction of healthy persons will decline if these disorders have deadly consequences, decreasing the amount of labor available. The affected population remains in the labor force when the diseases have non-fatal outcomes, but their productivity is substantially reduced (Malik, 2006: 4). Pandemics also negatively affect human capital because education must stop (Callegari & Feder, 2022: 185). This effect could be seen in the long-term economic growth.

Vaccination against the pandemic is the best weapon in the hands of human beings. Producing vaccines against diseases or epidemics has emerged thanks to scientific progress. Except for the COVID-19 pandemic, vaccines could not be used publicly (Correia et al., 2022: 920). Therefore, the question of how the vaccination policy will affect economic variables during the pandemic is difficult to answer. Nevertheless, many countries have only allowed a vaccinated person to enter their country during COVID-19. This helped the volume of tourism and international trade to reach the same level as before pandemic period. In short, health expenditures positively affect the level of output by increasing the efficiency of the economy. The vaccination policy implemented during epidemic periods should also be considered in this context.

4. Data Set, Method and Findings

In this study, the monthly data of 28 European countries for the period between 2021:01 and 2022:01 were used[2]. Inflation, unemployment rate, and export and import volumes have been chosen as dependent variables. The reason for including the unemployment rate is the fact that pandemics have dramatically affected the labor market (Callegari & Feder, 2022: 186; Correia et al., 2022: 919). The inflation rate is also a critical variable, especially during a pandemic. The COVID-19 pandemic has disrupted the global value chain. As a result, inflation has gone high globally in the pandemic era (Buheji et al., 2020: 213). Trade has an essential role in today's globalized world economy. Due to global trade, the world economy has been more integrated and has created more economic growth. Pandemics and measurements against pandemics have interfered with trade relationships worldwide, and thus, it has decreased economic growth.

The data on the rates of unemployment and inflation included in the study can be found on the website of the European Statistical Office (Eurostat). There are two reasons for choosing these 28 countries. The first one is that the data on vaccination could only be obtained for these countries, and the second one is that the aim of this study is to examine only 28 European countries. Export and import data were taken from the World Trade Organization (WTO) websites. In addition, the number of people vaccinated monthly by country was obtained from the website of Our World in Data[3]. The data for unemployment and inflation are included in the study proportionally, export and import data are included in million US dollars, and vaccine data are included in the study as the number of vaccinated people. Since the data in the study consisted of different units and it was thought that it would be more appropriate to interpret the results flexibly, all variables were included in the analysis in their natural logarithmic values.

Panel data analysis was performed in the study. Four separate models were established using the panel ARDL model. Since it is aimed to examine the effect of vaccination on economic variables, the dependent variable in all models was determined as economic variables (unemployment rate, export, import, and inflation rate). The independent variable in all models used in the study is the number of individuals vaccinated in that country. The equational representations of the four models established in the study are given below.

Model 1: $Unem_{it} = \beta_0 + \beta_1 Vac_{it} + \varepsilon_{\text{it}}$ (1)

Model 2: $X_{it} = \beta_0 + \beta_1 Vac_{it} + \varepsilon_{\text{it}}$ (2)

Model 3: $M_{it} = \beta_0 + \beta_1 Vac_{it} + \varepsilon_{\text{it}}$ (3)

Model 4: $Inf_{it} = \beta_0 + \beta_1 Vac_{it} + \varepsilon_{\text{it}}$ (4)

In Equations 1,2,3 and 4, i = 1,.. N is the number of countries; t =1,…T represents the time period. β_0 represents the constant parameter and β_1 represents the explanatory variable parameter. Table 1 contains the descriptive statistics of the variables included in the study. There are 308 observations in all variables. From here, it can be understood that the study is a balanced panel.

[2] Countries included in the study are Turkey, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Republic of Cyprus, Lithuania, Latvia, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden and Norway.

[3] The website address from which the data was obtained is https://ourworldindata.org/COVID-vaccinations

Table 1. Descriptive Statistics

Variables	Obs	Mean	Std . Dev.	Min	Max
lvac	308	17.66503	2.105644	11.05753	21.97699
lunem	308	1.831154	0.4210038	0.7884574	2.850707
lx	308	8.975403	1.485053	5.141664	11.93154
lm	308	9.091739	1.278393	5.958425	11.77842
linf	308	4.716186	0.1302285	4.589142	5.446004

Table 2 includes the correlation matrix of the variables included in the study. Since the study attempts to examine the effect of vaccination on economic variables, the first column of the matrix is essential. According to Table 2, the unemployment rate is negatively related to vaccination; Exports, imports, and inflation appear to be positively related.

Table 2. Correlation Matrix

Variables	lvac	lunem	lx	lm	linf
lvac	1.0000				
lunem	-0.0815	1.0000			
lx	0.5664	-0.0469	1.0000		
lm	0.5923	-0.0035	0.9837	1.0000	
linf	0.0175	0.1114	0.1596	0.1682	1.0000

In panel data methods, it is crucial to determine whether the slope coefficient is homogeneous or heterogeneous. Homogeneity of the slope coefficients indicates that all units are identical, and heterogeneity indicates that the units are different; therefore, the slope coefficients must be different. Determining coefficient homogeneity is highly decisive regarding accurate and effective analysis results. Pesaran and Yamagata's Delta homogeneity test, widely used in the literature, was used to test homogeneity in the study. Pesaran and Yamagata's delta test is based on the standardized form of Swamy (1970) test (Pesaran and Yamagata, 2008: 51). Swamy test was also introduced to eliminate the shortcomings of the F test used to test homogeneity. The Pesaran-Yamagata test gives more effective results in data sets with fewer units (N) and less time (T) dimension compared to F and Swamy tests. To address this issue, the test has been standardized for use on large panels (Pesaran and Yamagata, 2008: 57). Equations 5 and 6 provide mathematical representations of the Pesaran-Yamagata Delta test. Equation 6 is the mathematical expansion of equation 5 arranged to be adapted to large panel data.

$$\hat{\Delta} = \sqrt{N}\left(\frac{N^{-1}\hat{S}-k}{\sqrt{2k}}\right) \quad \text{(Delta Test for Small Sample)} \qquad (5)$$

$$\tilde{\Delta}_{\text{adj}} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}-\text{E}(\tilde{z}_{iT})}{\sqrt{\text{Var}\,(\tilde{z}_{iT})}}\right) \quad \text{(Delta Test for Large Sample)} \qquad (6)$$

Hypotheses of delta test are as follows H_1: β_i= β (slope coefficient is homogeneous for all panels); H_1: β_i≠ β_J(slope coefficient is heterogeneous for some panels). Table 3 shows the delta test results. Accordingly, it is seen that the coefficients were homogeneous in all models except the model established for imports. Whether the coefficients are homogeneous or not is vital in determining which values will be interpreted in co-integration tests. If the slope coefficients are homogeneous, the group values in the co-integration test will be considered. Otherwise, panel values will be taken into account.

Table 3. Delta Test Results

Variables	lunem = f(lvac)	lx = f(lvac)	lm = f(lvac)	linf = f(lvac)
$\hat{\Delta}$	4.405	2.168	1.435	3.160
$\tilde{\Delta}_{\text{adj}}$	5.165	2.542	1.682	3.706
$\hat{\Delta}$ p -value	0.000	0.030	0.151	0.002
$\tilde{\Delta}_{\text{adj}}$ p-value	0.000	0.011	0.093	0.000

The nations, businesses, etc., that were analyzed using panel data different units could have a correlation relationship. This correlation relationship is called cross-section dependence. In analyses carried out with panel data, cross-sectional dependence is decisive for applying unit root and co-integration tests. If cross-sectional dependence is encountered in the analysis, it is necessary to apply second-generation unit root and co-integration tests. The existence of cross-section dependence in this study of Pesaran M. H. (2004) is due to the cross-section. It was examined with the Cross-Sectional Dependence (CD) test. The Ho hypothesis of the test is that there is no cross-sectional dependency, and the H1 hypothesis is that there is cross-sectional dependency. The equational representation of the CD test is as follows;

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \left(T\hat{\rho}_{ij}^2\right)\right. \qquad (7)$$

In Equation 7, N represents the units, and T represents the time dimension. $\hat{\rho}_{ij}^2$ represents the correlation between the residues of units i and j. Table 4 shows the results of the CD test performed for the variables used in the study. According to the CD test results, all variables have cross-sectional dependence. Therefore, second-generation unit root and co-integration tests need to be applied.

Table 4. CD Test Results

Variables	lvac	lunem	lx	lm	linf
CD Test Value	19.983	43.918	33.305	32.100	33.478
Prob.	0.000	0.000	0.000	0.000	0.000

The results may be biased if stationarity tests are performed without considering cross-sectional dependency. First-generation panel unit root tests do not take cross-sectional dependence into account. In case of cross-sectional dependence, it is necessary to apply second-generation panel unit root tests (Pesaran M. H., 2007: 266). Cross-sectional dependence was detected in the variables included in the study. The Pesaran (2007) CIPS panel unit root test was preferred in the study. If the Ho hypothesis of the test is (p> 0.05), there is no unit root, and the H1 hypothesis is (p <0.05), there is a unit root. Equation 8 shows the CADF regression.

$$\Delta y_{it} = \alpha_i + \beta_i y_{it-1} + \varphi \bar{y}_{t-1} + \sum_{j=0}^{q} \theta_{j+1} \Delta \bar{y}_{t-j} + \sum_{k=1}^{q} \omega_k \Delta y_{it-k} + \varepsilon_{it} \quad (8)$$

Here, $\bar{y}_{t-1}$is the average of the lagged levels of all N observations at time t and $\bar{y}_t$ is the first difference of the variables. After estimating the CADF regression for each unit, the CIPS (Cross-sectional) coefficient was calculated by averaging the t statistics of the β coefficient in the CADF model. Augmented IPS) statistics can be calculated using the following equation number 9:

$$CIPS = N^{-1} \sum_{i=1}^{N} CADF_i \quad (9)$$

Here $CADF_i$ are the Dickey-Fuller test statistics of the ith unit. In cases with cross-sectional dependency, this test gives more consistent and accurate results than the first-generation test. Table 5 shows the unit root test results. Accordingly, all variables are stationary at the I(0) or I(1) level.

Table 5. Unit Root Test Results

	Intercept	**Trend**	**Intercept**	**Trend**
	Level		**First Difference**	
lvac	-5,598*	-2,277*	-3,256*	-3,756*
lunem	-1,650	-1.697*	-3,322*	-3.846*
lx	2,587	-1.495	-4,742*	-2,550*
lm	-0.736	-0.710	-2.944*	-1,047*
linf	0.124	-0.083	-2,476*	-3,034*

In the unit root tests conducted in the study, it was seen that the variables in all models were stationary at their first differences. Therefore, it can be checked that whether there is a co-integration relationship between the series can be checked. With co-integration analysis, it can be examined whether the variables move together in the long run. It was determined that there was cross-sectional dependence in the variables included in the study. For this reason, the Westerlund co-integration test, the 2nd generation co-integration test that can be used in the presence of cross-sectional dependence, was applied in the study (Persyn and Westerlund, 2008: 232). The Ho hypothesis of the test ($p > 0.05$) is that there is no co-integration relationship between the series, and the H1 hypothesis ($p < 0.05$) is that there is a co-integration relationship between the series. The following is a possible representation of the test correction model's primary error:

$$\Delta Y_{it} = \delta_i' d_t + a_i \left(Y_{i,t-1} - \lambda_i' X_{i,t-1} \right) + \sum_{j=1}^{P_i} a_{ij} \Delta Y_{i,t-j} + \sum_{j=-q_i}^{P_i} \gamma_{ij} \Delta X_{i,t-1} + \mu_{it} \quad (10)$$

Equation 10 are d_t; $a_i$refers to the speed at which the system returns to equilibrium after an unpredictable shock. Y_{it}, presents the dependent variable and $X_{i,t}$ presents the vector of explanatory variables. In this system, average group statistics ($G_t$and G_α) can be calculated in three steps. In the first step, In the first step, γ_{ij} is obtained from Equation 10 by the least squares method for each horizontal section and μ_{it} is estimated. Second, the equation of $\hat{u}_{it} = \sum_{j=-q_i}^{P_i} \gamma_{ij} \Delta X_{i,t-1} + \mu_{it}$it is calculated. Then, the equation of $\hat{u}_{it}$is calculated in ΔY_{it}using $\hat{a}_i(1) = \widehat{\omega}_{ui} / \widehat{\omega}_{Ei}$. Newey-West (1994) long-term variance estimators are $\widehat{\omega}_{ui}$and $\widehat{\omega}_{Ei}$. Finally, the mean group statistic is calculated with the help of the following equation:

$$G_t = \frac{1}{N}\sum_{i=1}^{N}\frac{\hat{a}_i}{SE(\hat{a}_i)}, \quad G_a = \frac{1}{N}\sum_{i=1}^{N}\frac{T\hat{a}_i}{\hat{a}_i(1)} \tag{11}$$

SE in Equation 11 represents error coefficient. In order to calculate the panel statistics of $P_t$and P_α, firstly, the terms of $\Delta\tilde{Y}_{it}$and $\Delta\tilde{Y}_{i,t-1}$ terms are calculated as follows:

$$\Delta\tilde{Y}_{it} = \Delta Y_{it} - \delta_i' d_t - a_i(Y_{i,t-1} - \lambda_i' X_{i,t-1}) - \sum_{j=1}^{P_i} a_{ij}\Delta Y_{i,t-j} - \sum_{j=-q_i}^{P_i} \gamma_{ij}\Delta X_{i,t-1} \tag{12}$$

$$\Delta\tilde{Y}_{i,t-1} = \Delta Y_{i,t-1} - \delta_i' d_t - a_i(Y_{i,t-1} - \lambda_i' X_{i,t-1}) - \sum_{j=1}^{P_i} a_{ij}\Delta Y_{i,t-j} - \sum_{j=-q_i}^{P_i} \gamma_{ij}\Delta X_{i,t-1} \tag{13}$$

For the next step, partner error correction parameter needs to be calculated. Moreover, standard errors are obtained as follows:

$$\hat{a} = \left(\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{Y}_{i,t-1}^2\right)\sum_{i=1}^{N}\sum_{t=2}^{T}\frac{1}{\hat{a}_i(1)}\hat{Y}_{i,t-1}\Delta\tilde{Y}_{it} \tag{14}$$

$$SE(\hat{a}) = \left((\hat{S}_N^2)\sum_{i=1}^{N}\sum_{t=2}^{T}\frac{1}{\hat{a}_i(1)}\hat{Y}_{i,t-1}^2\right)^{\frac{-1}{2}} \tag{15}$$

Equation 15 $\hat{S}_N^2 = \frac{1}{N\sum_{i=1}^{N}\hat{\sigma}_i/a_i}$ expresses the standard error of the regression. Finally, the third statistic P_t is obtained by the equation of $P_t = \hat{a}/SE$ and the fourth statistic $P_\alpha$is calculated by $P_\alpha = T\hat{a}$. Table 6 shows the results of the co-integration test. Model 1 in the table represents the models established to examine the effect of COVID-19 vaccination on unemployment, model 2 on exports, model 3 on imports, and model 4 on inflation. According to the delta test results in Table 3, the coefficients in the model (model 3) regarding imports were found to be heterogeneous, while the coefficients in the other models were homogeneous. If the slope coefficients are homogeneous, Group values (G) will be considered in the co-integration test; Otherwise, it is necessary to interpret the Panel values (P). In the Westerlund co-integration test, if the p-value is less than 0.05, there is co-integration; In the opposite case, it is interpreted as not happening. According to Table 6, it was seen that there was a co-integration relationship between the variables in all models.

Table 6. Westerlund Co-integration Test Results

Statistics	Value	p- value	value	p- value	value	p- value	value	p- value
	Model 1		Model 2		Model 3		Model 4	
Gt	-9.168	0.00	-6,353	0.00	-4.794	0.00	-4,048	0.00
Ga	-6.32	1.00	-7.18	1.00	-7,549	1.00	-19,054	0.00
Pt.	-9,502	0.975	-21,547	0.00	-11,162	0.5	-8,498	0.999
Pa	-5,934	0.996	-15.97	0.00	-5.326	0.99	-7,131	0.947

In panel data, analysis can also be made when the variables are stationary at different levels. If the variables are stationary at I(0) and I(1) levels, the Autoregressive Distributed Lag model (ARDL) model can be used (Pesaran, Shin, and Smith, 2001: 290). However, if one of the variables is at I (2) level, ARDL analysis cannot be performed. The ARDL model was used in the study since all variables were stationary at the I (0) or I (1) level. In their study, Pesaran, Shin, and Smith developed the PMG (Pooled

Mean Group) estimator, which can be applied when using the ARDL model in series with co-integration relationships (Pesaran, Shin and Smith, 1999: 621). PMG probability estimators are used to estimate long-run coefficients. In short, for PMG to be used, the variables must be cointegrated. A basic ARDL (p, q) model in Equation 16 is as follows:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{it-j} + \sum_{j=0}^{q} \delta_{ij} x_{it-j} + \mu_i + \varepsilon_{it} \quad (16)$$

In Equation 16 $\mathrm{t} = 1,2 \ldots.\mathrm{T}, \mathrm{i} = 1,2 \ldots..\mathrm{N}, x_{it} = \mathrm{i}$. The group is the explanatory variable vector, μ_i =Fixed Effect Term is the coefficient λ_{ij} =of the dependent variable without lagging, δ_{ij} = represents the coefficient vector. Moving from ARDL analysis to Error Correction Model (ECM), in the period with any imbalance, it will show how long it is taken to turn to its own last balance aftershocks. ECM model is provided in Equation 17. Accordingly;

$$\Delta y_{it} = \phi_i y_{i,t-1} + \beta_i' x_{i,t} + \sum_{j=1}^{p-1} \lambda_{i,t-j} + \sum_{j=0}^{q} \delta_{j=0}' \Delta x_{i,t-j} + \mu_i + \varepsilon_{it} \quad (17)$$

Here, $\phi_i = -\left(1 - \sum_{j=1}^{p} x_{ij}\right)$, and i. Error Correction Term for Group represents $\beta_i = \sum_{j=0}^{q} \delta_{ij}$, I. The long-term coefficient for the group ($x_{ij} = -\sum_{m=j+1}^{p} \lambda_{im}$) is included in the model as $\mathrm{J} = 1,2 \ldots \ldots = \mathrm{p} - 1$, $\delta_{ij} = -\sum_{m=j+1}^{q} \lambda_{im}$, $\mathrm{J} = 1,2 \ldots \ldots = \mathrm{q} - 1$.

Table 7 includes the results of four ARDL models established with the PMG estimator to see the effect of COVID-19 vaccination on four economic variables. In this section, firstly, models were established with Mean Group (MG) and PMG estimators, and the selection between them was made with the Hausman test. The hypothesis of the Hausman test $H_0$is PMG, and H_1hypothesis is that MG estimator should be chosen. The analysis concluded that the PMG estimator should be selected in all four models.

According to the PMG model results, there was no statistically significant relationship between COVID-19 vaccination and exports and imports in the long term. A statistically significant relationship was determined between unemployment, inflation, and vaccination. In the long term, a 1 percent increase in COVID-19 vaccination reduces unemployment by 1.12 percent; It was observed to increase inflation by 0.18.

Error Correction Term (ECT) is the coefficient that shows how long it will take for the disturbances in the short term to be eliminated and the balance to be reached again in the long term. The ECT coefficient is expected to be statistically significant between 0 and -1. When the ECT coefficients of the established models are examined, it is seen that they are statistically significant in all four models. However, the coefficient has a positive sign in the model established for inflation. In other models, ECT coefficients were found to be both statistically significant and between 0 and -1. Accordingly, 26.19 percent of deviation from equilibrium for unemployment, 94.44 percent of deviation for exports, and 92.21 percent of deviation for imports will reach a former balance within one year.

To interpret the results economically, while there was no statistically significant relationship between vaccination and exports (model 2) and imports (model 3) in the long term, it was observed that this relationship existed in the short term. This may be because the ECT coefficients, which examine how long it takes for the balance to be regained in the short term, are very high. In other words, the shock experienced in exports and imports was overcome in a short time, and its effect was not reflected in the long term. This result parallels the findings of other studies such as Ateş (2022) and Bekkers and Koopman (2022). When we look at the results regarding unemployment (model 1), the results are parallel to expectations. Since economic activities increase as a result of vaccination, it is a natural result that unemployment also decreases. This finding parallels other studies' findings; when we look at inflation, it is seen that there is a significant effect in the long term but an insignificant effect in the short term. The long-term result is that vaccination increases inflation. The result obtained regarding inflation is similar to Hansen and Mano's results (2023).

Table 7. PMG Model Results

	Model 1		**Model 2**		**Model 3**		**Model 4**	
The Dependent Variable	**lunem (Unemployment)**		**lx (Export)**		**lm (Import)**		**linf (Inflation)**	
Hausman Test	0.68		0.49		0.59		0.92	
Selected Model	P.M.G.		P.M.G.		P.M.G.		P.M.G.	
	Coefficient	p- value	Coefficient	p- value	Coefficient	p- value	Coefficient	p- value
Long Term								
lvac	-0.1121	0.0000	-0.0015	0.8510	0.0026	0.7440	0.0180	0.0000
Short Term								
ECT	-0.2619	0.0000	-0.9444	0.0000	-0.9221	0.0000	0.2298	0.0000
D.lvac (-1)	-0.0128	0.2530	-0.0628	0.0000	-0.0784	0.0000	-0.0035	0.0000
c	0.9997	0.0000	8.6135	0.0000	8.4421	0.0000	-1.0004	0.0000

5. Conclusion and Discussion

This paper examines the different perspectives on the relationship between vaccination policy and the economy. There are a few papers the related literature, but none examine the direct effects of vaccination policy on economic variables. The aim of this exploratory study is to explore this novel topic which has not been studied so far, and to provide preliminary information so that descriptive and explanatory studies with more in-dept analyses can be conducted in the future.

The COVID-19 pandemic emerged as a health crisis but quickly turned into an economic crisis due to the globalizing world economy. In addition to the global value chain becoming important in world trade, the decrease in trade costs thanks to developing transportation and communication technologies has increased world trade volume and strengthened countries' trade ties. The strengthened trade ties of countries with the COVID-19 epidemic have brought about negative consequences for countries' economies. The pandemic caused negative economic effects such as an increase in unemployment, an increase in inflation rates, a decrease in exports and imports and budget deficits and so forth. These negative economic effects rapidly affected each other due to the countries' strengthening economic and commercial ties.

In order to reduce the spread of the epidemic, many countries have taken precautions such as quarantine, travel restrictions, closing borders, and banning the export of some products. Although these measures should be taken for human health, it can be said that they cause the economic effects of the epidemic to deepen. In the later stages of the pandemic, the vaccine against COVID was found and began to be rapidly implemented worldwide as a reflection of scientific progress. As many studies in the literature show, the epidemic has been controlled with the widespread use of vaccination, and today, the life before the epidemic has returned. With the effect of vaccination, economies have slowly started to return to their pre-pandemic normal. Within the scope of the study, it was examined how vaccination affects economies in terms of some economic variables.

According to the findings, the unemployment rate decreases as the number of administrated vaccines increases. It has been determined that the inflation rate increases when the number of administrated vaccines increases. Regarding these two variables, the findings coincide with expectations. Looking at the variable results regarding foreign trade, it has been determined that exports and imports did not have a significant relationship with the number of administrated vaccines. This might be the case because, as supported by some studies, the declines in international trade that occurred after the epidemic recovered rapidly in the short term, and the effect was not reflected in the long term. These results are so coherent with other research papers such as Antonini et al. (2022), Guo (2022), Maro (2023) and Ahangar and Prybudak (2023). Consequently, vaccination program can decrease the negativity on economic variables.

In light of the study findings, it can be said that the vaccination policy in the fight against COVID-19 positively impacts economies returning to their old normal. World economies that have returned to their old normal must quickly implement policies to compensate for the economic damage caused by COVID-19. In the globalizing world economy, just as the effects of the epidemic were seen on a global scale, it is clear that the economic recovery after the pandemic can also be seen globally. Therefore, taking coordinated and global economic measures is a necessity for the rapid recovery of the world economy.

Ethics approval and consent to participate

Not applicable.

Authors Contribution Statement

The contribution of the 1st author to the article is 100%.

Competing interest

The author declares no competing interests.

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