CESifo WORKING PAPERS

9307
2021

September 2021

An Old Plug and a New Virus: Effect of Public Corruption on the Covid-19 Immunization Progress

Mohammad Reza Farzanegan, Hans Philipp Hofmann

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 9307*

An Old Plug and a New Virus: Effect of Public Corruption on the Covid-19 Immunization Progress

Abstract

The coronavirus disease (COVID-19) outbreak has resulted in the death of over four million people since late 2019. To reduce the human and economic costs of COVID-19, different vaccines have been developed and distributed across countries. There has been significant cross-country variation in the vaccination of people against COVID-19. In this study, we focus on public corruption to explain the significant cause of cross-country variation in immunization progress. We suggest that countries with a higher degree of public corruption before the pandemic have been less successful in the vaccination of their population, controlling for other important determinants of immunization progress.

JEL-Codes: D730, I150, I180.

Keywords: Covid-19, pandemic, immunization, vaccination, health sector, corruption, cross-country regression.

*Mohammad Reza Farzanegan**
Center for Near and Middle Eastern Studies,
Economics of the Middle East Research Group
& School of Business and Economics
Philipps-University Marburg
Deutschhausstr. 12
Germany – 35032 Marburg
farzanegan@uni-marburg.de

Hans Philipp Hofmann
Center for Near and Middle Eastern Studies,
Economics of the Middle East Research
Group & School of Business and Economics
Philipps-University Marburg
Deutschhausstr. 12
Germany – 35032 Marburg
hans-philipp.hofmann@uni-marburg.de

*corresponding author

We thank the helpful comments and suggestions of Jhoana Ocampo.

1. Introduction

> *"Corruption is criminal, immoral and the ultimate betrayal of public trust. It is even more damaging in times of crisis – as the world is experiencing now with the COVID-19 pandemic. […] As an age-old plague takes on new forms, let us combat it with new heights of resolve. "*
>
> António Guterres, Secretary-General of the United Nations (2020)

The end of 2019 saw the emergence of a novel and particularly infectious disease which had a sudden and profound global impact. The new coronavirus spread rapidly and soon took over the planet. There have been more than 213 million confirmed cases and close to 4.5 million deaths as of August 2021. To limit the spread of the virus, COVID-19 containment measures were implemented throughout countries. These measures, such as social distancing, entail economic and psychological costs (see for example Mandel and Veetil 2020; Le and Nguyen 2021; Fazio et al. 2021). The only long-term response to the crisis will be the immunization against the severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2).

Several vaccines have been developed and offer high protection against disease and infection from the virus. For example, the Pfizer/BioNTech vaccine has 92% efficacy at preventing the COVID-19 disease for the ancestral type and Alpha variant and 90% for the Beta, Gamma, and Delta variants. The vaccine has 86% efficacy at preventing the infection for the ancestral and Alpha and has 78% efficacy for the Beta, Gamma, and Delta variants (Institute for Health Metrics and Evaluation 2021). However, vaccinating the global population does not go unhindered. The problem of corruption in the vaccine process has gained the attention of media and international organizations.

The Secretary-General of the United Nations, António Guterres warns of the dangers of corruption in the fight against the COVID-19 pandemic (United Nations 2020). In the report "COVID-19 Vaccines and Corruption Risks: Preventing Corruption in the Manufacture, Allocation and Distribution of Vaccines," the United Nations Office on Drugs and Crime (2021) discusses the potential risks of corruption in the distribution process, where vaccine doses could be stolen, the theft of emergency funding and opportunities for nepotism, favoritism, and corrupted procurement systems. Transparency International (2021b) and the European Anti-Fraud Office (2021) raised similar concerns with regards to the distribution of vaccines.

The supply shortage of COVID-19 vaccines creates opportunities for corruption throughout the world. In South America, Peruvian and Argentinian politicians and their families received vaccinations prior to being officially eligible for them (Brasileiro 2021). There have also been reports of wide-ranging corruption scandals related to the COVID-19 vaccine in Brazil and Venezuela (Brasileiro 2021). In Spain, local mayors received preferential access to vaccine doses before they were widely available to the general public. In Italy, there have been reports of vaccine sales on the grey market (France 24 2021; Human Rights Watch 2021). Corruption scandals around the vaccine also erupted in Lebanon, South Africa and China (Hubbard 2021; Smith 2021). Another example is Iran, which is struggling with significant mortality rates due to COVID-19 and slow vaccination progress. In May 2021, Kianoush Jahanpur, the spokesman for Iran's Food and Drug Administration, noted significant over-invoicing of imported vaccines by private firms (up to 12 times higher than the real price of the vaccines). Such firms with access to subsidized rates on vaccines are incentivized to over-invoice their imports and sell the additional amounts in the foreign exchange black market at a high premium (Iran International, 2021).[1] In addition to the recent COVID-19 vaccine scandals, it is worth mentioning that some of the pharmaceutical companies manufacturing the COVID-19 vaccine (AstraZeneca, Johnson & Johnson, Pfizer) were sued over bribery previously to the pandemic (Smith 2021). All these examples argue for the possible destructive effects of public corruption on the successful implementation of vaccination against COVID-19. However, a data-driven cross-country investigation on the role of corruption in vaccinations is lacking. In this study, using data on the share of the population who have been vaccinated against COVID-19, public corruption, healthcare capabilities and economic indicators from over 90 countries, we examine the association between corruption and COVID-19 vaccination coverage. We find strong evidence of the damaging effects of pre-pandemic corruption on immunization progress across countries.

2. Literature review

Lambsdorff (2007) defines corruption as "[…] the misuse of public power for private benefit." Therefore, corruption occurs at the intersection of public spending and the private sector. Misuse is defined as a behavior that deviates from the formal and informal rules of a political society or "[…] more generally, where narrow interests are followed at the expense of the broader interests of the public at large" (Lambsdorff 2007). Corruption can take different forms such as extortion, fraud, embezzlement and bribery (Lambsdorff 2007).

But how can corruption affect the speed and scale of worldwide vaccination projects? In light of the extraordinary speed and global scale of COVID-19 vaccine distribution, Goel et al. (2021) identify, based on pre-pandemic research on corruption, at which stages of the vaccination process can public power be misused for private benefit. Goel et al. argue that the urgent political need for a vaccine creates an additional layer of government intervention compared

[1] For more information on rent-seeking in foreign trade of Iran and mis-invoicing in trade see Farzanegan (2009). Zamani et al. (2021) also show how international sanctions have increased black market premiums in Iran which can increase incentives for corruption.

to previous distribution processes of pharmaceutical goods. The accompanying increased number of involved bureaucrats would create opportunities for corrupt activities. Hastily negotiated contracts could give incentives for rent-extracting behavior. Goel et al. explain that at the vaccine development and approval stage, pharmaceutical companies might bribe regulatory institutions to expedite the approval of new vaccines. Finally, they suggest that in the distribution process, consumers might try to bribe bureaucrats for two reasons: to obtain vaccines before their official eligibility and to seek additional doses to subsequently sell on the grey market.

Another channel for the effect of corruption on vaccination progress is the quality of health systems. The quality of the health sector essentially defines the speed and effectiveness of the COVID-19 vaccination process. However, the health sector is also prone to corruption. Savedoff and Hussmann (2006) state: "No other sector has the specific mix of uncertainty, asymmetric information and large numbers of dispersed actors that characterize the health sector. As a result, susceptibility to corruption is a systemic feature of health systems […]." The authors underscore the enormous amounts of global government spending on health, which would make the health sector highly profitable and therefore especially vulnerable to corruption. Transparency International estimates that 7.5 trillion dollars every year are spent on public health globally, 500 billion dollars of which vanish due to corruption (Transparency International 2021c).

Sommer (2020) argues that corruption in the health sector reduces the available capital for health, increases the costs for patients, inhibits service improvement, reduces the quality of care and generally hinders reform and improvement. Health sectors which suffered from corruption prior to the crisis could be less effective during the Covid-19 pandemic. Farzanegan (2021), for example, has shown that the level of corruption is positively and significantly associated with COVID-19 fatality rates across countries. This negative effects of corruption could also lower the speed and scale of vaccination projects worldwide.

Moreover, there is scientific evidence for the substantial negative effects of corruption on the health sector. Hanf et al. (2011) find a positive relationship between corruption and child mortality. The authors estimate that more than 140,000 deaths of children every year could be indirectly attributed to corruption. Sommer (2020) also focuses on child and infant mortality as the dependent variable and concludes that the interaction between corruption and health expenditures negatively affects child and infant mortality. Li et al. (2018) also verify the negative effects of corruption on five different measures of health outcomes and conclude that corruption causes deaths. Habibov (2016) finds a negative relationship between corruption experienced in the healthcare sector and satisfaction with healthcare as subjective indicators. Achim et al. (2020) find that higher levels of corruption negatively affect physical (expressed as life expectancy and mortality) and mental health (expressed by happiness).

Another way in which corruption may affect COVID-19 vaccination progress is in social and political trust. Studies find that corruption negatively affects trust (see for example Wang 2016; Rothstein and Eek 2009; Peerthum and Luckho 2021). Low levels of political trust may decrease the acceptance of vaccines against the COVID-19 virus. Empirical research finds a negative effect of trust on vaccine acceptance during previous immunization campaigns (Rönnerstrand 2016; Freimuth et al. 2017). During COVID-19, trust in institutions and the health sector is especially crucial due to the shortened clinical trials and emergency approvals of the vaccines in many countries.

In addition to the direct causes of corruption on the vaccination progress, the development stage of the COVID-19 vaccines needs to be considered. The first vaccine approved by the US Food and Drug Administration was from Pfizer/BioNTech (United States Food and Drug Administration 2021). BioNTech is a German startup that collaborated with Pfizer to develop a COVID-19 vaccine. One of the co-founders of the BioNTech Company, Dr. Ugur Sahin, commented in an interview with the New York Times regarding the development of the vaccine: "There are not too many companies on the planet which have the capacity and the competence to do it so fast as we can do it […]" (Gelles 2020). The fast development of effective vaccines against the COVID-19 virus presupposed a constructive climate for entrepreneurship and highly educated scientists. Higher levels of corruption have been shown to have negative effects on productive entrepreneurship (Avnimelech et al. 2014) and quality of education (Farzanegan and Thum 2020). Therefore, corruption may additionally have indirect impacts on the vaccination projects by reducing entrepreneurship and the quality of education in the long term.

In short, based on additional government intervention due to the urgent response required by the virus, the high potential to sell vaccines on the grey market, the negative effects of corruption on the health sector and its role in the vaccine distribution process, and the potential negative effect of corruption on public trust in the vaccine, we expect corruption to be negatively associated with cross-country COVID-19 vaccination progress. Our hypothesis is, therefore:

Hypothesis: Higher levels of pre-pandemic corruption have a negative effect on the percentage of the population who are partially or fully vaccinated against COVID-19, *ceteris paribus.*

3. Methods

Study variables and data sources

Our main dependent variables are the percentage of the population who received at least their first dose of a COVID-19 vaccine and the percentage of the population who are fully vaccinated, whereas “fully vaccinated” refers to people who have been fully vaccinated with either a single- or two-dose vaccine. The data for vaccination coverage is from Bloomberg (2021). Our dependent variable shows the status of countries on 30 August 2021.

The primary independent variable is a measure of corruption. We use the control of corruption index from World Governance Indicators (WGI, 2021), which shows perception of the extent to which public power is exercised for private gain and capture of the state by private interest and elites. We reverse this index by multiplying it with -1. Thus, a higher score means a higher level of perceived corruption. We use the scores of countries in 2019, reducing the risk of reverse feedback from the COVID-19 outbreak in 2020 and 2021 and vaccination projects (Goel and Nelson 2021 explain the implications of COVID-19 vaccine rollouts on corruption in the case study of the US). For a robustness check, we also use the corruption perception index (CPI) from Transparency International in 2019. CPI is a composite index based on a combination of 13 surveys that shows how corrupt a country’s public sector is perceived to be by experts and business executives (Transparency International 2021a). Theoretically, it is in the range of 0 (most corrupt) to 100 (least corrupt). We subtract the original scores from 100 and thus higher values refer to more corruption.

Progress in COVID-19 immunization is not just a function of administrative corruption. To check for other possible drivers of speed and coverage of vaccination projects, we consider a set of socio-economic, health and institutional indicators in the pre-pandemic period. The inclusion of such variables is important because they can be correlated with both corruption and vaccination coverage. These control variables are the log of GDP per capita, the log of physicians (per 1,000 people), the log of domestic general government health expenditure per capita, the log of nurses and midwives (per 1,000 people), and urban population (% of total population). These variables are taken from the World Development Indicators of the World Bank (2021). In addition, we control for the quality of political institutions by including the Polity2 index, which is taken from Marshall et al. (2019), and the government effectiveness index from WGI (2021). Government effectiveness has already been proven to be negatively associated with COVID-19 mortality (Liang et al. 2020). Moreover, countries with high ethnical fractionalization may suffer from a variety of socio-economic and policy distortions (Alesina et al. 2003). We also control for this issue using the fractionalization index from Drazanova (2020). Countries with higher integration in international markets and more economic openness may have faster access to suppliers of COVID-19 vaccines. Thus, we also control for the globalization using the

2018 index (latest available year) from Gygli et al. (2019). Finally, we control for continent dummy variables that consider other regional characteristics which may explain cross-country variations in the progress of vaccination against COVID-19.

Appendix A provides detailed information on the variables and their sources. Table 1 presents the summary statistics of variables.

The baseline econometric model has the following form and we estimate it with ordinary least squares (OLS) and robust standard errors.

$$covid19\_vaccinations_i = \alpha + \beta_1 . corruption_i + \beta'_2 . Z_i + \varepsilon_i \quad (1)$$

The subscript *i* refers to country *i*. Corruption denotes the corruption index. In our baseline specification, we use the corruption index from 2019 and expect a negative influence of corruption on the percentage of the population who have been vaccinated against COVID-19. *Z* is a vector of control variables including continent dummy variables. We distinguish between six different continents: Africa, Asia, Europe, North America, South America, and Oceania (reference category). In addition, *Z* contains the political–socio-economic control variables in pre-pandemic time (in most cases, to increase the number of observations, the average values between 2017 and 2019 are used).

4. Results

Table 2 shows the estimation results for the share of people in the total population who were vaccinated once as the dependent variable. Table 3 shows the share of people who are fully vaccinated as the dependent variable. Our focus lies on corruption as the explanatory variable. The first 13 models show the level of corruption according to the (reversed) control of corruption index from the World Governance Indicators. Model 14 in Tables 2 and 3 is a robustness test by applying the level of corruption in countries according to the (modified) corruption perceptions index from Transparency International. Higher levels in the index can be understood as higher levels of corruption.

Model 1 in Table 2 shows the bivariate regression between levels of corruption, based on WGI data, and the share of people who have been vaccinated once as the dependent variable and explains 50% of the variation in cross-country vaccination progress. In Table 3 (Model 1), corruption explains 48% of the differing levels in fully vaccinated people in the total population. We progressively add the regional dummies and socio-economic and health indicators to reduce the possibility of omitted variable bias. Corruption shows a robust negative association with vaccination progress in Tables 2 and 3. The negative influence of pre-pandemic corruption is robust to other socio-economic differences, as well as differences in the quality of political institutions, degree of globalization and ethnic fractionalization. Model 12 shows the effect of corruption based on WGI data on the share of people who have been vaccinated once (Table 2) and the share of people who are fully vaccinated (Table 3) after including all control variables, showing satisfactory results in line with our hypothesis. We examined the issue of multicollinearity in our general specifications and excluded two variables with *variance inflation factors* larger than 10 (government effectiveness index and domestic general government health expenditure per capita). This process has no influence on our main results.

Model 13 for both dependent variables show the net effect of the WGI corruption index on vaccination progress after considering the effects of socio-economic, health and institutional indicators. A robust negative association between cross-country vaccination progress and different levels of corruption according to both indexes can be observed in Table 2 and Table 3. In Model 13 of Table 2, our measure of corruption is from a minimum of -2.17 (for New Zealand) to the maximum of 1.60 (for Libya). An interquartile change for this variable in Model 13 is 1.44. In this model, the share of people who have been vaccinated once ranges from 0.2% (Chad) to 82.8% (Qatar) and has a standard deviation of 26.8. The interquartile change in this variable is 51 percentage points.

In Table 2, Model 13 shows that an increase of corruption by 1.44 unit (an interquartile change) is associated with a decline by 14.5 percentage points in the share of the population who have been vaccinated once, adjusting for other factors. This effect is statistically significant at 99% confidence interval, keeping other factors constant.

An increase in the (reversed) WGI corruption index by 1.49 unit of an interquartile change is associated with a decrease of 13.5 percentage points in the share of fully vaccinated people and can be observed in Table 3, Model 13. The effect of corruption (WGI) in this model is statistically significant at the 95% confidence interval. Among the other identified drivers of the vaccination process, the log of GDP per capita shows a positive and significant association with the share of people who are partially and fully vaccinated (Tables 2 and 3, Model 13). The Polity index also shows significance in Model 13 of both tables, with a negative effect on the partially and fully vaccinated population. The negative association is only significant at 10% level for the fully vaccinated population. Goel et al. (2021) argue that authoritarian regimes may be more efficient in vaccination projects due to "fewer time-consuming checks and balances." In democratic regimes, different layers of administration could also decrease trust in vaccines. In spring 2021, many European countries suspended the use of Astra Zeneca due to the risk of blood clots (Deutsche Welle 2021b). After a few days of suspension, the vaccine was approved by the European Medicines Agency (EMA) and its usage was resumed. However, the suspension resulted in a sharp decrease in trust in the Astra Zeneca substance (Deutsche Welle 2021a).

In Model 14 of Tables 2 and 3, we use the corruption index from Transparency International as a robustness check. The level of corruption according to the CPI score has a standard deviation of 18.5 and ranges, after being re-scaled by us, from 13 (in New Zealand) to 84 (in Sudan) with an interquartile change of 30 (Table 2, Model 14). An increase of 30 units in the Transparency International corruption index in Model 14 of Table 2 is associated with a decline of 16.8 percentage points in the vaccinated population. A similar increase in corruption in Model 14 of Table 3 is associated with a decline of 16.7 percentage points in the fully vaccinated population across countries.

Table 1. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max	Sources
Given 1 dose (30 Aug. 2021) % of population	190	35.945	26.464	0.1	83.6	a)
Fully vaccinated (30 Aug. 2021) % of population	186	28.446	24.806	0.1	83.4	a)
Control of corruption (in 2019) (re-scaled) *	188	0	1.003	-2.17	1.774	b)
Corruption perceptions index (in 2019) (re-scaled) **	171	56.07	19.008	13	91	c)
log of GDP per capita (2017-19)	183	8.807	1.467	5.936	12.192	d)
log of physicians (per 1,000 people) (2017-19)	113	0.092	1.327	-3.33	2.123	d)
log of domestic general government health expenditure per capita (2017-19)	177	5.835	1.738	1.424	8.645	d)
log of nurses and midwives (per 1,000 people) (2017-19)	146	0.981	1.166	-2.643	4.541	d)
Urban population (% of population) (2017-19)	191	60.349	23.927	13.174	100	d)
Polity2 index (in 2018)	160	4.375	6.04	-10	10	e)
Government effectiveness (in 2019)	188	0.033	0.997	-2.452	2.221	b)
Fractionalization	149	0.461	0.25	0.019	0.889	f)
Globalization (in 2018)	184	62.78	14.243	30.164	90.794	g)

*re-scaled by multiplying the original index by -1. Higher scores show higher levels of petty and grand corruption. **rescaled by subtracting the original index from 100. Higher scores show higher levels of public corruption.

Sources: a) Bloomberg (2021); b) WGI (2021); c) Transparency International (2021a); d) WDI (2021); e) Marshall et al. (2019); f) Drazanova (2020); g) Gygli et al. (2019)

Table 2. Regression results with the population who have received one COVID-19 vaccine as of 30.08.2021 in % of the population and corruption as the explanatory variable.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
							Given 1 dose (by 30 August 2021)							
Corruption in 2019 (WGI)	-18.650***	-14.811***	-7.160***	-12.785***	-7.993***	-10.306***	-12.226***	-16.768***	-2.477	-16.083***	-11.760***	-10.383**	-10.100***	
	(-17.10)	(-10.71)	(-3.80)	(-6.75)	(-4.28)	(-5.59)	(-7.92)	(-13.45)	(-0.73)	(-12.14)	(-6.42)	(-2.17)	(-2.89)	
Corruption in 2019 (TI)														-0.560***
														(-3.00)
log of GDP per capita			8.852***									5.380*	8.103***	8.136***
			(6.41)									(1.67)	(2.84)	(2.92)
log of physicians (per 1,000 people)				5.184***								0.048	1.061	0.787
				(3.12)								(0.02)	(0.42)	(0.32)
log of domestic general government health expenditure per capita					7.108***							3.795		
					(5.32)							(1.19)		
log of nurses and midwives (per 1,000 people)						4.628***						-1.407	-0.711	-0.760
						(3.26)						(-0.60)	(-0.35)	(-0.38)
Urban population (% of total population)							0.265***					-0.103	-0.074	-0.079
							(4.39)					(-0.71)	(-0.53)	(-0.56)
Polity2 index								-0.630**				-0.639**	-0.671**	-0.628**
								(-2.15)				(-2.16)	(-2.29)	(-2.08)
Government effectiveness									14.910***			-1.196		
									(4.35)			(-0.20)		
Fractionalization										-2.947		5.853	4.613	4.211
										(-0.52)		(0.87)	(0.69)	(0.64)
Globalization											0.561***	0.325	0.246	0.210
											(3.40)	(0.76)	(0.64)	(0.52)
Africa		-11.136*	-7.299	8.106	-6.317	-11.653*	-13.791**	-4.377	-9.462	-1.303	-7.968	15.046*	15.609*	15.091*
		(-1.73)	(-1.21)	(1.15)	(-0.98)	(-1.82)	(-2.12)	(-0.66)	(-1.65)	(-0.12)	(-1.17)	(1.70)	(1.82)	(1.74)
Asia		10.342	6.518	20.498***	7.215	9.489	5.059	16.201**	5.706	21.292**	9.541	28.482***	28.319***	28.179***
		(1.61)	(1.05)	(3.02)	(1.11)	(1.44)	(0.76)	(2.34)	(0.94)	(2.05)	(1.35)	(3.99)	(3.94)	(3.80)
North America		9.344	2.710	14.759**	0.342	5.368	4.946	24.927***	6.542	25.742**	10.238	28.508***	30.373***	31.182***
		(1.33)	(0.40)	(2.20)	(0.05)	(0.75)	(0.71)	(3.28)	(1.04)	(2.35)	(1.33)	(4.17)	(4.66)	(4.44)
South America		20.257***	15.582**	32.266***	11.617*	18.926***	11.267	29.593***	18.754***	31.605***	18.598**	44.039***	45.257***	45.749***
		(3.05)	(2.35)	(5.06)	(1.66)	(2.89)	(1.59)	(4.37)	(3.07)	(3.04)	(2.55)	(6.98)	(7.82)	(7.54)
Europe		12.232*	3.807	23.508***	2.897	11.753*	6.478	20.452***	6.300	20.610**	3.623	26.627***	27.859***	27.522***
		(1.96)	(0.61)	(4.01)	(0.43)	(1.77)	(0.98)	(3.18)	(1.08)	(2.09)	(0.46)	(3.95)	(4.19)	(3.97)
Observations	183	183	179	112	174	145	182	158	183	147	179	92	93	93
R-squared	0.50	0.64	0.71	0.73	0.70	0.65	0.68	0.72	0.68	0.70	0.68	0.81	0.81	0.81

Note: Method of estimation is ordinary least squares. Robust *t* statistics are in parentheses. ***, **, * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3. Regression results with the population who have been fully vaccinated against COVID-19 as of 30.08.2021 in % of the population and corruption as the explanatory variable.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Fully vaccinated (by 30 August 2021)													
Corruption in 2019 (WGI)	-16.898***	-13.200***	-5.407***	-11.324***	-7.187***	-9.053***	-10.810***	-14.508***	-1.590	-14.338***	-11.170***	-8.187	-9.065**	
	(-14.63)	(-9.00)	(-2.61)	(-5.52)	(-3.56)	(-4.20)	(-6.49)	(-10.32)	(-0.45)	(-9.95)	(-5.88)	(-1.45)	(-2.34)	
Corruption in 2019 (TI)														-0.538**
														(-2.63)
log of GDP per capita			8.841***									6.537**	7.159**	6.947**
			(5.58)									(2.11)	(2.64)	(2.60)
log of physicians (per 1,000 people)				4.086**								0.854	0.994	0.799
				(2.32)								(0.31)	(0.38)	(0.32)
log of domestic general government health expenditure per capita					5.901***							0.641		
					(4.17)							(0.21)		
log of nurses and midwives (per 1,000 people)						3.166*						-1.617	-1.547	-1.730
						(1.86)						(-0.67)	(-0.67)	(-0.79)
Urban population (% of total population)							0.237***					-0.058	-0.063	-0.060
							(3.63)					(-0.44)	(-0.48)	(-0.46)
Polity2 index								-0.491				-0.558*	-0.566*	-0.527
								(-1.62)				(-1.70)	(-1.74)	(-1.59)
Government effectiveness									14.057***			1.415		
									(3.95)			(0.20)		
Fractionalization										-1.302		5.771	5.750	5.269
										(-0.25)		(0.87)	(0.91)	(0.85)
Globalization											0.408**	0.242	0.287	0.232
											(2.40)	(0.54)	(0.76)	(0.60)
Africa		-2.086	2.555	13.801	2.803	-3.527	-3.352	4.924	0.445	11.141*	4.654	24.908***	25.049***	25.193***
		(-0.30)	(0.42)	(1.48)	(0.42)	(-0.52)	(-0.47)	(1.04)	(0.07)	(1.76)	(0.80)	(2.83)	(2.88)	(2.87)
Asia		12.567*	9.729	20.524**	10.785	11.975	8.964	19.417***	9.058	27.866***	16.426***	32.552***	32.847***	33.208***
		(1.78)	(1.51)	(2.30)	(1.53)	(1.65)	(1.22)	(3.80)	(1.38)	(4.45)	(2.72)	(4.36)	(4.41)	(4.38)
North America		12.354*	6.847	15.940*	4.626	7.665	9.572	23.416***	10.758	28.022***	17.397***	30.779***	31.267***	32.642***
		(1.67)	(1.03)	(1.89)	(0.65)	(1.06)	(1.29)	(3.96)	(1.65)	(4.06)	(2.61)	(4.29)	(4.73)	(4.64)
South America		19.584***	15.785**	28.578***	13.582*	18.610**	12.663	28.982***	19.220***	34.626***	22.856***	43.295***	43.593***	44.492***
		(2.66)	(2.15)	(3.12)	(1.72)	(2.47)	(1.57)	(5.39)	(2.83)	(5.32)	(3.54)	(5.34)	(5.60)	(5.75)
Europe		20.935***	13.724**	32.317***	14.709**	23.124***	16.988**	29.546***	16.379**	33.530***	19.109***	39.766***	39.604***	39.968***
		(3.05)	(2.10)	(4.15)	(2.05)	(3.18)	(2.34)	(6.34)	(2.56)	(6.12)	(2.77)	(5.55)	(5.72)	(5.66)
Observations	179	179	175	110	171	141	178	155	179	144	175	91	91	91
R-squared	0.48	0.59	0.66	0.69	0.64	0.61	0.62	0.67	0.63	0.66	0.62	0.76	0.76	0.77

Note: Method of estimation is ordinary least squares. Robust *t* statistics are in parentheses. ***, **, * refer to statistical significance at the 1%, 5%, and 10% levels, respectively.

5. Conclusion and policy implications

The goal of this study was to analyze the effects of corruption on the global vaccination progress against COVID-19 across countries. Based on the overall hindering effect of corruption on vaccine development, we expected corruption to be negatively associated with COVID-19 vaccination progress. The hypothesis was that countries with higher pre-pandemic corruption levels, on average, show a lower level of progress in the vaccination of the population against COVID-19, *ceteris paribus*. We tested our hypothesis by applying multivariate regression models with ordinary least squares. The data was cross-sectional and we held a set of pre-pandemic socio-economic, health and institutional indicators constant in order to minimize the possibility of a spurious relationship. Our final model included more than 90 countries.

Both re-scaled corruption indicators, control of corruption from the World Governance Indicators and the corruption perceptions index from Transparency International, showed a significant and robust negative effect on the share of people who have been partially or fully vaccinated, *ceteris paribus*.

Our findings provide the first empirical insight on the destructive role of pre-pandemic public corruption on the success of vaccination projects and are in line with related evidence in current literature. Azfar and Gurgur (2008) find that in areas in the Philippines with widespread corruption, respondents reported longer wait times in public clinics and a higher frequency of being denied vaccines even prior to the COVID-19 crisis. Among other health outcomes, which were negatively associated with corruption, the authors find that corruption reduces immunization rates and delays the vaccination of newborns. Li et al. (2018) study the effect of corruption on different health outcomes. Dependent variables include DPT (diphtheria, pertussis or whooping cough, and tetanus) immunization and measles immunization rates. They find a negative effect of corruption on DPT and measles immunization. Factor and Kang (2015) analyze the effects of corruption on different health indicators, including immunization. Their results show that higher corruption is associated with lower levels of health expenditures as a percentage of GDP per capita, and with poorer health outcomes in general. Higher levels of corruption show a negative effect on the DPT immunization rates in particular. Lewis (2006) finds a negative effect of the control of corruption index on measles immunization coverage (% of children ages 12-23 months).

Corruption has proven to be a significant driver of the cross-country COVID-19 vaccination progress. Our findings have important policy implications for the global fight against the COVID-19 pandemic. Much work remains in vaccinating the global population against the COVID-19 virus and constantly mutating virus variants might force the need for recurring booster vaccinations. Anti-corruption reforms are urgently needed in the fight against the virus of corruption, which hampers the fight against the COVID-19 virus.

Appendix

Table A1: Data description

Dependent Variables	Definition	Source
Given 1dose	People vaccinated at least once with Covid-19 vaccinations as of 30.08.2021 in % of the population	Bloomberg 2021
Fully vaccinated	Completed Covid-19 vaccinations as of 30.08.2021 in % of the population	Bloomberg 2021
Explanatory Variables		
Corruption (WGI)	Control of corruption: Estimate, latest year available: 2019*-1	WGI 2021
Corruption (TI)	100- Corruption perceptions index scores 2019	Transparency International 2021a
GDP per capita	Log of GDP per capita, (constant 2010 US$), average 2017-2019	WDI 2021
Physicians	Log of Physicians (per 1,000 people), average 2017-2019	WDI 2021
Domestic general government health expenditure per capita	Log of domestic general government health expenditure per capita, PPP (current international $), average 2017-2019	WDI 2021
Nurses and midwives	Log of nurses and midwives (per 1,000 people), average 2017-2019	WDI 2021
Urban population	Urban population (% of total population), average 2017-2019	WDI 2021
Polity2 index	Combined Polity 2 Score in 2018 from -10 (full autocracy) to 10(full democracy)	Marshall et al. 2019
Government effectiveness	Government effectiveness: Estimate, latest year available: 2019	WGI 2021
Fractionalization	Historical Index of Ethnic Fractionalization,	Drazanova 2020
Globalization	KOF Globalisation Index in 2018	Gygli et al. 2019

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on request.

References

Achim, M. V., Văidean, V. L., Borlea, S. N. 2020. Corruption and health outcomes within an economic and cultural framework. *The European Journal of Health Economics* 21 (2), 195–207.

Alesina, A., Devleeschauwer, A., Easterly, W., Kurlat, S., Wacziarg, R. 2003. Fractionalization. *Journal of Economic Growth* 8, 155–194.

Avnimelech, G., Zelekha, Y., Sharabi, E. 2014. The effect of corruption on entrepreneurship in developed vs non-developed countries. *International Journal of Entrepreneurial Behavior & Research* 20 (3), 237–262.

Azfar, O., Gurgur, T. 2008. Does corruption affect health outcomes in the Philippines? *Economics of Governance* 9 (3), 197–244.

Bloomberg. 2021. Vaccine Tracker. Available at: https://www.bloomberg.com/graphics/covid-vaccine-tracker-global-distribution/ (accessed 8/30/2021).

Brasileiro, A. 2021. VIP vaccine scandals add to political instability in Latin America. Available at: https://www.miamiherald.com/news/coronavirus/article249536473.html (accessed 9/3/2021).

Deutsche Welle. 2021a. European trust in AstraZeneca COVID vaccine plunges. Available at: https://www.dw.com/en/european-trust-in-astrazeneca-covid-vaccine-plunges-survey/a-56946669 (accessed 9/6/2021).

Deutsche Welle. 2021b. Germany suspends use of AstraZeneca vaccine, along with Italy, France, Spain. Available at: https://www.dw.com/en/germany-suspends-use-of-astrazeneca-vaccine-along-with-italy-france-spain/a-56878920 (accessed 9/6/2021).

Drazanova, L. 2020. Historical Index of Ethnic Fractionalization (HIEF) Dataset: Accounting for Longitudinal Changes in Ethnic Diversity. *Journal of Open Humanities Data* 6.

European Anti-Fraud Office. 2021. OLAF warns against fraudsters offering COVID-19 vaccines. Press Release from the European Anti-Fraud Office. Available at: https://ec.europa.eu/anti-fraud/media-corner/news/15-02-2021/olaf-warns-against-fraudsters-offering-covid-19-vaccines_en (accessed 9/3/2021).

Factor, R., Kang, M. 2015. Corruption and population health outcomes: an analysis of data from 133 countries using structural equation modeling. *International Journal of Public Health* 60 (6), 633–641.

Farzanegan, M. R. 2009. Illegal trade in the Iranian economy: Evidence from a structural model. *European Journal of Political Economy* 25 (4), 489–507.

Farzanegan, M. R. 2021. The effect of public corruption on Covid-19 fatality rate: A cross-country examination. CESifo Working Paper No. 8938, 1–14.

Farzanegan, M. R., Thum, M. 2020. Does oil rents dependency reduce the quality of education? *Empirical Economics* 58, 1863–1911.

Fazio, A., Reggiani, T. G., Sabatini, F. 2021. The political cost of lockdown's enforcement. Discussion Paper Series from the Institute of Labor Economics, Working Paper No.14032, 1–31.

France 24. 2021. Spanish officials under fire for jumping queue for Covid-19 vaccine. Available at: https://www.france24.com/en/europe/20210125-spanish-officials-under-fire-for-jumping-queue-for-covid-19-vaccine (accessed 9/3/2021).

Freimuth, V. S., Jamison, A. M., An, J., Hancock, G. R., Quinn, S. C. 2017. Determinants of trust in the flu vaccine for African Americans and Whites. *Social Science & Medicine* 193, 70–79.

Gelles, D. 2020. The husband-and-wife team behind the leading vaccine to solve Covid-19. Available at: https://www.nytimes.com/2020/11/10/business/biontech-covid-vaccine.html (accessed 9/3/2021).

Goel, R. K., Nelson, M. A. 2021. Drivers of COVID-19 vaccinations: vaccine delivery and delivery efficiency in the United States. *Netnomics*.

Goel, R. K., Nelson, M. A., Goel, V. Y. 2021. COVID-19 vaccine rollout-scale and speed carry different implications for corruption. *Journal of Policy Modeling* 43 (3), 503–520.

Gygli, S., Haelg, F., Potrafke, N., Sturm, J.-E. 2019. The KOF Globalisation Index – Revisited. *Review of International Organizations* 14 (3), 543–574.

Habibov, N. 2016. Effect of corruption on healthcare satisfaction in post-soviet nations: A cross-country instrumental variable analysis of twelve countries. *Social Science & Medicine* 152, 119–124.

Hanf, M., Van-Melle, A., Fraisse, F., Roger, A., Carme, B., Nacher, M. 2011. Corruption kills: estimating the global impact of corruption on children deaths. *PloS One* 6 (11), 1-7.

Hubbard, B. 2021. Politicians in Lebanon jump the vaccine line, touching off a scandal. Available at: https://www.nytimes.com/2021/02/23/world/politicians-in-lebanon-jump-the-vaccine-line-touching-off-a-scandal.html (accessed 9/3/2021).

Human Rights Watch. 2021. Rights key to tackle corruption, inequity in vaccine access. Available at: https://www.hrw.org/news/2021/03/11/rights-key-tackle-corruption-inequity-vaccine-access (accessed 9/3/2021).

Institute for Health Metrics and Evaluation. 2021. COVID-19 vaccine efficacy summary. Available at: http://www.healthdata.org/covid/covid-19-vaccine-efficacy-summary (accessed 9/3/2021).

Iran International. 2021. Iran health official accuses companies of corruption in vaccine imports. Available at: https://iranintl.com/en/iran/iran-health-official-accuses-companies-corruption-vaccine-imports

Lambsdorff, J. G. 2007. The institutional economics of corruption and reform. Cambridge: Cambridge University Press.

Le, K., Nguyen, M. 2021. The psychological consequences of COVID-19 lockdowns. *International Review of Applied Economics* 35 (2), 147–163.

Lewis, M. 2006. Governance and corruption in public health care systems. *SSRN Electronic Journal.* Center for Global Development, Working Paper Number 78.

Li, Q., An, L., Xu, J., Baliamoune-Lutz, M. 2018. Corruption costs lives: evidence from a cross-country study. *The European Journal of Health Economics* 19 (1), 153–165.

Liang, L.-L., Tseng, C.-H., Ho, H. J., Wu, C.-Y. 2020. Covid-19 mortality is negatively associated with test number and government effectiveness. *Scientific reports* 10 (1), 12567.

Mandel, A., Veetil, V. 2020. The economic cost of COVID lockdowns: An out-of-equilibrium analysis. *Economics of Disasters and Climate Change* 4, 431–451.

Marshall, M. G., Gurr, T. R., Jaggers, K. 2019. Polity IV Project: Dataset Users' Manual v2018. Center for Systemic Peace.

Peerthum, S., Luckho, T. 2021. Exploring the Linkage Between Public Corruption and Political Trust in Mauritius: a PLS-SEM Approach. *Public Organization Review* 21 (2), 317–335.

Rönnerstrand, B. 2016. Contextual generalized trust and immunization against the 2009 A(H1N1) pandemic in the American states: A multilevel approach. *SSM - Population Health* 2, 632–639.

Rothstein, B., Eek, D. 2009. Political corruption and social trust. *Rationality and Society* 21 (1), 81–112.

Savedoff, W. D., Hussmann, K. 2006. Why are Health Systems Prone to Corruption? In: Transparency International (Ed.), Global Corruption Report 2006. Pluto Press, London; Ann Arbor, pp.4–13.

Smith, M. 2021. The global vaccine rollout means heightened corruption risk. Here's what to know. Available at: https://www.barrons.com/articles/the-global-vaccine-rollout-means-heightened-corruption-risk-heres-what-to-know-51616796521 (accessed 9/3/2021).

Sommer, J. M. 2020. Corruption and health expenditure: A cross-national analysis on infant and child mortality. *The European Journal of Development Research* 32 (3), 690–717.

Transparency International. 2021a. Corruptions perceptions index. Berlin: Transparency International.

Transparency International. 2021b. COVID-19 vaccine transparency. Available at: https://www.transparency.org/en/news/covid-19-vaccine-transparency (accessed 9/3/2021).

Transparency International. 2021c. Health. Available at: https://www.transparency.org/en/our-priorities/health-and-corruption (accessed 9/3/2021).

United Nations. 2020. Statement on corruption in the context of Covid-19. Available at: https://www.unodc.org/unodc/en/corruption/covid19.html (accessed 9/3/2021).

United Nations Office on Drugs and Crime. 2021. Covid-19 vaccines and corruption risks: Preventing corruption in the manufacture, allocation and distribution of vaccines. Available at: https://www.unodc.org/documents/corruption/COVID-19/Policy_paper_on_COVID-19_vaccines_and_corruption_risks.pdf (accessed 9/3/2021).

United States Food and Drug Administration. 2021. FDA approves first COVID-19 vaccine. Available at: https://www.fda.gov/news-events/press-announcements/fda-approves-first-covid-19-vaccine. (accessed 9/3/2021).

Wang, C.-H. 2016. Government performance, corruption, and political trust in East Asia. *Social Science Quarterly* 97 (2), 211–231.

WDI. 2021. World Development Indicators. Washington DC: World Bank.

WGI. 2021. World Governance Indicators. Washington DC: World Bank.

Zamani, O., Farzanegan, R. M., Loy, J.-P., Einian, M. 2021. The impact of energy sanctions on the black-market premium: Evidence from Iran. *Economics Bulletin* 41 (2), 432–443.