

Ngo, Vu M.; Zimmermann, Klaus F.; Nguyen, Phuc V.; Huynh, Toan L.D.;
Nguyen, Huan H.

Working Paper

How education and GDP drive the COVID-19 vaccination campaign

GLO Discussion Paper, No. 986

Provided in Cooperation with:
Global Labor Organization (GLO)

Suggested Citation: Ngo, Vu M.; Zimmermann, Klaus F.; Nguyen, Phuc V.; Huynh, Toan L.D.;
Nguyen, Huan H. (2021) : How education and GDP drive the COVID-19 vaccination campaign,
GLO Discussion Paper, No. 986, Global Labor Organization (GLO), Essen

This Version is available at:
<http://hdl.handle.net/10419/246812>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen
Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle
Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich
machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen
(insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten,
gelten abweichend von diesen Nutzungsbedingungen die in der dort
genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

*Documents in EconStor may be saved and copied for your
personal and scholarly purposes.*

*You are not to copy documents for public or commercial
purposes, to exhibit the documents publicly, to make them
publicly available on the internet, or to distribute or otherwise
use the documents in public.*

*If the documents have been made available under an Open
Content Licence (especially Creative Commons Licences), you
may exercise further usage rights as specified in the indicated
licence.*

How education and GDP drive the COVID-19 vaccination campaign

Vu M. Ngo¹ Klaus F. Zimmermann² Phuc V. Nguyen³ Toan L.D. Huynh⁴ Huan H. Nguyen⁵

Draft: November 11, 2021

Abstract

Since vaccination is the decisive factor for controlling the COVID-19 pandemic, it is important to understand the process to vaccination success. We identify a variety of factors playing a crucial role including the availability of vaccines, pandemic pressures, economic strength (GDP), educational development and political regimes. Examining the speed of vaccinations across countries, we find that initially authoritarian countries are slow in the vaccination process, while education is most relevant for scaling up the campaign and financial strength of the economies drive them to higher vaccination rates.

JEL Classification: D72; C30; P16; I19

Keywords: COVID-19; educational development; political regimes; vaccination

¹ University of Economics Ho Chi Minh City (Vietnam). Email: vunm@ueh.edu.vn

² UNU-MERIT & Maastricht University, Netherlands & Centre for Economic Policy Research (CEPR), United Kingdom & Global Labor Organization (GLO), Germany. Email: klaus.f.zimmermann@gmail.com; corresponding author. ORCID ID: 0000-0003-2804-5692

³ Massey University (New Zealand) & Global Labor Organization (GLO, Germany). Email: p.nguyen@massey.ac.nz

⁴ University of Economics Ho Chi Minh City (Vietnam) & WHU – Otto Beisheim School of Management (Germany) & IPAG Business School (France) & Global Labor Organization (GLO, Germany). Email: toanhld@ueh.edu.vn

⁵ University of Economics Ho Chi Minh City (Vietnam). Email: huannguyen@ueh.edu.vn

1. Introduction

Vaccination is the dominant strategy to fight the COVID-19 disease. Access to vaccines, the effectiveness of vaccination campaigns and the acceptance among populations are determined by many factors like the political regime, the state of the health system, the financial resources and the educational conditions of the respective countries. Top priority is to reinstate normalcy after high numbers of deaths, overloaded sanitary systems, and huge economic burdens. Challenges are high for countries with incompetent health systems and hygiene facilities as well as aging populations (Boodoosingh et al., 2020). However, vaccine availability does not equate to vaccines accessibility. ‘*Vaccine nationalism*’ became popular amongst rich nations thereby exacerbating the vaccine shortage (Burki, 2021; Alaran et al., 2021).

Recent literature on COVID-19 suggests that democratic countries suffered more through higher infections but had lower case fatality rates (Karabulut et al., 2021). While vaccine acceptance was highest in authoritarian countries (China, Vietnam), cash is used for vaccination promotion in some democratic countries like the US, Serbia, Greece, and Canada (Wouters et al., 2021). Vaccination hesitancy of the population across policy regimes could lead to large differences in vaccination speed. Further, political-related anti-vaccine conspiracy theories that have been prevalent since the start of the COVID-19 pandemic are also strongly associated with reduced vaccination intentions (Jolley and Douglas, 2014). Moore (2018) also points out that conspiracy theorists are more prevalent amongst the poor and poorly educated.

Trust in science and confidence in vaccinations are strongly related. Social consensus on trust in science is substantially stronger in countries with higher levels of formal education. Studying data collected before the COVID-19 pandemic, Sturgis et al., (2021) document that people are more confident about vaccination in countries where trust in science is high. Based on large-scale, longitudinal, and representative surveys for 12 countries during the pandemic in 2020, also employing experimental data, Algan et al. (2021) confirm that acceptance of non-pharmaceutical interventions as well as vaccinations during COVID-19 are strongly related to perceived trust in scientists as the key driving force.

There is a large expectation that better education in general leads to a stronger vaccination acceptance rate among populations, although direct evidence in the economics literature is missing. For instance, Mayuko et al. (2012) for the US and Damiani et al. (2007) for Italy find that the lower educated were less likely influenza vaccinated. Lu et al. (2009) document that among adults aged 60 years or older, the better educated were more likely to receive herpes zoster vaccination than others. Khattak et al. (2021) reveal that parents in Pakistan who had no education were more likely to refuse vaccination of their children. A major contribution of our study therefore is to provide extra knowledge on the effects of educational development on vaccination performance.

To understand the factors affecting the success of the COVID-19 vaccination campaign better, this study reveals the relative strength of the effects of education, political regimes, vaccination policies and countries’ specific demographic factors on how they implement and scale up vaccination campaigns in the context of diverse COVID-19 infection challenges. The larger the pressure from infections, the stronger vaccination efforts of a country should be.

2. Data and Methodology

We investigate the success of the COVID-19 vaccination campaign by studying the number of days countries needed since its respective start to reach certain shares among populations: Daysto1%/5%/10%/20%/30%. The major driving factors considered are political, educational and economic backgrounds. The countries’ classifications of political regimes include full democracy, flawed democracy, hybrid, and authoritarian regimes provided by the 2020 *Economist* democracy report (EIU, 2020) based on their democratic score (1 to 10) calculated using key criteria such as electoral process and pluralism, functioning of government, political participation, political culture, and civil liberties. Compared

to the well-known Freedom House index (Freedomhouse, 2021), the EIU index covers more democratic features such as political culture and participation. The expected years of schooling index (UNDP, 2020) proxies development of the educational system (*YearsofSchooling*), and GDP per capita, economic development and capacity (*GDPpercapita*). Other control variables are population density (*PopulationDensity*), population shares of age of 65 and older (*Aged65older*), vaccines purchased (*VaccinesPurchased*), vaccine policies, average daily new infected COVID-19 cases (January 2020 to October 11, 2021; *AverageNewCases*) to capture relevance of societal pressures, and continent dummies. Estimation method is weighted least squares using population size as weight with robust standard errors. We also calculate the Owen–Shapley R^2 -decomposition to judge the contributions of key variables (Huettner and Sander, 2012). The Appendix provides explanations of data, sources, descriptive statistics and a number of robustness investigations.

3. Results

Table 1 shows the findings for vaccination levels 1%, 5%, 10%, 20%, and 30%, respectively, with rising R^2 's from 0.556 for 1% to 0.730 for 30%. They reveal a negative association with democracy with authoritarian country as the reference group. While estimated parameters are typically negative for the three types (full, flawed and hybrid), significance and size vary. For thresholds 1%, 5% and 10% they are significant at least at the 10% level. 14.2% points of the $R^2=0.556$ explanatory power in column (1) comes from these three political variables; political regimes explain 14.2% of the total variance of the *Daysto1%* total variance. This remains fairly stable in the vaccination process and is 14.8% points of $R^2=0.730$ for threshold *Daysto30%*.

Educated countries exhibit also a negative but throughout statistically significant effect on the duration to vaccination. The percentage contribution of *YearsofSchooling* to the explained variation is 24.1% for *Daysto1%*, but are somewhat smaller but robust (19.1%, 15.1%, 18.7% and 17.8%) in the next steps. Education is always more relevant for speeding up the process than political regimes.

The *GDPpercapita* effect is negative but small at the beginning, and becomes large and strongly significant with rising vaccination thresholds. The Owen-Shapley decomposition allocates the highest contributions for *Daysto10%*, *Daysto20%* and *Daysto30%* with 17.7%, 34.5% and 34.7%, respectively. *GDPpercapita* provides also the strongest contribution among all variables including the group of political regime variables from the 10% threshold level on.

AverageNewCases has throughout negative and 1% statistically significant coefficients. The pandemic provides extra incentives for countries to intensify the vaccination campaign. Measured by the Owen-Shapley contributions this pressure is strongest for 1% and 5%. *VaccinePolicy* matters for *Daysto1%*, and *VaccinesPurchased* speeds up vaccinations for the 5% and 10% thresholds significantly. *PopulationDensity* and *Aged65older* are mostly not statistically significant.

Extensions and robustness tests are documented in the Appendix. Using the Freedom House democracy classifications (Free, Partial Free, Not Free) to capture political regimes provides no conflicting results (Table A4). Using standard OLS instead of WLS for estimation keeps the core story, but at a much lower level of significance and explanatory power (Table A5), which confirms the WLS choice. Taking *AverageNewCases*, *VaccinesPurchased* and *VaccinePolicy* out of the regressions leads to stronger and all significant effects for *GDPpercapita*, and more negative and more significant estimates for the *Political Regime* variables, but the qualitative story remains again (Table A6). *YearsofSchooling* has just somewhat weaker and less significant effects. Obviously, those factors are also associated with the pandemic and vaccine-related control variables. A Cox proportional hazard model with failure event of reaching 30% vaccination uptake rate shows consistent findings to our main results.

4. Conclusions

The two most potent variables explaining the speed of the COVID-19 vaccination campaign are countries' education level and GDP per capita. More democratic countries have an initial advantage. Infection intensities support early vaccinations.

References

- Alaran, A.J., et al. (2021). Uneven power dynamics must be levelled in COVID-19 vaccines access and distribution. *Public Health in Practice*, 2:100096. et al.
- Algan, Y., Cohen, D., Davoine, E., Foucault, M., Stantcheva, S. (2021). Trust in scientists in times of pandemic: Panel evidence from 12 countries. *Proceedings of the National Academy of Sciences*, 118(40).
- Boodoosingh, R., Olayemi, L.O., Sam, F.A.L. (2020). COVID-19 vaccines: Getting anti-vaxxers involved in the discussion. *World Development*, 136:105177.
- Burki, T.K. (2021). Challenges in the rollout of COVID-19 vaccines worldwide. *The Lancet Respiratory Medicine*, 9(4):e42–e43.
- Damiani, G., Federico, B. Visca, M., Agostini, F., W. Ricciardi, W. (2007). The impact of socioeconomic level on influenza vaccination among Italian adults and elderly: A cross-sectional study. *Preventive Medicine* 45(5):373–79.
- Duke Global Health Innovation Center. (2021). COVID-19 Launch and Scale Speedometer. <https://launchandscalefaster.org/COVID-19>
- Fonseca, E.M., Jarman, H., King, E.J., Greer, S.L. (2021). Perspectives in the study of the political economy of COVID-19 vaccine regulation. *Regulation & Governance*.
- Huettner, F., Sunder, M. (2012). Axiomatic arguments for decomposing goodness of fit according to Shapley and Owen values. *Electronic Journal of Statistics*, 6:1239-1250.
- Jolley, D., Douglas, K.M. (2014). The effects of anti-vaccine conspiracy theories on vaccination intentions. *PLOS ONE*, 9(2):e89177.
- Karabulut, G., Zimmermann, K.F., Bilgin, M.H., & Doker, A.C. (2021). Democracy and COVID-19 outcomes. *Economics Letters*, 203:109840.
- Khattak, F.A., et al. (2021). Prevalence of parental refusal rate and its associated factors in routine immunization by using WHO vaccine hesitancy tool: A cross sectional study at district Bannu, KP, Pakistan. *International Journal of Infectious Diseases* 104:117–24.
- Lu, P.jun, Euler, G.L., Jumaan, A.O., Harpaz, R. (2009). Herpes zoster vaccination among adults aged 60 years or older in the United States, 2007: Uptake of the first new vaccine to target seniors. *Vaccine* 27(6):882–87.
- Mayuko, T., Wetmore, C.M, Mokdad, A.H. (2012). Characteristics associated with the uptake of influenza vaccination among adults in the United States. *Preventive Medicine* 54(5):358–62.
- Moore, A. (2018). Conspiracies, conspiracy theories and democracy: *Political Studies Review* 16(1):2–12.
- Sturgis, P., Brunton-Smith, I., Jackson, J. (2021). Trust in science, social consensus and vaccine confidence. *Nature Human Behaviour*. doi: 10.1038/s41562-021-01115-7.

The Economist Intelligence Unit. (2020). Democracy Index 2020.

<https://www.eiu.com/n/campaigns/democracy-index-2020/>

UNDP (2020). Human Development Index (HDI), Human Development Reports.

<http://hdr.undp.org/en/content/human-development-index-hdi>

Wouters, O.J., et al. (2021). Challenges in ensuring global access to COVID-19 vaccines: production, affordability, allocation, and deployment. *The Lancet*, 397(10278): 1023–1034.

Table 1: Speed of COVID-19 vaccinations

| | (1) | (2) | (3) | (4) | (5) |
|---|------------|------------|------------|------------|------------|
| | Daysto1% | Daysto5% | Daysto10% | Daysto20% | Daysto30% |
| Democracy (reference: authoritarian) | | | | | |
| Full | -21.869* | -18.624** | -21.015** | -12.673 | -20.985 |
| | (11.448) | (8.307) | (10.253) | (13.496) | (17.132) |
| Flawed | -19.927** | -23.632** | -15.869* | -2.844 | 0.571 |
| | (8.799) | (9.930) | (9.234) | (10.824) | (12.519) |
| Hybrid | -17.589* | -30.058* | -35.121** | -19.774 | -6.077 |
| | (8.919) | (16.314) | (17.600) | (15.779) | (15.624) |
| YearsofSchooling | -5.444*** | -7.946*** | -7.382*** | -6.859*** | -3.949* |
| | (1.800) | (2.137) | (2.600) | (2.193) | (2.076) |
| AverageNewCases | -0.176*** | -0.132** | -0.144*** | -0.215*** | -0.267*** |
| | (0.065) | (0.059) | (0.054) | (0.074) | (0.080) |
| GDPpercapita | -0.152 | -0.584* | -0.735** | -0.887*** | -1.063*** |
| | (0.196) | (0.304) | (0.296) | (0.293) | (0.301) |
| PopulationDensity | -1.622 | 0.141 | -1.282 | -0.816 | -2.045 |
| | (1.778) | (2.301) | (2.504) | (2.508) | (3.143) |
| Aged65older | 0.697 | 1.122* | 1.073 | -0.351 | -0.870 |
| | (0.501) | (0.608) | (0.666) | (0.778) | (0.942) |
| VaccinePurchased | -0.004 | -0.098*** | -0.148*** | -0.033 | 0.006 |
| | (0.024) | (0.028) | (0.037) | (0.044) | (0.045) |
| VaccinePolicy | -5.691** | 0.079 | 3.241 | -3.948 | -4.603 |
| | (2.702) | (5.339) | (4.314) | (4.839) | (5.628) |
| Asia | -16.017* | -19.581** | -15.352* | -8.441 | -4.375 |
| | (8.419) | (7.836) | (8.217) | (9.161) | (10.659) |
| Africa | -3.605 | 25.273 | 18.766 | -10.509 | 4.491 |
| | (14.512) | (17.434) | (23.461) | (38.434) | (44.365) |
| Europe | -0.053 | -18.168** | -16.788* | 19.524 | 33.205** |
| | (7.684) | (7.635) | (8.648) | (11.823) | (14.080) |
| Oceania | 19.805* | 11.121 | 11.945 | 33.513* | 32.039 |
| | (11.823) | (15.993) | (17.448) | (18.360) | (20.200) |
| SouthAmerica | -0.047 | -14.673 | -19.106* | -8.486 | -5.601 |
| | (7.359) | (9.390) | (9.738) | (11.635) | (11.756) |
| Constant | 157.727*** | 238.800*** | 250.561*** | 288.770*** | 277.442*** |
| | (24.146) | (36.732) | (37.928) | (33.151) | (30.602) |
| <i>Number of countries</i> | 118 | 109 | 104 | 96 | 91 |
| <i>Adj.R²</i> | 0.556 | 0.678 | 0.697 | 0.696 | 0.730 |
| Owen–Shapley R-squared-decomposition (%R²): | | | | | |
| Political regimes | 14.214 | 14.739 | 14.935 | 10.940 | 14.790 |
| AverageNewCases | 19.208 | 14.789 | 10.154 | 10.566 | 12.349 |
| YearofSchooling | 24.086 | 19.079 | 15.110 | 18.740 | 17.775 |
| GDPpercapita | 10.568 | 11.880 | 17.699 | 34.495 | 34.728 |

Notes: Weighted least squares with population size. Daysto 1/5/10/20/30%: number of days until 1%/5%/10%/20%/30% vaccination levels (total number of vaccine doses to total population); AverageNewCases: Average daily new infected COVID-19 cases per million of people since the first infected case recorded to the date of 1%/5%/10%/20%/30% vaccinated levels; YearsofSchooling: average number of years in formal education a person can expect to receive with the current enrolment rate at all levels of education; GDPpercapita: GDP per capita (\$1000); PopulationDensity: population density index (1,000 people/km²); Aged65older: share of populations with age 65 and over (%); VaccinePurchased: number of vaccine doses contracted from COVID-19 vaccine manufacturers (10 millions units); VaccinePolicy: average score of the COVID-19 vaccination policy chosen by countries overtime (0-5), the higher the score, the broader vaccination targets. Asia/Africa/Europe/Oceania/SouthAmerica: continent dummies. Robust standard errors in parentheses: *p< 0.10, **p< 0.05, ***p< 0.01.

Appendix

Table A1. Countries and Codes

| Countries | Codes | Countries | Codes | Countries | Codes |
|---------------------------|-------|-------------------------|-------|-------------------------------|-------|
| Afghanistan ² | AFG | Hungary | HUN | Panama | PAN |
| Angola ³ | AGO | India | IND | Papua New Guinea ¹ | PNG |
| Argentina | ARG | Indonesia | IDN | Paraguay | PRY |
| Australia | AUS | Iraq ³ | IRQ | Peru | PER |
| Austria | AUT | Ireland | IRL | Philippines | PHL |
| Bahrain | BHR | Israel | ISR | Poland | POL |
| Belarus | BLR | Italy | ITA | Portugal | PRT |
| Belgium | BEL | Jamaica ⁴ | JAM | Qatar | QAT |
| Benin ¹ | BEN | Japan | JPN | Romania | ROU |
| Bolivia | BOL | Jordan | JOR | Russia | RUS |
| Bosnia and Herzegovina | BIH | Kazakhstan | KAZ | Rwanda ⁴ | RWA |
| Botswana ⁴ | BWA | Kenya ² | KEN | Saudi Arabia | SAU |
| Brazil | BRA | Kuwait | KWT | Senegal ³ | SEN |
| Bulgaria | BGR | Kyrgyzstan ⁴ | KGZ | Serbia | SRB |
| Burkina Faso ¹ | BFA | Laos | LAO | Singapore | SGP |
| Cambodia | KHM | Latvia | LVA | Slovakia | SVK |
| Cameroon ¹ | CMR | Lebanon | LBN | Slovenia | SVN |
| Canada | CAN | Libya ⁴ | LBY | South Africa | ZAF |
| Chile | CHL | Lithuania | LTU | South Korea | KOR |
| Colombia | COL | Luxembourg | LUX | Spain | ESP |
| Costa Rica | CRI | Malaysia | MYS | Sri Lanka | LKA |
| Croatia | HRV | Mali ¹ | MLI | Sweden | SWE |
| Czechia | CZE | Malta | MLT | Switzerland | CHE |
| Denmark | DNK | Mauritius | MUS | Tajikistan | TJK |
| Dominican Republic | DOM | Mexico | MEX | Thailand | THA |
| Ecuador | ECU | Moldova | MDA | Togo ³ | TGO |
| Egypt ³ | EGY | Mongolia | MNG | Trinidad and Tobago | TTO |
| El Salvador | SLV | Morocco | MAR | Turkey | TUR |
| Estonia | EST | Mozambique ³ | MOZ | Uganda ² | UGA |
| Fiji | FJI | Namibia ³ | NAM | Ukraine | UKR |
| Finland | FIN | Nepal | NPL | United Arab Emirates | ARE |
| France | FRA | Netherlands | NLD | United Kingdom | GBR |
| Gabon ² | GAB | New Zealand | NZL | United States | USA |
| Georgia | GEO | Nicaragua ³ | NIC | Uruguay | URY |
| Germany | DEU | Niger ¹ | NER | Venezuela | VEN |
| Ghana ² | GHA | Nigeria ¹ | NGA | Vietnam | VNM |
| Greece | GRC | Norway | NOR | Yemen ¹ | YEM |
| Guatemala | GTM | Oman | OMN | Zambia ¹ | ZMB |
| Honduras | HND | Pakistan | PAK | Zimbabwe | ZWE |
| Hong Kong | HKG | | | | |

Note: This table describes the full names and codes of 118 countries in model (1) in Table 1.

¹: Countries that are not available for analyses in models (2), (3), (4), and (5) because they have not reached the vaccination rates of 5%, 10%, 20%, and 30%.

²: Countries that are not available for analyses in models (3), (4), and (5) because they have not reached the vaccination rates of 10%, 20%, and 30%.

³: Countries that are not available for analyses in models (4), and (5) because they have not reached the vaccination rates of 20%, and 30%.

⁴: Countries that are not available for analyses in model (5) because they have not reached the vaccination rates of 30%.

Table A2. Data and Sources

| Variables | Description | Sources |
|---|--|---|
| Daysto1% Daysto5% Daysto10% Daysto20% Daysto30% | Number of days needed to achieve the 1%/5%/10%/20%/30 % COVID-19 vaccination levels (total number of doses to total population) | Ritchie et al. (2020) |
| YearsofSchooling | The average number of years in formal education that a person can expect to receive with the current countries' enrolment rates at all levels of education | UNDP (2020) |
| Democracy classifications according to countries' democracy index score from The Economist | <p>Full democracy: all areas such as basic political freedoms, civil liberties, political culture, government functioning are at high level.</p> <p>Flawed democracy: free and fair elections, basic civil liberties respected but suffered from problems in government functioning, underdeveloped political cultures and weak political participant</p> <p>Hybrid regime: substantial irregularities in election, more prevalent problems in government functioning, underdeveloped political cultures, rule of law is weak, corruption is widespread, no independent judiciary</p> <p>Authoritarian: state political plurals is absent, outright dictatorship, election is not free and fair and infringements of civil liberties, no independent judiciary</p> | The Economist Intelligence Unit (2020) |
| Democracy classifications according to countries' democracy index score from The FreedomHouse | Democracy index score based on the aggregate score of two main dimensions: Political rights (0-40) and Civil liberties (0-60). The total Political Rights and Civil Liberties scores are equally weighted in this calculation and based on that classifications (Free/Partial Free/Not Free) are decided | Freedom House (2021). 'Freedom in the world 2021' |
| AverageNewCases (1%/5%/10%/20%/30 %) | Average daily new infected COVID-19 cases to the date of 1%/5%/10%/20%/30% vaccinated levels | Ritchie et al. (2020) |
| PopulationDensity (1,000 people/km2) | Population density index | World Bank national accounts data |
| Aged65older (%) | Share of populations with age 65 and over | World Bank national accounts data |
| GDPpercapita (\$1,000) | Gross domestic product per capita | |

| | | |
|---|--|---|
| | | World Bank national accounts data |
| VaccinePurchased (10 millions of units) | Number of vaccines doses that countries have contracted to purchase from COVID-19 vaccine manufacturers | Duke Global Health Innovation Center (2021) |
| VaccinePolicy (1%/5%/10%/20%/30 %) | <p>Countries are grouped into six categories:</p> <p>0: No availability</p> <p>1: Availability for ONE of following: key workers/ clinically vulnerable groups / elderly groups</p> <p>2: Availability for TWO of following: key workers/ clinically vulnerable groups / elderly groups</p> <p>3: Availability for ALL of following: key workers/ clinically vulnerable groups / elderly groups</p> <p>4: Availability for all three plus partial additional availability (select broad groups/ages)</p> <p>5: Universal availability</p> <p>Average score of Vaccine policies calculated based on the changes of vaccine policies since the beginning of the vaccine program to the 1%/5%/10%/20%/30 % vaccination level (total doses/total population)</p> | Ritchie et al. (2020) |

Note: This table shows the description and sources of variables used in this study.

References for data sources

- Duke Global Health Innovation Center. (2021). *COVID-19 | Launch and Scale Speedometer*. Duke Global Health Innovation Center. <https://launchandscalefaster.org/COVID-19>
- Free House (2021). 'Freedom in the world 2021'. <https://freedomhouse.org/countries/freedom-world/scores>
- Ritchie, H., Ortiz-Ospina, E., Beltekian, D., Mathieu, E., Hasell, J., Macdonald, B., Giattino, C., Appel, C., Rodés-Guirao, L., & Roser, M. (2020). Coronavirus Pandemic (COVID-19). *Our World in Data*. <https://ourworldindata.org/coronavirus>
- The Economist Intelligence Unit. (2020). *Democracy Index 2020 - Economist Intelligence Unit*. Democracy Index 2020. <https://www.eiu.com/n/campaigns/democracy-index-2020/>
- UNDP (2020). *Human Development Index (HDI) | Human Development Reports*. Human Development Reports. <http://hdr.undp.org/en/content/human-development-index-hdi>

Table A3. Descriptive statistics of variables used

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|--------------------------------------|------------|-------------|------------------|------------|------------|
| Daysto1% | 118 | 35.95763 | 28.23328 | 0 | 129 |
| Daysto5% | 109 | 73.58716 | 44.02908 | 0 | 214 |
| Daysto10% | 104 | 93.69231 | 42.89071 | 4 | 222 |
| Daysto20% | 96 | 116.3333 | 40.39298 | 14 | 193 |
| Daysto30% | 91 | 134.5385 | 43.72752 | 24 | 229 |
| AverageNewCases (to 1%) | 118 | 67.7721 | 64.57344 | 0.0185814 | 254.0549 |
| AverageNewCases (to 5%) | 109 | 79.80594 | 69.7637 | 0.1911751 | 295.0323 |
| AverageNewCases (to 10%) | 104 | 87.68681 | 72.05924 | 0.4018115 | 340.575 |
| AverageNewCases (to 20%) | 96 | 100.0747 | 74.98198 | 0.6498013 | 361.3624 |
| AverageNewCases (to 30%) | 91 | 106.2103 | 77.77639 | 1.142303 | 356.5833 |
| Full democracy | 118 | 0.1779661 | 0.3841153 | 0 | 1 |
| Flawed democracy | 118 | 0.3728814 | 0.4856331 | 0 | 1 |
| Hybrid regime | 118 | 0.1864407 | 0.3911227 | 0 | 1 |
| Authoritarian regime | 118 | 0.2627119 | 0.441984 | 0 | 1 |
| Free | 118 | 0.4152542 | 0.4948672 | 0 | 1 |
| Partial Free | 118 | 0.3305085 | 0.4724022 | 0 | 1 |
| Not Free | 118 | 0.2542373 | 0.4372885 | 0 | 1 |
| YearsofSchooling | 118 | 14.15666 | 2.79901 | 6.47145 | 21.95433 |
| GDPpercapita (\$1,000) | 118 | 22.76324 | 21.19165 | 0.926 | 116.9356 |
| PopulationDensity (1,000 people/km2) | 118 | 0.2758711 | 0.9824308 | 0.00198 | 7.915731 |
| Aged65older (%) | 118 | 10.09064 | 6.72996 | 1.144 | 27.049 |
| VaccinePurchased (10 million units) | 118 | 7.05846 | 27.32845 | 0 | 234.5 |
| VaccinePolicy (1%) | 118 | 1.797115 | 0.884347 | 0 | 4 |
| VaccinePolicy (5%) | 109 | 2.14452 | 0.7986983 | 0.6292135 | 4.664122 |
| VaccinePolicy (10%) | 104 | 2.34739 | 0.7963662 | 0.78 | 4.864865 |
| VaccinePolicy (20%) | 96 | 2.492691 | 0.7428048 | 0.7719298 | 4.864865 |
| VaccinePolicy (30%) | 91 | 2.638591 | 0.7204832 | 1 | 4.876543 |

Table A4: Robustness test with Freedom House democracy index

| | (1) | (2) | (3) | (4) | (5) |
|---|------------------------|------------------------|------------------------|------------------------|------------------------|
| | Daysto1% | Daysto5% | Daysto10% | Daysto20% | Daysto30% |
| Democracy (Not Free is the base group): | | | | | |
| Free | -20.487 (14.787) | -14.548 (10.487) | -13.072 (13.118) | 3.442 (16.944) | -3.734 (18.826) |
| Partial Free | -15.284** (6.643) | -29.659*** (11.225) | -11.445 (13.510) | -1.165 (12.519) | -0.118 (12.790) |
| YearsofSchooling | -6.447*** (1.679) | -8.761*** (1.791) | -6.388*** (2.160) | -5.687*** (1.712) | -3.933** (1.643) |
| AverageNewCases | -0.163*** (0.050) | -0.192*** (0.061) | -0.170*** (0.063) | -0.235*** (0.063) | -0.214*** (0.059) |
| GDPpercapita | -0.076 (0.205) | -0.572** (0.270) | -0.618** (0.256) | -0.909*** (0.288) | -1.178*** (0.300) |
| PopulationDensity | -1.804 (2.005) | 1.474 (2.925) | -3.124 (3.778) | -1.154 (3.433) | -1.026 (3.948) |
| Aged65older | 0.945 (0.849) | 0.846 (0.930) | 0.862 (0.951) | -1.108 (1.189) | -1.504 (1.329) |
| VaccinePurchased | -0.007 (0.018) | -0.073*** (0.019) | -0.116*** (0.029) | -0.000 (0.024) | 0.017 (0.024) |
| VaccinePolicy | -3.241 (3.303) | 2.257 (4.807) | 6.062 (4.678) | -4.952 (5.060) | -5.969 (5.982) |
| Asia | -19.029** (8.958) | -26.848*** (10.175) | -19.752* (11.552) | -9.758 (10.884) | -6.454 (12.142) |
| Africa | -3.425 (13.073) | 15.263 (21.405) | 21.918 (29.764) | -13.260 (43.730) | 3.075 (48.036) |
| Europe | -1.265 (8.609) | -16.693* (8.851) | -16.201* (9.378) | 24.215* (12.799) | 33.108** (14.388) |
| Oceania | 21.954** (10.438) | 7.764 (14.902) | -3.099 (13.545) | 20.730 (14.955) | 26.961 (16.907) |
| SouthAmerica | 0.324 (8.211) | -17.001 (10.629) | -16.721 (10.176) | -7.510 (11.842) | -8.243 (11.559) |
| Constant | 161.860*** (24.395) | 252.907*** (37.276) | 225.113*** (34.474) | 275.490*** (33.264) | 283.982*** (31.316) |
| <i>Number of countries</i> | 118 | 109 | 104 | 96 | 91 |
| <i>Adj. R2</i> | 0.551 | 0.694 | 0.666 | 0.680 | 0.719 |
| Owen–Shapley R-squared decomposition (% R2): | | | | | |
| Political regimes | 14.129 | 13.797 | 11.099 | 10.600 | 15.123 |
| AverageNewCases | 19.313 | 14.520 | 10.288 | 9.828 | 10.718 |
| YearOfSchooling | 23.046 | 19.271 | 15.034 | 18.947 | 18.088 |
| GDPpercapita | 9.202 | 11.130 | 16.072 | 34.036 | 35.109 |

Notes: Weighted least squares with population size as weight. Daysto 1/5/10/20/30%: number of days until the 1%/5%/10%/20%/30 % COVID-19 vaccination levels (total number of vaccine doses to total population); AverageNewCases: Average daily new infected COVID-19 cases per million of people since the first infected case recorded to the date of 1%/5%/10%/20%/30% vaccinated levels; YearsofSchooling: the average number of years in formal education that a person can expect to receive with the current enrolment rate at all level of education; GDPpercapita: GDP per capita (\$1000); PopulationDensity: population density index (1,000 people/km²); Aged65older: share of populations with age 65 and over (%); VaccinePurchased: number of vaccines doses which countries have contracted to purchase from COVID-19 vaccine manufacturers (10 millions units); VaccinePolicy: average score of the COVID-19 vaccination policy chosen by a countries overtime (0-5), the higher the score, the broader vaccination targets are. Asia/Africa/Europe/Oceania: dummy continent control. Robust standard errors are in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

Table A5: Speed of COVID-19 vaccination programs (standard OLS regression)

| | (1) | (2) | (3) | (4) | (5) |
|---|------------------------|------------------------|------------------------|------------------------|------------------------|
| | Daysto1% | Daysto5% | Daysto10% | Daysto20% | Daysto30% |
| Democracy (Authoritarian is the base group): | | | | | |
| Full | -4.009 (9.763) | -7.786 (13.368) | -12.665 (13.427) | -3.682 (16.260) | -7.794 (18.225) |
| Flawed | -10.284 (8.885) | -16.398 (11.794) | -18.784* (11.054) | -8.194 (14.526) | -7.502 (16.051) |
| Hybrid | -7.632 (9.865) | -15.165 (15.311) | -21.218 (15.058) | -9.167 (17.614) | 2.172 (16.323) |
| YearsofSchooling | -4.265*** (1.586) | -5.838*** (2.148) | -4.322* (2.244) | -3.509 (2.340) | -3.410 (2.377) |
| AverageNewCases | -0.088*** (0.032) | -0.118*** (0.042) | -0.077 (0.047) | -0.077 (0.053) | -0.116* (0.062) |
| GDPpercapita | -0.104 (0.152) | -0.322 (0.201) | -0.533** (0.207) | -0.643*** (0.241) | -0.666** (0.266) |
| PopulationDensity | -1.564 (1.753) | -2.396 (2.769) | -1.597 (2.985) | -1.592 (3.182) | -1.721 (3.758) |
| Aged65older | 0.440 (0.551) | 0.464 (0.927) | 0.780 (0.930) | -0.197 (1.136) | -0.451 (1.402) |
| VaccinePurchased | 0.025 (0.029) | -0.001 (0.052) | -0.026 (0.055) | 0.031 (0.085) | 0.110 (0.089) |
| VaccinePolicy | -0.894 (3.102) | 1.658 (5.326) | 6.215 (5.087) | 0.530 (6.677) | -0.624 (8.432) |
| Asia | -4.805 (8.362) | -2.791 (11.104) | -11.421 (11.625) | -6.463 (14.465) | -2.858 (16.656) |
| Africa | 7.083 (11.632) | 28.614 (17.610) | 22.964 (17.960) | 8.783 (23.235) | 9.671 (33.506) |
| Europe | 1.644 (8.019) | 3.517 (12.670) | -8.848 (13.138) | 6.938 (16.084) | 24.548 (18.842) |
| Oceania | 13.289 (21.171) | -15.239 (31.686) | -24.625 (29.959) | -16.433 (34.243) | -10.125 (44.277) |
| SouthAmerica | 8.818 (9.370) | 5.637 (11.472) | -5.206 (12.540) | -3.966 (16.213) | 1.139 (17.484) |
| Constant | 106.247*** (22.559) | 173.544*** (34.997) | 173.142*** (32.932) | 200.492*** (37.935) | 219.318*** (37.462) |
| <i>Number of countries</i> | 118 | 109 | 104 | 96 | 91 |
| <i>Adj. R2</i> | 0.283 | 0.383 | 0.388 | 0.172 | 0.175 |

Notes: Daysto 1/5/10/20/30%: number of days until the 1%/5%/10%/20%/30 % COVID-19 vaccination levels (total number of vaccine doses to total population); AverageNewCases: Average daily new infected COVID-19 cases per million of people since the first infected case recorded to the date of 1%/5%/10%/20%/30% vaccinated levels; YearsofSchooling: the average number of years in formal education that a person can expect to receive with the current enrolment rate at all level of education; GDPpercapita: GDP per capita (\$1000); PopulationDensity: population density index (1,000 people/km²); Aged65older: share of populations with age 65 and over (%); VaccinePurchased: number of vaccines doses which countries have contracted to purchase from COVID-19 vaccine manufacturers (10 millions units); VaccinePolicy: average score of the COVID-19 vaccination policy chosen by a countries overtime (0-5), the higher the score, the broader vaccination targets are. Asia/Africa/Europe/Oceania: dummy continent control. Robust standard errors are in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

Table A6: Speed of COVID-19 vaccination programs (without pandemic and vaccine-related control variables)

| | (1) | (2) | (3) | (4) | (5) |
|---|------------------------|------------------------|------------------------|------------------------|------------------------|
| | Daysto1% | Daysto5% | Daysto10% | Daysto20% | Daysto30% |
| Democracy (Authoritarian is the base group): | | | | | |
| Full | -18.858* (10.331) | -20.372* (10.671) | -24.861** (12.274) | -11.532 (15.041) | -15.092 (18.637) |
| Flawed | -24.279*** (8.015) | -38.909*** (9.922) | -39.235*** (10.429) | -18.208 (11.118) | -13.563 (14.210) |
| Hybrid | -17.810* (9.381) | -30.312** (15.084) | -35.158* (19.223) | -25.636* (15.203) | -18.920 (16.575) |
| YearsofSchooling | -4.885** (1.873) | -6.714*** (2.396) | -5.620 (3.471) | -6.075** (2.567) | -4.478* (2.305) |
| GDPpercapita | -0.534** (0.213) | -0.854*** (0.298) | -1.049*** (0.325) | -1.335*** (0.297) | -1.620*** (0.312) |
| PopulationDensity | 0.547 (2.435) | 0.052 (3.669) | -1.432 (5.765) | 0.713 (4.504) | 1.623 (4.748) |
| Aged65older | 1.041* (0.550) | 1.044 (0.685) | 0.780 (0.840) | -0.168 (0.888) | -0.614 (1.035) |
| Asia | -10.400 (9.869) | -13.102 (11.514) | -7.109 (12.826) | -2.420 (11.717) | 0.730 (12.424) |
| Africa | 0.627 (15.184) | 35.592* (19.997) | 31.758 (25.209) | -6.658 (38.172) | 5.652 (40.703) |
| Europe | -8.365 (9.125) | -14.905 (10.114) | -8.125 (10.572) | 9.215 (11.191) | 17.116 (12.652) |
| Oceania | 28.158** (12.664) | 19.618 (16.729) | 24.757 (20.495) | 41.887** (18.299) | 48.170** (18.397) |
| SouthAmerica | -10.884 (11.569) | -11.432 (12.851) | -11.191 (12.262) | -18.550 (13.103) | -23.561* (12.902) |
| Constant | 134.481*** (24.583) | 216.246*** (34.889) | 228.183*** (47.471) | 264.914*** (36.488) | 270.952*** (34.319) |
| <i>Number of countries</i> | 118 | 109 | 104 | 96 | 91 |
| <i>Adj. R2</i> | 0.513 | 0.635 | 0.603 | 0.647 | 0.691 |

Notes: Weighted least squares with population size as weight. Daysto 1/5/10/20/30%: number of days until the 1%/5%/10%/20%/30% COVID-19 vaccination levels (total number of vaccine doses to total population); YearsofSchooling: the average number of years in formal education that a person can expect to receive with the current enrolment rate at all level of education; GDPpercapita: GDP per capita (\$1000); PopulationDensity: population density index (1,000 people/km²); Aged65older: share of populations with age 65 and over (%). Asia/Africa/Europe/Oceania: dummy continent control. Robust standard errors are in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

Table A7: Cox proportional hazards model with failure event of reaching 30% vaccination uptake rate

| | Hazard Ratio | Standard Error | z-statistic | 95% Confidence interval | p-value |
|--|---------------------|-----------------------|--------------------|--------------------------------|----------------|
| <u>Democracy (reference: authoritarian):</u> | | | | | |
| Full | 1.440 | 0.745 | 0.71 | (0.522-3.969) | 0.481 |
| Flawed | 1.312 | 0.499 | 0.71 | (0.621-2.768) | 0.476 |
| Hybrid | 1.145 | 0.493 | 0.32 | (0.492-2.666) | 0.753 |
| YearsofSchooling | 1.162** | 0.085 | 2.05 | (1.006-1.343) | 0.041 |
| AverageNewCases | 1.003** | 0.001 | 2.02 | (1.000-1.007) | 0.043 |
| GDPpercapita | 1.025*** | 0.009 | 2.68 | (1.006-1.044) | 0.007 |
| PopulationDensity | 1.030 | 0.036 | 0.86 | (0.961-1.105) | 0.392 |
| Aged65older | 1.123 | 0.149 | 0.87 | (0.865-1.458) | 0.383 |
| VaccinePurchased | 1.000 | 0.003 | 0.11 | (0.993-1.007) | 0.909 |
| Asia | 1.237 | 0.503 | 0.52 | (0.557-2.746) | 0.6 |
| Africa | 0.149 | 0.103 | -2.74 | (0.038-0.583) | 0.006 |
| Europe | 0.527 | 0.258 | -1.3 | (0.201-1.379) | 0.192 |
| Oceania | 0.552 | 0.429 | -0.76 | (0.120-2.536) | 0.446 |
| SouthAmerica | 1.287 | 0.622 | 0.52 | (0.498-3.323) | 0.601 |

Test of proportional-hazards assumption: Chi-Square (χ^2): 6.39; p-value : 0.956

Number of subjects (countries in analysis): 118

Number of failures (countries reach 30% vaccination uptake rate): 91

Notes: Breslow method for ties. AverageNewCases: Average daily new infected COVID-19 cases per million of people since the first infected case recorded to the date of 1%/5%/10%/20%/30% vaccinated levels; YearofSchooling: the average number of years in formal education that a person can expect to receive with the current enrolment rate at all level of education; GDPpercapita: GDP per capita (\$1000); PopulationDensity: population density index (1,000 people/km²); Aged65older: share of populations with age 65 and over (%); VaccinePurchased: number of vaccines doses which countries have contracted to purchase from COVID-19 vaccine manufacturers (10 millions units); Asia/Africa/Europe/Oceania: dummy continent control. * p < 0.10, ** p < 0.05, *** p < 0.01

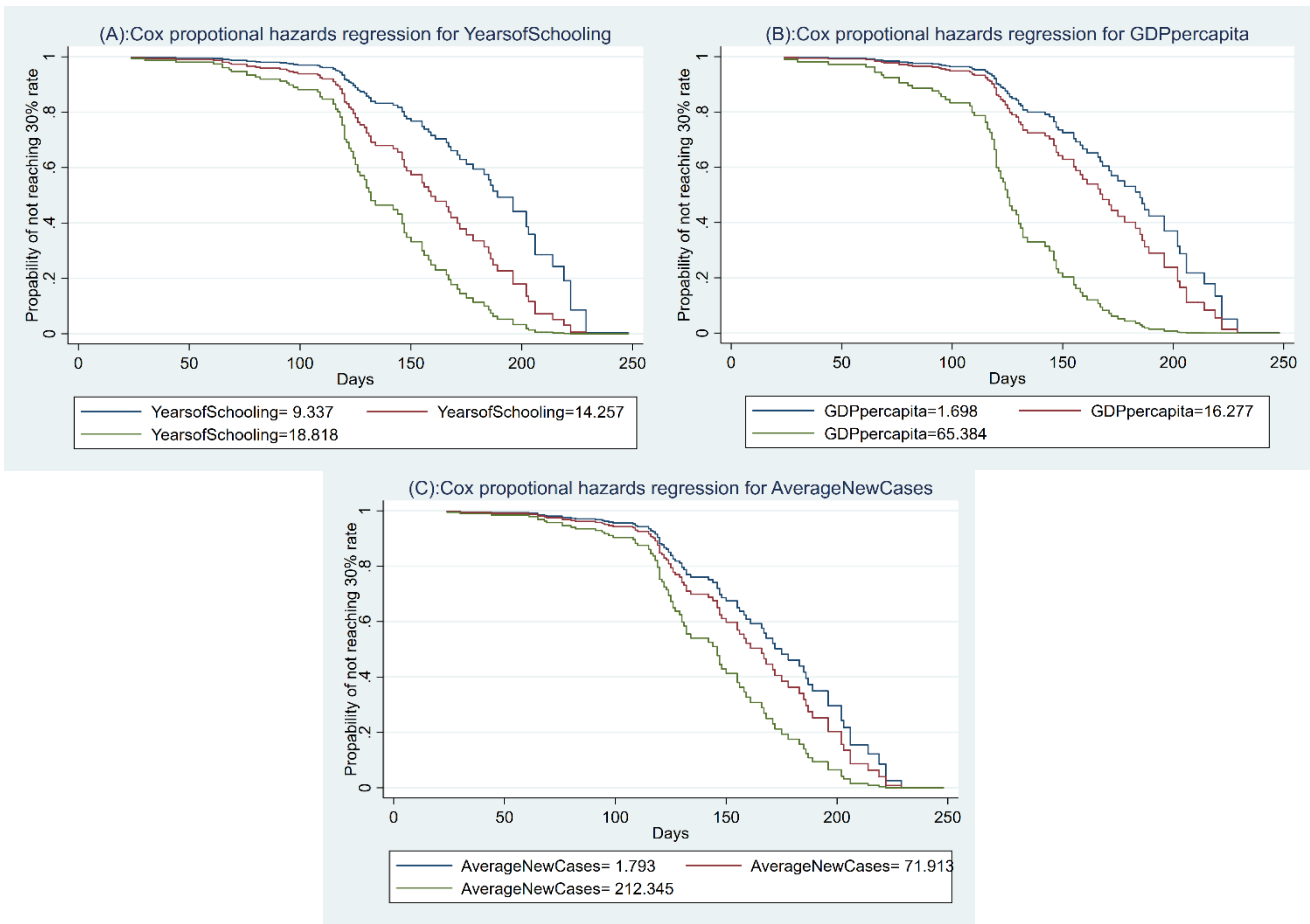


Figure A1. Predicted 250 days of reaching 30% vaccination uptake rate by Years of Schooling, GDP per capita, and Average New Cases (at 5th, 50th and 95th percentiles values)

Note: Average New Cases: Average daily new infected COVID-19 cases per million of people since the first infected case recorded to the date of 1%/5%/10%/20%/30% vaccinated levels; Years of Schooling: the average number of years in formal education that a person can expect to receive with the current enrolment rate at all level of education; GDP per capita: GDP per capita (\$1000). Panel (A), (B), (C) show that the probability to reach 30% vaccination uptake rate is higher (survival probability is smaller) for a country with higher values of Years of Schooling, GDP per capita and Average New Cases at a given time under the analysis.