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Review Article

What are the Causes of Variation in Vaccination Rates Between Countries? Empirical Evidence from a Set of Developed and Developing Countries

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Abstract:

Over two years, the Coronavirus pandemic radically changed the worldwide people's lifestyles and widely affected the socioeconomic environment. However, the development of new vaccines against covid-19 seems to be the first and only hope to mitigate this pandemic and go back to normal life. Several mass vaccination campaigns have been planned to vaccinate as many people as possible. Nonetheless, a wide range of people did not take their vaccines for hesitancy reason of the inequality of disturbance of vaccines. Hence, focusing on the macroeconomic factors, this study outlines the primary causes of the gap in vaccination rates between countries, specifically between developed and developing countries. The results provide interested insights: GDP has a positive and significant effect on the vaccination rate. However, the rural population rate negatively affects the vaccination rate. It is noteworthy that a more equitable disturbance of vaccines is required. Moreover, mass media campaign should be omnipresent to encourage people, particularly in rural zones, to obtain the vaccine.

Key words: COVID-19; vaccination strategy; vaccine hesitancy; developed countries; developing countries

1. Introduction

While COVID-19 initially appeared in the city of Wuhan in the Hubei province of China in December 2019, it has spread rapidly across the world, affecting the lifestyles of people, involving lockdowns around the world for months, and increasing the number of deaths (according to "our world in data" update, until 23-03-2022, the confirmed COVID-19 deaths have reached at least 6.09 million deaths). Specifically, before the absence of treatment or vaccines, the world faced a new common disease crisis (Al Ali, 2020).

Undoubtedly, the gravity of the pandemic situation has affected not just the population's health but also the socioeconomic environment. Over a span of over two years, the coronavirus pandemic had a significant impact on economic growth and contributed to the sluggishness of tremendous economic damage. However, during 2020–2021, the economic environment faced hefty fiscal imbalances, which were coupled with rising world uncertainties posed by high volatility in oil prices and high interest rates.

Fortunately, medical researchers have developed a new set of vaccines based on messenger RNA (mRNA) vaccines (such as Pfizer-BioNTech and Moderna), viral vector technology (AstraZeneca or Oxford University vaccine, Johnson and Johnson, Sputnik V), and classic techniques based on inactivated vaccines (Sinovac; Sinopharm). Months after the spread of the coronavirus (SARS-CoV-2) around the world, the majority of the COVID-19 vaccines have been approved by the World Health Organization to be used. According to medical scientists, vaccination remains the most powerful weapon against the emergence of new variants. No one is safe until everyone is safe (Seth Berkley, 2021), CEO of Gavi and co-founder of COVAX, so equitable access to safe and effective vaccines is critical to bringing the COVID-19 pandemic to an end (Sam-Agudu et al. 2022). Several tools have been proposed to help developing countries, mainly the COVAX pillar, which aims to ensure that every country gets fair and equitable access to eventual COVID-19 vaccines through the largest portfolio of vaccine candidates in the world.

Nevertheless, despite the proven efficacy and the success of different COVID-19 vaccines to deal with the COVID-19 symptoms, the level of vaccination in several countries in the world remains low. This could be explained by two main factors: First, a high degree of hesitancy. It is worth noting that there is an increasing amount of misinformation that is beginning to appear on social media to discourage people from taking vaccines. Indeed, the improvement of internet access has been coupled with the spread of misinformation, specifically in the COVID-19 vaccine concerns. These issues create a sort of media war between medical scientists and fake news promoters. The administration rates remain low. We emphasize that "vaccine hesitancy is considered among the top 10 global health threats identified by the World Health Organization (WHO)". Further, according to the last update of "our world in data" statistics (24/03/2022), 64.1% of the world population has received at least one dose of the COVID-19 vaccine. Thus, since their initial introduction and in spite of more than four billion people around the world being vaccinated, vaccine hesitancy remains an important issue in fighting COVID-19. (Galasso et al., 2022). Second, another factor that could affect the success of the vaccination strategy is the inequality in the disturbance of vaccines between developed and developing countries. Despite the widespread availability, vaccine distribution is low (Hao and Shao, 2022). Regarding the people in low-income countries, only 14.4% of them have received at least one dose. The WHO Director-General, Doctor Tedros Adhanom Ghebreyesus, expressed alarm at the "scandalous inequality" in the vaccine distribution. He estimated a "tragic" consequence if nothing changes between rich and poor countries. Only ten countries have 75% of the world's vaccinated people in May 2021.

This paper focuses on the impact of economic development level, the number of physicians, and the rate of rural population on vaccination rates and the relationship between vaccination campaigns and the country type. In other words, we want to study if the developed countries accept the vaccination strategy more widely than the developing countries, and what are the determinants of the success of the vaccination strategy?

In the empirical part, since we have time-invariant regressors, we choose to estimate two types of models: static and dynamic. Regarding the dynamic model, we follow the methodology of Kripfganz and Schwarz (2019), which is based on a sequential approach to estimating a dynamic Hausman–Taylor model. We choose the Fixed Effect Filtred (FEF) model proposed by Pesaran and Zhou (2014) and published in 2018 for the static form of modeling.

This paper contributes to the COVID-19 research field by studying the main quantitative factors affecting the vaccination rate. Furthermore, the second contribution is to investigate the determinants of vaccination strategy success at the country level by exploring the difference between developed and developing countries. In other words, we assess the incidence of macroeconomic factors on vaccination variation between a set of developed and developing countries. Furthermore, the empirical contributions of the paper are reported as follows: first, the selection of a sequential approach to estimation remains novel because this method has never been applied to this topic before. The originality of this method is its capacity to overcome the endogeneity problem.

In what follows, section 2 outlines a literature review which tackles the impact of coronavirus on socioeconomic environment and the factors affecting the vaccine uptake. Section 3 will address the methodology by exploring the models applied and presenting our sample. Section 4 will discuss the results of our estimations, and we will end the paper with a conclusion in section 5.

2. Literature review:

The literature review tackling the COVID-19 pandemic has been developing each day (Akhtaruzzaman et al., 2022; Kartal, 2020; Loske, 2020; Phan and Narayan, 2020; Sobieralski, 2020) since the pandemic is a very recent phenomenon that all countries have been faced with (Kartal et al. 2021). Hence, several papers from different sectors focused on different impacts of the pandemic, Basilaia and Kvavadze (2020) and Subedi et al. (2020) studied the effect of COVID-19 disturbance on learning and education modality, Pokhrel and Chhetri (2021) presented a literature review on this topic. Adams-Prassl et al. (2020a), Coibion et al. (2020b), and Fairlie and Fossen (2021) focus on the relationship between the spread of coronavirus and labor market effectiveness, Almond et al. (2021), Muhammed et al. (2020), Singh and Mishra (2021) focus on the environmental impact of home policies and city lockdowns. Shen et al. (2020) show the Chinese experience in preventing and controlling measures in public transport. Arena and Aprea (2021), Warnock-Smith et al. (2021), and Suau-Sanchez et al. (2020) investigate the impact of COVID-19 on the air transportation market.

Regarding vaccine uptake, as mentioned previously, the two main threats to vaccination success are the failure of equal distribution of vaccination and the hesitancy of people, specifically in developing countries, to accept vaccines. In this regard, several papers have tried to understand the primary causes of hesitancy. That is to say, why is there a high rate of people who do not trust scientists and doctors? Is it because the COVID-19 vaccine was developed in record time (only 10 months after the virus spread globally)? Is it because of the failure of official media tools to face fake news promoters? Is it because of a lack of governmental trust?

Hao and Shao (2022) analyze the factors affecting the public behavior toward COVID-19 vaccination. The main results show that political orientation, social network tools, and economic effects have a significant effect on vaccination hesitancy. Bansal et al. (2022) use a non-parametric approach to investigate the determinants of vaccination preferences in India, and the results show that vaccine efficacy, distance to the vaccination center, and vaccine side effects are the most significant factors influencing vaccination demand.

In Sub-Saharan Africa, Osuagwu et al. (2022) assess the impact of information sources on vaccine hesitancy through an online survey and multinomial models. The main results show that social media users have a higher hesitancy level than newspaper readers. Suzuki et al. (2022) aim to assess the characteristics of people hesitating to take the COVID-19 vaccine via an online survey at the start of vaccination in Japan. The main finding shows that in regions with an ongoing pandemic, a high percentage of people refuse to receive the vaccine. Indeed, among 17911 participants in their survey established in February–March 2021, only 0.33% had been vaccinated.

Author(s)	Sample	Variables	Methods	Main results
Bansal et al. (2022)	1371 participants in India [May -June 2021].	Effectiveness of vaccine, vaccine developer, duration of protection, Place of vaccine administration, Proportion of friends and family members who has taken the vaccine	Discrete Choice Experiment (DCE), non-parametric model, conditional logit model.	Domestic vaccines are preferred, but 15% of the respondents are sensitive to the side effects of vaccines.
Suzuki et al. (2022)	17911 respondents in Japan [February 24-March 01 2021].	Age, sex, marital status, presence of children, household income, healthcare information, preventive behavior,	Survey, t-test	In regions with an ongoing pandemic spread, the degree of hesitancy is high.

		confidence in Covid-19 information source, intention for vaccination		Risk and protection factors should be taken into consideration in the vaccination strategy.
Hao and Shao (2022)	6000 participants from all 50 states in USA [June 9-July 21, 2021]	Vaccinated for the Covid-19, Political Party Control of Government, Biden Votes in the election, rate of people fully vaccinated (≥18), positive view of covid-19 vaccine, negative view of covid-19 vaccine, sex, age, race, marital status, incomes, employment status, education, proportion of friends and family receiving vaccine.	Multilevel logistic regression	Political orientation, social networking, and economic recovery all have a significant impact on vaccine uptake.
Van Oost et al. (2022)	February 2021 (sample1) and April 2021 (sample 2) (Total $N = 8264$) in Belgium.	Age, sex, Language, education, comorbidity, vaccination intention, governement trust, conspiracism, identified motivation, external distrust, effort,	Structural Equation Modeling	Government trust positively predicts vaccination intention, whereas conspiracism negatively predicts vaccination intention. French-speaking people have lower levels of government trust and higher levels of conspiracism than Dutch speakers.
Williams et al. (2021)	340,046 respondents in USA [January 6, March 29, 2021]	Vaccination coverage, age, education, employment, health insurance, income, employment status, Economic hardship during the pandemic.	regression-based decomposition method	Both socioeconomic factors, and experiencing economic hardship during the pandemic have a statistically significant impact on vaccination coverage disparities between non-Hispanic white and racial/ethnic minority individuals. Differences in health insurance, income, education, age, and employment explained a large portion of the disparity in vaccination COVID-19 coverage between respondents.
Awijen et al. (2022)	194 countries observed [December 1st, 2020 to March 4th, 2021]	Recession, Conspiracy Theory, Stock Market Crash, Survivalism, Covid-19 confirmed cases, Covid-19 deaths, Covid-19 recovered.	Difference-in-differences investigation approach	Google search trends measuring fear and anxiety have increased. With the arrival of the vaccine, people have a lack of confidence in the vaccine's efficiency to overcome the COVID-19 crisis.
Huang et al. (2022)	1047 primary care professionals in USA [Early 2021].	thinking and feeling, social processes, direct behavior change.	The Increasing Vaccination Model	Vaccine uptake was higher among physicians than among nurses and advanced practice providers.
Yuen (2022)	1079 participants aged 18–77 years in Hong Kong [May 26 - June 3, 2021].	Sex, education, origins, covid-19 experience, political stance, quarantine experience.	Quota sampling, Chi-squared test, ANOVA, logistic regression.	There was more support for the vaccine among pro-government respondents and less support for the vaccine among those opposed to the vaccine.
Shaw et al. (2022)	247 refuges in USA.	Sex, age, Educational Attainment, Region of Origin, number of years since U.S. arrival, household size, vaccine intent,	Differences in proportions, Fisher's exact tests, differences in means, ANOVA	57.4% of the participants intend to get vaccinated. There is no significant relationship between country of origin and vaccination status or intent. The main reasons for vaccine hesitancy are that it is religiously prohibited, communication barriers, and transportation barriers.
Alagarsamy et al. (2022)	625 respondents from India.	Autonomy, Perceived Threat about Vaccine, Trust in Healthcare Sector, Vaccine Government Communication Strategy, Vaccine Uptake Intention.	Structural equation modeling	85% of the sample were intended to get the vaccine due to the government's strategy for communication, the threat of the vaccine, and their trust in healthcare professionals.

				The BSD model is an efficient way to explain the vaccination uptake in India.
Baumann et al. (2022)	1298 participants [July 07- August 13, 2021]	Age, Sex, Vaccination status, Relation to child, Race/Ethnicity of Parent, Primary Language, Highest level of education, Income, Chronic medical condition (child).	cross-sectional survey, Kruskal-Wallace analysis.	50% of the parents were either fully vaccinated (45%) or had received one dose (5%), In the case of unvaccinated parents, 28% were very unlikely to receive the vaccine. 27% of children 12 years old were vaccinated. 12, 28% of parents believe their child should be vaccinated. The main reasons for hesitancy were the long-term and short-term effects and safety of the vaccine and religious beliefs.
Sherman et al. (2022)	1500 participants in the United Kingdom [January 13– January 15 January 2021].	Sex, ethnicity, religion, highest qualification, employment status, key worker, income, region, number of people in household, extremely clinically vulnerable, Influenza vaccine last winter /this winter.	online cross-sectional survey, Principal component analyses, linear regression analyses.	73.5% of respondents are likely to get the vaccine. The positive intention was related to having been (or intending to be) vaccinated for influenza last winter/this winter; stronger beliefs about the social acceptability of the COVID-19 vaccine; the adequacy of information about the vaccine; and weaker beliefs that the vaccine is unsafe. Negative intentions are explained by the fact that only people at high risk of illness should receive vaccines and that coronavirus vaccines are merely a means for manufacturers to profit.

Table 1: Studies focusing on the main factors influencing vaccination uptake and refusal

3. Methodology:

As mentioned in the introduction, since we use daily data related to the vaccination rate per day and the socioeconomic data cannot vary daily, we have a model containing time-variant and time-invariant covariates. Therefore, according to the econometric literature, the presence of time-invariant regressors and time-variant regressors could present a problem of endogeneity.

This is in violation of the hypothesis of the absence of correlation between the random term and the factors considered. Hence, using conventional panel data approaches in our case could be biased. Consequently, it is legitimate to proceed with the use of instrumental variable techniques. The Hausman-Taylor (1981) method is appropriate for this situation where one can have time-varying factors and time-invariant factors. This method has the advantage of increasing the number of instruments by using the double dimension of the panel.

Then, Plumper and Troeger (2007) proposed a three-stage procedure for the estimation of time-invariant variables in panel data models. The technique is called fixed effects vector decomposition (FEVD). The authors criticized the previous approach of Hausman and Taylor since there is a risk of correlation between the instruments and the errors and the unit effects; then, Pesaran and Zhou (2018) proposed the Fixed Effects Filtered (FEF) model. They showed that the FEF model overcomes the drawbacks of the FEVD estimator since the variance estimator of FEVD is inconsistent and its application could lead to a misleading inference.

Regarding dynamic panel models, Kripfganz and Schwarz (2019) suggest a dynamic Hausman-Taylor model via a sequential approach based on two-step estimation: firstly, they estimate the parameters of the time-varying explanatory covariates via GMM or QML (Baltagi, 2021) and subsequently regress the first-stage residuals on the time-invariant variables. The command *xtseqreg* in Stata, proposed by Kripfganz and Schwarz, is available for such model estimation.

The dataset consists of twenty-four countries divided into developed and developing countries spread from June 01, 2021 to February 16, 2022. The selected countries are Argentina, Australia, Azerbaijan, Bahrain, Belgium, Brazil, Canada, Chile, Cuba, Czechia, Esonia, France, Germany, Greece, India, Indonesia, Italy, Mexico, Norway, Switzerland, Tunisia, Turkey, Ukraine, United Kingdom.

Variable	Obs	Mean	Std. Dev.	Min	Max
rate of people fully vaccinated (	6264	48,8	22,7	0,3	89,5
Number of confirmed cases per day ()	6264	18292,8	41218,7	0,0	502507,0
Gross Domestic Product (	6264	30120,5	15815,0	6426,7	64800,1
Population Density ()	6264	202,2	379,1	3,2	1935,9

rural population rate ()	6264	23,5	13,1	1,9	65,1
Number of physicians per 1000 inhabitants ()	6264	4,0	2,1	0,5	8,4
Country type (dummy variable) ()	6264	0,5	0,5	0,0	1,0

Table2: Descriptive statistics of variables.

Table 2 presents the summary of descriptive statistics. The number of observations is equal to 6264, covering 24 countries for the period [01-06-2021] to [16-02-2021].

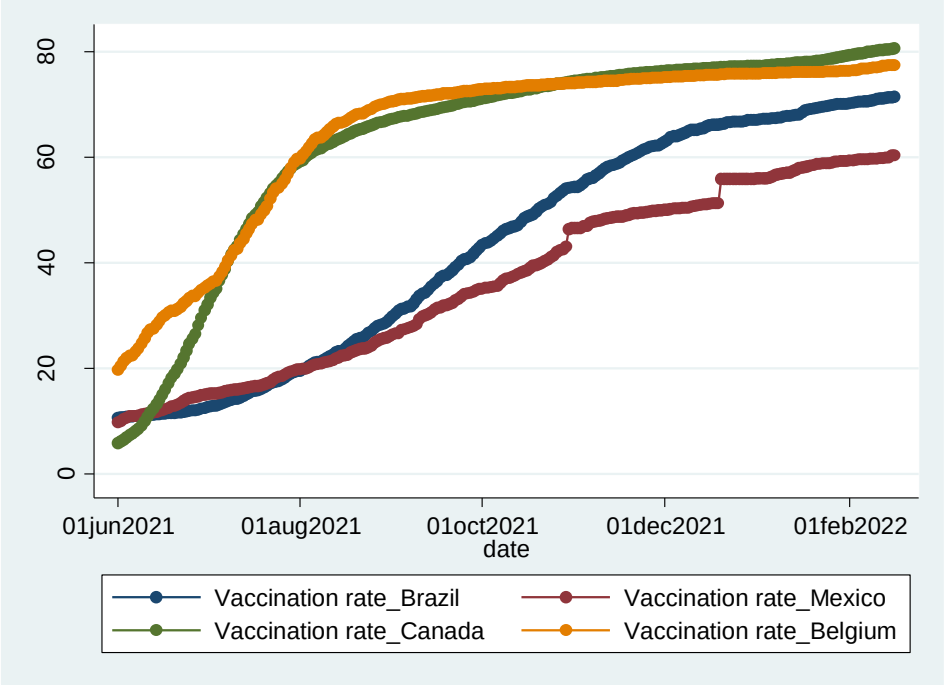

Figure1: Vaccination rates of developed countries VS. developing countries

Figure 1 above shows the evolution of vaccination rates. We take two developed countries: Canada and Belgium, and two developing countries: Brazil and Mexico. Despite all the countries being at the same level in the first months of vaccination (except for Belgium, which exceeded them a little with a rate equal to 20%), the developed countries surpass the developing ones mainly during the period from July to January. At the end of the period, we can see that the curves of developing countries are getting closer to the curves of developed countries.

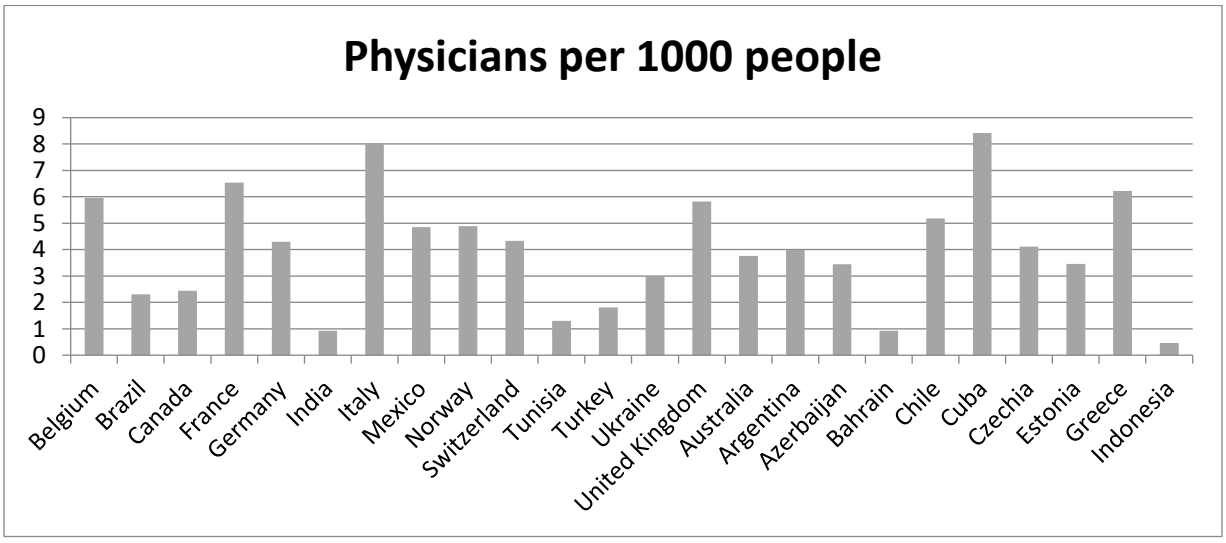

Figure 2: physicians per 1000 people for 24 countries

The histogram above (Figure 2) shows the number of physicians per 1000 people in our 24 countries. It can be seen the gap between the majority of developed and developing countries regarding this variable, Indonesia, Bahrain, and India have the lowest values with respectively 0.465, 0.928, and 0.926 physicians per 1000 people. On the other hand, despite major developed countries such as Belgium, Italy, and the United Kingdom having a high level of physicians, we find some countries, such as Canada, Estonia, and Switzerland, have a low number of physicians per 1000 people.

4. Results and discussion:

The aim of this section is to explore the results of our estimation. We used two models: the first one is based on a sequential approach and the second is based on a static approach. We justify our choice since the set of variables selected included time-varying and time-invariant regressors. The results of estimation are presented in tables 3 and 4.

	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
Number of confirmed cases per day ()	0,075	0,004	17,400	0,000	0,067	0,084
Constant	-1,206	0,298	-4,050	0,000	-1,789	-0,622
Gross Domestic Product (	0,814	0,025	32,590	0,000	0,765	0,863
Population density ()	0,035	0,006	5,860	0,000	0,023	0,046
Number of physicians per 1000 inhabitants ()	0,121	0,016	7,490	0,000	0,089	0,153
rural population rate ()	-0,031	0,016	-1,860	0,063	-0,063	0,002
Country type ()	-0,270	0,031	-8,700	0,000	-0,331	-0,209
Constant	0,000	0,406	0,000	1,000	-0,796	0,796

Table 3: Estimation results of sequential two step estimation

	Coef.	Std. Err.	T
Time-varying variables			
Number of confirmed cases per day ()	0,113	0,054	2,09
Time-invariant variables			
	Coef.	Std. Err.	T
Gross Domestic Product (	0,854	0,182	4,70
Population density ()	0,026	0,037	0,71
Number of physicians per 1000 inhabitants ()	0,094	0,104	0,91
rural population rate ()	-0,023	0,048	-0,49
Country type ()	-0,293	0,232	-1,26

Table 4: Estimation results of FEF estimation

The main results show the positive and significant impact of GDP on the vaccination rate. This could be explained for two reasons: the first one is that developed countries have a greater number of vaccines than developing countries, since their financial resources are more important than those of developing countries. While wealthy countries had made vaccine doses in sufficient quantities, there was a lack of vaccines available and distribution locations in low-income countries. These poorest countries found themselves waiting for the aid of the richest nations and non-lucrative organizations. The second reason is that the acceptance level of vaccination among the population living in developing countries is lower than that of people living in developed countries. The social media, via its different tools (Facebook, Instagram, Twitter, YouTube, etc.), could affect the population's acceptance of vaccination. Therefore, it is required to fight the misinformation with a big media campaign in which medical scientists should be present to explain the advantages of different vaccines to save thousands of lives and encourage people to take them.

Moreover, beyond the vaccination rate disparities, we argue that wealthy countries have more capacity to impose lockdowns for long periods of time and implement physical distancing protocols. Hence, despite this unprecedented speed of global vaccine rollout, the last statistics of WHO (May; 2022), revealed that only 16% of people in low-income nations have received a single vaccine, compared to 80% in high-income nations. The equity gap between wealthy and poor nations threatens thousands of lives and increases the risk of the emergence of new variants. Therefore, even though the governments of the poorest countries fail to provide vaccination to their populations, it is necessary to support the efforts of developing countries toward giving access to the vaccines in order to mitigate the health disparities and meet the global target fixed by the WHO of protecting 70% of the population in each nation. Our results are in line with those found by Alimoradi et al. (2021) and Basak et al. (2022), who showed that the GDP affected positively and significantly the number of doses administrated.

Another interesting insight is shown in the negative relationship between the rate of rural population and the vaccination rate, with a coefficient equal to -0,031 and -0,023 in models (1) and (2), respectively. Concerning the urban areas, the rural zones are deprived of information about the COVID-19 vaccination. Moreover, the behavior of the rural population is certainly different from that of the urban population. Several factors are involved in this difference, which explains the low vaccination rate in rural areas, mainly fear, conspiracism, misinformation, distrust in government, and side effects of vaccines. Our results are in line with those found by Murthy et al. (2021). They revealed that the vaccination rates in

urban areas are higher than those in rural areas in the United States. Further, Adunlin et al. (2021) confirmed the existence of vaccine hesitancy in rural communities throughout the USA. Compared with urban residents, Fisher et al. (2020) pointed out that people from rural areas have no intention of uptaking the COVID-19 vaccine.

Prusaczyk (2021) reported that community leaders have an important role in convincing people to take their vaccine. A wide range of rural people trust community leaders more than central government, and the influence of these leaders is significant in rural areas. They can influence the beliefs of people and convince them to take the COVID-19 vaccine. For instance, Thomas et al. (2015) conducted a study about the acceptability of the human papillomavirus vaccine in rural areas. The authors recognized that religiosity was a key driver of the choice of parents to vaccinate their children. They argued that decisions about vaccinations are dependent on the beliefs of church members since they are considered an active disseminator of information.

Social media networks can influence decisions related to vaccination. It allows people to learn about the COVID-19 vaccine through anonymous sources of information. Thus, when utilizing the internet, people should be vigilant since it can influence their decisions related to vaccine acceptance. It is quite important to not trust all the information disseminated on the internet, specifically those coming from anonymous people. One more important thing to note is the lack of vaccination locations such as hospitals, physician's offices, or health departments. Prusaczyk (2021) emphasized this limitation and recognized that it contributes indirectly to the lower vaccination rate in rural areas than those in urban regions. Accordingly, it is necessary to increase the distribution sites to improve access to vaccination in rural areas and therefore mitigate the rural-urban health disparities.

The dummy variable explaining the country type has shown a significant and negative impact on the vaccination rate. That is to say, the vaccination rate in developed countries is superior to those in developing countries. Previous studies have shown how rich countries can spend more financial resources on the health sector to control the pandemic spread through massive vaccination policies.

Population density is positively correlated with vaccination rate, which means the impact of global acceptance of vaccines on the individual decision. Brown et al. (2021) found a similar result regarding the population density. They said that density is higher in urban areas than in rural areas, which explains the positive nexus between population density and vaccination rate.

The number of physicians per 1000 inhabitants has a positive and significant impact on the vaccination rate with a coefficient equal to 0.121. This indicator is one of the main determinants of vaccination strategy success. Increasing the number of physicians could improve the availability of vaccination centers and the vaccinated population.

Regarding the daily confirmed cases of COVID-19, we find a positive impact of this variable on the vaccination rate, which means the increase in fear feelings since the outbreak of this pandemic on health. Therefore, people find themselves encouraged to take their vaccines.

5. Conclusion:

Despite large take-up rates in several countries, millions of people still refuse COVID-19 vaccination (Galasso et al. 2022). Therefore, we aimed in this current study to focus on the main determinants of the success of vaccination policies against the COVID-19 pandemic between countries. There is a lack of previous studies on this topic, in particular, at the country-level, so we aimed to fill this gap by conducting a comparative analysis between developed and developing countries. GDP, rural population rate, and number of physicians per 1000 inhabitants are among the factors influencing the success of vaccination spread. For instance, we found that an increase of 1% in GDP implies a significant increase of 0.814% in the vaccination rate. Further, the negative impact of country type coefficient on the vaccination rate highlights the significant effort of developed countries to increase the rate of vaccination, compared to developing countries. This disparity could threaten herd immunity and stimulate the emergence of new variants like the Omicron variant, which appeared in South Africa as a result of low vaccination.

Further, socioeconomic characteristics certainly play a vital role in the variation of vaccination rates between countries. Beyond the GDP, which is a key driver in vaccination policy success, we can report the educational level, the marital status, the number of close friends, family, and co-workers vaccinated. It is noteworthy that partnership efforts should be established between public authorities, investors, and financial backers to convince the minority hesitating and even refusing to get the vaccine of its efficacy and security proven by scientists around the world.

A successful vaccination strategy relies on the knowledge of people who have refused or accepted vaccines and thus understanding the social factors affecting vaccine uptake (Hao and Shao, 2022). As a solution, Hao and Shao (2022) propose that vaccinated people should encourage the vaccine-refused members of their family and close friends to take the vaccine, as well as establish a national inoculation program. Vaccines in people’s homes might further increase uptake, which suggests that the authorities should increase door-to-door vaccination efforts (Bansal et al., 2022). These efforts should complement, and not replace, the current strategy of vaccination at health centers since 30% of the population prefers to take vaccines at hospitals. Suzuki et al. (2022) said that collaborative efforts between different communities and the government are more efficient than efforts provided by only the government side. In focusing on the psychological factors, Van Oost et al. (2022) propose an autonomy-supportive campaign could be a solution to encourage citizens. Also, the authorities should provide solid rationales, reminding citizens of the benefits of vaccines. In the speech, using inviting instead of guilt-inducing language, is highly recommended. They said that external rewards and sanctions seem like ineffective ways to motivate "COVID-skeptics."

As with the majority of studies, this study is subject to some limitations. The first is the lack of some socioeconomic characteristics such as education, poverty rate, trust in the government, trust in scientists, etc. The second concerns the health indicators. Due to the unavailability, we would like to include the number of vaccination centers per country. Also, we would like to desegregate the vaccination rate according to the vaccine type. Nonetheless, these two variables are not available. Therefore, our research perspectives are to focus on the impact of social media such as Facebook, Twitter, etc. on vaccination hesitancy and to assess the public policy efforts to fight against disinformation. Further, trust in government could affect the vaccination uptake. Thus, we aim in future research to stress the effect of government trust and scientists' trust on the vaccination uptake.

References:

1. Adams-Prassl, A., Boneva, T., Golin, M., & Rauh, C. (2020). Inequality in the impact of the coronavirus shock: Evidence from real time surveys. *Journal of Public economics*, *189*, 104245.
2. Adunlin, G., Murphy, P. Z., & Manis, M. (2021). COVID-19: how can rural community pharmacies respond to the outbreak? The Journal of Rural Health.
3. Akhtaruzzaman, M., Boubaker, S., & Umar, Z. (2022). COVID–19 media coverage and ESG leader indices. *Finance Research Letters*, *45*, 102170.
4. Alagarsamy, S., Mehrolia, S., Pushparaj, U., & Jeevananda, S. (2022). Explaining the intention to uptake COVID-19

vaccination using the Behavioral and Social Drivers of Vaccination (BeSD) model. *Vaccine: X*, 100140.
5. AlAli, M. S. (2020). The effect of who COVID-19 announcement on Asian stock markets returns: An event study analysis. *Journal of Economics and Business*, *3*(3).
6. Alimoradi, Z., Lin, C. Y., & Pakpour, A. H. (2021). Coronavirus disease-19 vaccine inequity and gross domestic product. *Asian Journal of Social Health and Behavior*, *4*(4), 129.
7. Almond, D., Du, X., Karplus, V. J., & Zhang, S. (2021, May). Ambiguous Air Pollution Effects of China's COVID-19 Lock-Down. In *AEA Papers and Proceedings* (Vol. 111, pp. 376-80).
8. Arena, M., & Aprea, C. (2021). Impact of Covid-19 Pandemic on Air Transport: Overview and Implications. *Advances in Environmental and Engineering Research*, *2*(1), 1-1.
9. Awijen, H., Zaied, Y. B., & Nguyen, D. K. (2022). Covid-19 vaccination, fear and anxiety: Evidence from Google search trends. *Social Science & Medicine*, *297*, 114820.
10. Baltagi, B. H. (2021). Dynamic panel data models. In *Econometric Analysis of Panel Data* (pp. 187-228). Springer, Cham.
11. Bansal, P., Raj, A., Shukla, D. M., & Sunder, N. (2022). COVID-19 vaccine preferences in India. *Vaccine*.
12. Basak, P., Abir, T., Al Mamun, A., Zainol, N. R., Khanam, M., et al. (2022). A Global Study on the Correlates of Gross Domestic Product (GDP) and COVID-19 Vaccine Distribution. Vaccines, 10(2), 266.
13. Basilaia, G., & Kvavadze, D. (2020). Transition to online education in schools during a SARS-CoV-2 coronavirus (COVID-19) pandemic in Georgia. *Pedagogical Research*, *5*(4).
14. Baumann, B. M., Rodriguez, R. M., DeLaroche, A. M., Rayburn, D., Eucker, S. A., et al. (2022). Factors Associated with Parental Acceptance of COVID-19 Vaccination: A Multicenter Pediatric Emergency Department Cross-sectional Analysis. *Annals of Emergency Medicine*.
15. Brown, C. C., Young, S. G., & Pro, G. C. (2021). COVID-19 vaccination rates vary by community vulnerability: A county-level analysis. *Vaccine*, *39*(31), 4245-4249.
16. Coibion, O., Gorodnichenko, Y., & Weber, M. (2020). *Labor markets during the COVID-19 crisis: A preliminary view* (No. w27017). National Bureau of economic research.
17. Fairlie, R., & Fossen, F. M. (2021). The early impacts of the COVID-19 pandemic on business sales. *Small Business Economics*, 1-12.
18. Fisher, K. A., Bloomstone, S. J., Walder, J., Crawford, S., Fouayzi, H., et al. (2020). Attitudes toward a potential SARS-CoV-2 vaccine: a survey of US adults. *Annals of internal medicine*, *173*(12), 964-973.
19. Galasso, V., Pons, V., Profeta, P., Becher, M., Brouard, S., et al. (2022). *From anti-vax intentions to vaccination: Panel and experimental evidence from nine countries* (No. w29741). National Bureau of Economic Research.
20. Hao, F., & Shao, W. (2022). Understanding the influence of political orientation, social network, and economic recovery on COVID-19 vaccine uptake among Americans. *Vaccine*, *40*(14), 2191-2201.
21. Hausman, J. A., & Taylor, W. E. (1981). Panel data and unobservable individual effects. *Econometrica: Journal of the Econometric society*, 1377-1398.
22. Huang, Q., Gilkey, M. B., Thompson, P., Grabert, B. K., Dailey, S. A., & Brewer, N. T. (2022). Explaining higher Covid-19 vaccination among some US primary care professionals. *Social Science & Medicine*, 114935.
23. Kartal, M. T. (2020). The effect of the COVID-19 pandemic on oil prices: Evidence from Turkey. *Energy Research Letters*, *1*(4).
24. Kartal, M. T., Depren, Ö., & Depren, S. K. (2021). The relationship between mobility and COVID-19 pandemic: Daily evidence from an emerging country by causality analysis. *Transportation Research Interdisciplinary Perspectives*, *10*, 100366.
25. Kripfganz, S., & Schwarz, C. (2019). Estimation of linear dynamic panel data models with time-invariant regressors. *Journal of Applied Econometrics*, *34*(4), 526-546.
26. Loske, D. (2020). The impact of COVID-19 on transport volume and freight capacity dynamics: An empirical analysis in German food retail logistics. *Transportation Research Interdisciplinary Perspectives*, *6*, 100165.
27. Muhammad, S., Long, X., & Salman, M. (2020). COVID-19 pandemic and environmental pollution: A blessing in disguise? *Science of the total environment*, *728*, 138820.
28. Murthy, B. P., Sterrett, N., Weller, D., Zell, E., Reynolds, L., Toblin, R. L., ... & Harris, L. Q. (2021). Disparities in COVID-19 vaccination coverage between urban and rural counties—United States, December 14, 2020–April 10, 2021. *Morbidity and Mortality Weekly Report*, *70*(20), 759.
29. Osuagwu, U. L., Mashige, K. P., Ovenseri-Ogbomo, G., Envuladu, E. A., Abu, E. K., et al. (2022). The impact of information sources on COVID-19 Vaccine hesitancy and resistance in Sub-Saharan Africa.
30. Pesaran, M. H., & Zhou, Q. (2014). Estimation of Time-invariant Effects in Static Panel Data Models. Center for Applied Financial Economics (CAFE) Working Paper.
31. Pesaran, M. H., & Zhou, Q. (2018). Estimation of time-invariant effects in static panel data models. *Econometric Reviews*, *37*(10), 1137-1171.
32. Phan, D. H. B., & Narayan, P. K. (2020). Country responses and the reaction of the stock market to COVID-19—A preliminary exposition. *Emerging Markets Finance and Trade*, *56*(10), 2138-2150.
33. Plümper, T., & Troeger, V. E. (2007). Efficient estimation of time-invariant and rarely changing variables in finite sample panel analyses with unit fixed effects. *Political analysis*, *15*(2), 124-139.
34. Pokhrel, S., & Chhetri, R. (2021). A literature review on impact of COVID-19 pandemic on teaching and learning. *Higher Education for the Future*, *8*(1), 133-141.
35. Prusaczyk, B. (2021, June). Strategies for disseminating and implementing Covid-19 vaccines in rural areas. In *Open Forum Infectious Diseases* (Vol. 8, No. 6, p. ofab152). US: Oxford University Press.
36. Sam-Agudu, N. A., Quakyi, N. K., Masekela, R., Zumla, A., & Nachega, J. B. (2022). Children and adolescents in African countries should also be vaccinated for COVID-19. *BMJ Global Health*, *7*(2), e008315.
37. Shaw, J., Anderson, K. B., Fabi, R. E., Thompson, C. A., Harris, M., Aljabbarin, N., ... & Shaw, A. V. (2022). COVID-19 vaccination intention and behavior in a large, diverse, US refugee population. Vaccine, 40(9), 1231-1237.
38. Shen, J., Duan, H., Zhang, B., Wang, J., Ji, J. S., Wang, J., ... & Shi, X. (2020). Prevention and control of COVID-19 in public transportation: Experience from China. *Environmental pollution*, *266*, 115291.
39. Sherman, S. M., Sim, J., Cutts, M., Dasch, H., Amlôt, R., Rubin, G. J., ... & Smith, L. E. (2022). COVID-19 vaccination acceptability in the UK at the start of the vaccination programme: a nationally representative cross-sectional survey (CoVAccS–wave 2). Public health, 202, 1-9.

40. Singh, V., & Mishra, V. (2021). Environmental impacts of coronavirus disease 2019 (COVID-19). *Bioresource Technology Reports*, *15*, 100744.
41. Sobieralski, J. B. (2020). COVID-19 and airline employment: Insights from historical uncertainty shocks to the industry. *Transportation Research Interdisciplinary Perspectives*, *5*, 100123.
42. Suau-Sanchez, P., Voltes-Dorta, A., & Cugueró-Escofet, N. (2020). An early assessment of the impact of COVID-19 on air transport: Just another crisis or the end of aviation as we know it?. *Journal of Transport Geography*, *86*, 102749.
43. Subedi, S., Nayaju, S., Subedi, S., Shah, S. K., & Shah, J. M. (2020). Impact of E-learning during COVID-19 pandemic among nursing students and teachers of Nepal. *International Journal of Science and Healthcare Research*, *5*(3), 68-76.
44. Suzuki, N., Yamamoto, T., Uchiumi, C., & Sugaya, N. (2022). Socio-economic and behavioral characteristics associated with COVID-19 vaccine hesitancy under a declared state of emergency in Japan. *Brain, Behavior, & Immunity-Health*, 100448.
45. Thomas, T., Blumling, A., & Delaney, A. (2015). The influence of religiosity and spirituality on rural parents' health decision-making and human papillomavirus vaccine choices. *ANS. Advances in nursing science*, *38*(4), E1.
46. Van Oost, P., Yzerbyt, V., Schmitz, M., Vansteenkiste, M., Luminet, O., Morbée, S., ... & Klein, O. (2022). The relation between conspiracism, government trust, and COVID-19 vaccination intentions: The key role of motivation. *Social Science & Medicine*, 114926.
47. Warnock-Smith, D., Graham, A., O'Connell, J. F., & Efthymiou, M. (2021). Impact of COVID-19 on air transport passenger markets: Examining evidence from the Chinese market. *Journal of air transport management*, *94*, 102085.
48. WHO, (2020). https://www.who.int/news/item/20-05-2022-covax-calls-for-urgent-action-to-close-vaccine-equity-gap.
49. Williams, A. M., Clayton, H. B., & Singleton, J. A. (2022). Racial and ethnic disparities in COVID-19 vaccination coverage: the contribution of socioeconomic and demographic factors. *American journal of preventive medicine*, *62*(4), 473-482.
50. Yuen, V. W. H. (2022). Political attitudes and efficacy of health expert communication on the support for COVID-19 vaccination program: Findings from a survey in Hong Kong. *Vaccine*, *40*(15), 2282-2291.

Statements and Declarations

Please check the following as appropriate:

- All authors have participated in (a) conception and design, or analysis and interpretation of the data; (b) drafting the article or revising it critically for important intellectual content; and (c) approval of the final version.
- This manuscript is not under review at, another journal or other publishing venue.
- The authors have no affiliation with any organization with a direct or indirect financial interest in the subject matter discussed in the manuscript.
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