Policy Research Working Paper 10106

Indirect Effects of COVID-19 Nonpharmaceutical Interventions on Vaccine Acceptance

Maurizio Bussolo
Nayantara Sarma
Iván Torre

WORLD BANK GROUP
South Asia Region &
Europe and Central Asia Region
June 2022

Policy Research Working Paper 10106

Abstract

The information set from which individuals make their decision on vaccination includes signals from trusted agents, such as governments, community leaders, and the media. By implementing restrictions, or by relaxing them, governments can provide a signal about the underlying risk of the pandemic and indirectly affect vaccination take-up. Rather than focusing on measures specifically designed to increase vaccine acceptance, this paper studies how governments' nonpharmaceutical policy responses to the pandemic can modify the degree of preventive health behavior, including vaccination. To do so, the paper uses repeated waves of a global survey on COVID-19 beliefs, behaviors, and norms covering 67 countries from August 2020 to February 2021. Controlling for the usual determinants, the analysis explores how individuals' willingness to get vaccinated is affected by changes in government restriction measures (as measured by the Oxford Stringency Index). This relationship is mediated by individual characteristics, social norms (social pressure to conform with what most people do), and trust in government institutions. The results point to a complex picture as the implementation of restrictions is associated with increased acceptance in some contexts and decreased acceptance in others. The stringency of government restrictions has significant positive correlations with vaccine acceptance in contexts of weak social norms of vaccine acceptance and lower trust in government. In countries or communities where social norms are tighter and trust in government health authorities is high, vaccine acceptance is high but less sensitive to changes in policies. These results suggest that the indirect effect of government policy stringency is stronger among individuals who report lower trust and weaker social norms of vaccine acceptance.

This paper is a product of the Office of the Chief Economist, South Asia Region and the Office of the Chief Economist, Europe and Central Asia Region. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at mbussolo@worldbank.org, nsarma@worldbank.org, and itorre@worldbank.org.

Indirect Effects of COVID-19 Nonpharmaceutical Interventions on Vaccine Acceptance

Maurizio Bussolo, Nayantara Sarma and Iván Torre*

Declaration of Interest: none

Keywords: COVID-19**,** pandemic, vaccine hesitancy, vaccine acceptance, non-pharmacetutical interventions, trust, norms

JEL: I12,I18

*The authors are at the World Bank. This paper's findings, interpretations, and conclusions are entirely those of the authors and do not necessarily represent the views of the World Bank, its Executive Directors, or the countries they represent. We thank Holly Krambeck, Gabriel Stefanini Vicente and the World Bank, the MIT, and Facebook-META teams of the development data partnership (https://datapartnership.org/) for making the data for this study available to us, and Adanna Chukwuma and Tania Dmytraczenko for useful comments.

1. Introduction

How can countries vaccinate their populations against COVID-19? This question has become of paramount importance as governments across the world roll out vaccination campaigns to combat COVID-19. Vaccine hesitancy, or the "reluctance to get vaccinated despite availability" can undermine this effort.[1] Even with highly effective vaccines, the level of vaccine take-up in the population has to be very high for the pandemic to be contained and avoid a collapse of the health system. Understanding the drivers of vaccine acceptance, and the role that government action plays in it, is thus crucial to reduce the health and economic costs of the pandemic and accelerate its resolution.

The COVID-19 pandemic has resulted in 336 million cases and 5.56 million deaths (as of January 20, 2022). Economies across the world experienced sharp contractions linked to lockdowns to contain COVID-19 (World Bank GEP, 2021). Considering their economic toll, prolonged lockdowns are no longer considered a sustainable strategy to combat the virus. Governments are, instead, turning to the multiple and recently developed vaccines to provide a more effective solution. Ramped up production has eased supply constraints, particularly in some developed countries. However, vaccination programs are different from most other forms of health care, and demand-side factors play a substantial role in take-up. Household demand for preventive care is weaker than for curative health care and, often, the financial interests of the providers are also weaker (Gauri and Khaleghian, 2002).

The primary research aim of this paper is to examine the relationship between vaccine acceptance and governments' non-pharmaceutical policies to curb the spread of the virus, such as lockdowns and other government restrictions. These policies provide information signals about the virus and the risks it poses. However, the interpretation of the signals is mediated by individual and social factors. Controlling for the usual determinants of vaccine acceptance – such as education, age, other individual characteristics, as well as country level prevalence and mortality rates – we focus on the role of social norms, trust in authorities, and individuals' experience of the pandemic in mediating the link between the stringency of governments' pandemic restrictions and vaccine acceptance.

We find that individual characteristics like higher education and age are, predictably, positively correlated with vaccine acceptance. Individual perception of risk based on personal knowledge of a COVID-positive case plays a significantly strong role in increasing vaccine acceptance, significantly more than the objective COVID-19 death rate prevailing in the country. Our main specification finds that a unit increase in the stringency of government policies is associated with a 0.4 percentage point increase in vaccine acceptance. In other terms, an increase from the 25th percentile to the 75th percentile of the sample distribution of policy stringency is associated with a 7.8 percentage point increase in vaccine acceptance, a magnitude larger than the difference in vaccine acceptance between individuals with primary education and those with tertiary education, and about the same size as the effect of knowing a positive case of COVID-19.

We also find that the efficacy of signals conveyed by the government's non-pharmaceutical interventions is influenced by the prevailing social norms and the level of trust in the government. The correlations between policy

[1] The term vaccine hesitancy abstracts from challenges in *accessing* vaccines which is a serious concern in many countries. Our usage of the term is strictly a negation of vaccine acceptance while assuming availability and individual access to vaccines. Among international organizations, including the World Health Organization, the term acceptance is preferred as hesitancy can lead to blaming, so in the reminder of the paper we will use vaccine acceptance.

stringency and vaccine acceptance are significantly stronger in societies with weaker social norms about vaccine acceptance, i.e., in societies where individuals do not feel social pressure to get vaccinated due to their perception that the majority of their peers (or other relevant reference group) will not accept a vaccine. These stronger correlations are also found where trust in government is low. Lockdowns and stringent restrictions plausibly convey a stronger signal of COVID-19 risk in these societies, rather than in societies with tighter social norms and with populations trusting their government more. Higher vaccine acceptance in these societies tends to pre-exist the implementation of stringent non-pharmaceutical interventions. These findings are in line with evidence from other studies (Blair et al., 2022; Lazarus et al., 2021; Jabar et al., 2021; Mannan and Farhana, 2021; Kerr et al., 2021).

Our paper contributes to three branches of the literature on vaccine uptake and adoption of other preventive health measures. Firstly, a large body of work exists on individual drivers or correlates of vaccine take-up. In developing countries, these studies mainly focus on child immunization rates and find that mothers' characteristics such as education and household socio-economic status are significantly correlated to the probability of immunization (Devasenapathy et al., 2016). Education continues to play a role for adult vaccination, along with acceptance of vaccines for other diseases. Maurer et al. (2009) show that the intention to vaccinate against the novel H1N1 virus is strongly associated with uptake of seasonal influenza vaccinations in the US. The association between individual characteristics and vaccine take-up is often non-monotonic. For example, in a study conducted in Indonesia, illiterate women and women with secondary education are more likely to get their children vaccinated than women with primary education (Streatfield, Singarimbun, and Diamond, 1990). The authors argue that this is possibly due to higher social compliance with local authorities among women with no education, and greater awareness of the protective function of vaccines among women with higher education.

In addition to their socio-economic characteristics, individuals' *beliefs and experiences* are linked with their probability of being vaccinated. Perceptions of the risk of infection influence the decision to get vaccinated. Using data collected at the onset of the pandemic in the United States, Bundorf et al. (2020) find that individual beliefs about COVID-19 risks were related to actual preventive behavior. Those who considered themselves to be at high risk to infection significantly reduced activities which may expose them to the virus. Personal past experiences of disease positively affect the likelihood of getting vaccinated in the future. Jin and Koch (2018) show that this "learning by suffering" effect works both ways and find a negative impact on vaccination rate for individuals who got sick in the previous year despite having taken the shot.

The second strand of research that our paper contributes to deals with socio-cultural factors that influence individual health behavior. Social norms have increasingly been shown to play a role in vaccine acceptance and other preventive health measures (Moehring et al., 2021; Allen et al. 2021).[2] The direction of the effect is, however, dependent on the context. Social norms can have a conformity or peer effect such that individuals align themselves with others in adopting or rejecting preventive health measures (Goldberg et al., 2021). On the other hand, due to the positive externalities associated with vaccines, norms can generate a free-riding effect so that individuals benefit from others' immunity without incurring the associated costs themselves. Using a study in Mozambique, Allen et al. (2021) show that the dominating effect depends on the level of local infection rates.

[2] Norms can be descriptive (what people actually do) or injunctive (what people approve of) (Bicchieri, 2016 ; Benabou and Tirole, 2011).

When COVID-19 infection rates are low, individuals tend to free-ride and reduce protective measures but as infection increases, the perceived risk pushes people to conform and take greater precautions by social distancing. The dominance of free-riding or pro-social behavior has also been explained by long-standing cultural values. Gelfand et al. (2021) suggest that countries with greater "cultural tightness", i.e., stricter adherence to norms and punishments for deviance are better able to control the pandemic.

As our empirical analysis will show, the levels of vaccine acceptance in a society are not static. Since *individual* uptake of vaccines depends on *external* factors like access to information, perception of risk and social norms, there is a vital role for policy to "nudge" or influence individual behavior.[3] The third body of work that this paper contributes to is on effective policy action. The urgency and severity of the pandemic has spurred several studies focusing on informational interventions about the risks of exposure to COVID-19, effectiveness of preventive measures like masks (Abaluck et al., 2021), social distancing and vaccines, and updating people about prevailing social norms (Moehring et al., 2021). Interventions in the form of mandates or lockdowns also convey information about the threat of the virus.

Glaeser et al. (2020) find that when local governments lift mobility restrictions, individuals interpret this as a signal that the underlying risk of contracting COVID-19 is low and therefore indulge in more risky behavior – for instance, visiting an indoor restaurant. If the information signal is inaccurately interpreted – that is, if the level of virus circulation is not as low as individuals expect it to be – the lifting of restrictions can result in increased COVID-19 infections. Further, government mandates serve to reduce negative externalities arising from the relationship between subjective risk perceptions and preventive behaviors (Bundorf et al. 2021). To the point that demand for vaccination can also be related to perceived risks of infection (Betsch et al., 2015), if government action alters these risk perceptions, it has also the potential to affect the take up of COVID-19 vaccines – a topic which, so far, remains mostly unexplored. Recent evidence on the increase in interest in vaccination following the United States' CDC recommendation for vaccinated users not to wear a face mask[4] suggests that government action has indeed a role to play.

Apart from government mandates and mobility restrictions, other policy interventions which have seen some success in increasing vaccine take-up include behavioral nudges such as reminders to get vaccinated (Dai, et al., 2021), messaging campaigns about its benefits and social acceptance (Argote at al., 2021) and tackling misinformation (Loomba et al., 2021). According to evidence in Sweden however, monetary incentives to get vaccinated have more bite than information campaigns (Campos-Mercade et al., 2021). If we consider that estimates of the value of a cure for COVID-19 range between 5-15 percent of total global wealth (Acharya, 2021), the use of monetary incentives or behavioral nudges may well be cost-effective (Costa-Font et al., 2021).

The rest of this paper is organized as follows. Section 2 describes the data we use to explore the relationship between vaccine acceptance, government stringency and other mediating factors. Section 3 provides some

[3] 'Joints for Jabs': As part of its strategy to vaccinate more of its population, Washington State will allow adults to claim a free marijuana joint when they receive a COVID-19 vaccination shot (NYTimes June7, 2021).

[4] On the afternoon of May 13, 2021, the director of the US CDC announced the new face mask guidelines for vaccinated individuals, which recommended using face masks only in a limited set of circumstances. The website Vaccines.gov, which provides information on the vaccination campaign in the United States, saw its traffic increase to record levels in the hours following the announcement (https://www.cnn.com/2021/05/27/health/vaccination-interest-cdc-mask-guidance/index.html).

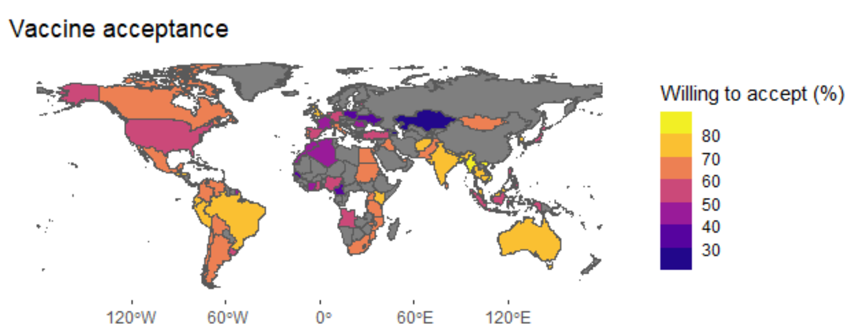
descriptive statistics and trends of the data, using some country specific examples. Section 4 outlines the methodology and framework we use for our empirical specifications. Section 5 presents the results of our analysis, and section 6 concludes.

2. Data

We use data from a global survey on *COVID-19 Beliefs, Behaviors and Norms* jointly conducted by researchers at the Massachusetts Institute of Technology, Facebook, Johns Hopkins University (JHU), the World Health Organization (WHO), and the Global Outbreak Alert and Response Network (GOARN). The survey was administered via Facebook to a sample of its users in 67 countries from August 2020 to March 2021. We restrict our main analysis to 18 countries for which data is available over multiple waves.[5] While survey respondents are mostly urban, aged between 20-50 years and with tertiary education, the data contain weights to represent each country's adult or Internet-using population, rather than just Facebook users, and to reduce bias due to nonresponse.

The survey contains information on willingness to be vaccinated, perception of community norms around preventive behaviors, access to information about the virus and trust in media and the government. It also includes data on individual characteristics and personal experience of the pandemic, with regard to health and employment. Some summary statistics of the data are presented in Table 1.[6] Globally, 69 percent of the sample report that they will accept the vaccine with some regional variation ranging from slightly above 50 percent in North America to relatively higher acceptance in South Asia at around 75 percent (Figure 1).[7]

Figure 1: Vaccine acceptance around the world



Source: Authors calculations using the Facebook COVID-19 Beliefs, Behaviors & Norms Survey (2021). Data are weighted using sample survey weights.

[5] In the remaining countries, "snapshot" surveys were administered and we did not get access to data for 4 wave countries in Europe due to GDPR.

[6] Appendix Table A1 contains summary statistics of relevant variables for the 18 countries for which multiple waves are available. These countries are Argentina, Bangladesh, Brazil, Colombia, the Arab Republic of Egypt, India, Indonesia, Japan, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Romania, Thailand, Turkey, United States, Vietnam.

[7] The vaccine acceptance rate from the Facebook COVID-19 Beliefs, Behaviors & Norms Survey (2021) is similar to rates found in other studies, e.g. 71.5 percent of participants in a study of 19 countries by Lazarus et al. (2021) report that they will accept a vaccine. Higher acceptance of around 80.3 percent is found in low- and middle-income countries relative to only 64.6 percent in the United States (Arce et al., 2021).

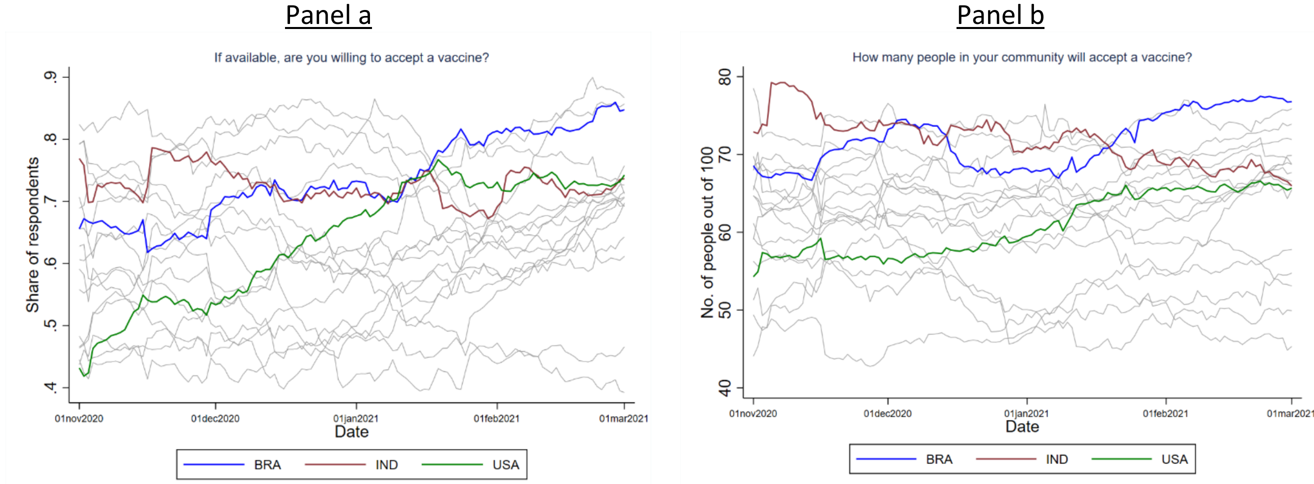
We complement the individual level survey data with the Stringency Index collected by the Blavatnik School of Government at Oxford University. This index measures how stringent are government's non-pharmaceutical interventions during the pandemic. The index is collected at the national level (with some sub-national data for selected countries) with a daily frequency and covers almost all countries and regions of the world. The underlying information used to calculate the Stringency Index is collated from publicly available information on government responses and containment measures such as school closures, travel bans and other restrictions on movement (Hale et al., 2021). Lastly, we use data on the incidence of the virus from the COVID-19 Data Repository by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University.

3. Descriptive Statistics

Vaccine acceptance is heterogeneous across countries -ranging during the sample period from as low as 55% in the Arab Republic of Egypt to as high as 80% in Bangladesh[8]- and is not static over time. The two panels of Figure 2 present the evolution of attitudes, or personal beliefs, towards the vaccine and the evolution of social descriptive norms about the vaccine. More in detail, panel *a* presents the evolution of the share of individuals willing to accept a vaccine in each country in the panel sample over the period November 2020-March 2021. In countries like the United States, attitudes towards vaccine acceptance increased from about 40% of the sample in early November 2020 to around 70% in late January 2021. In Brazil, they increased from around 65% to 85% in the same period, while in India they remained relatively stable around or slightly above 70%. Other countries show similar patterns. Panel *b* presents the social expectations about vaccine acceptance in the community - the *descriptive* social norm about vaccine acceptance measured by "the number of people out of 100 that *the respondent believes* will take the vaccine".

Figure 2: Trends in vaccine acceptance (panel a) and descriptive norms about vaccine acceptance (panel b)

Panel a | Panel b



Source: Authors calculations using the Facebook COVID-19 Beliefs, Behaviors & Norms Survey (2021). Data are weighted using sample survey weights.

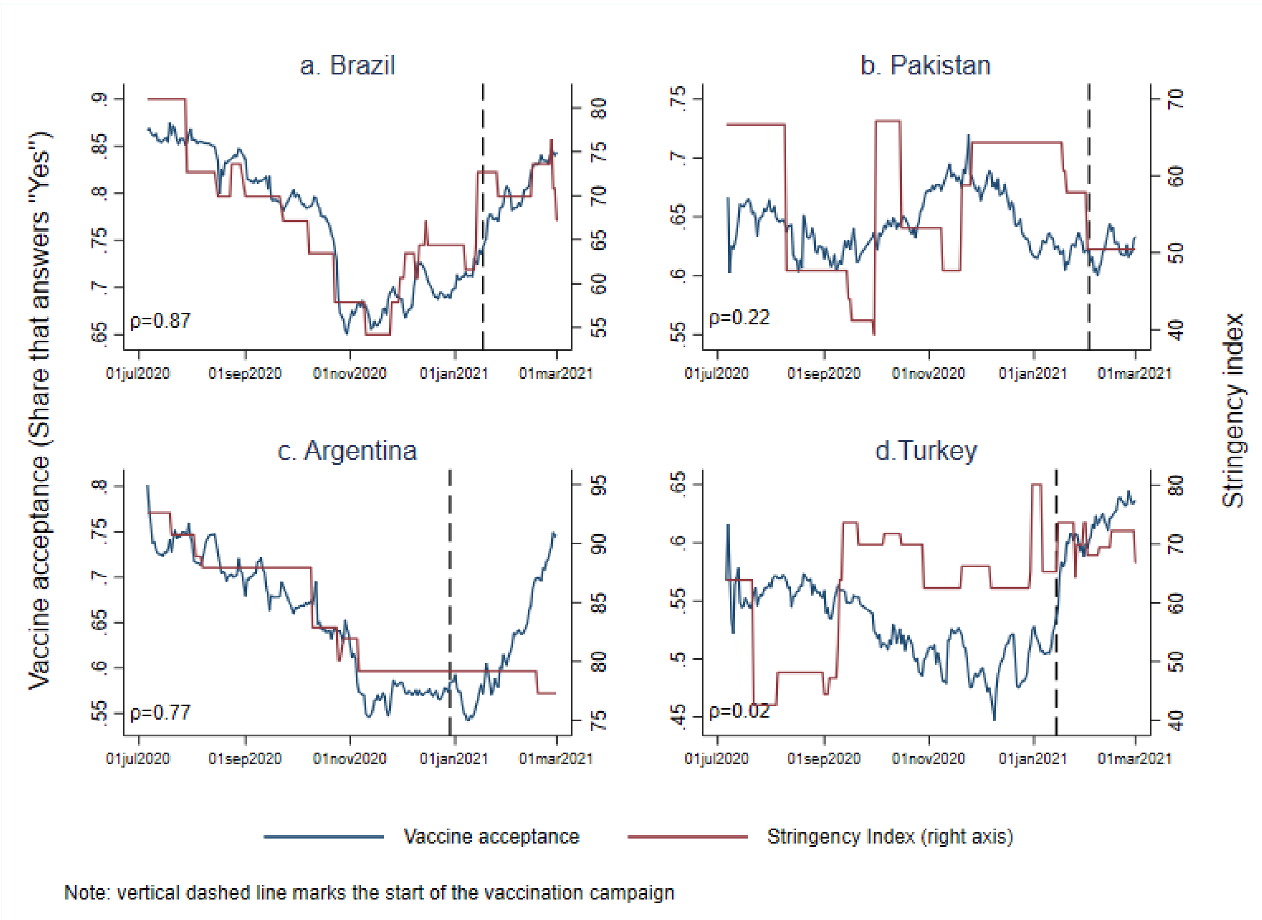
Compared to individual attitudes towards the vaccine, the variation over time is smaller for social norms. This is expected as social norms do not tend to change swiftly. However, some shifts are also recorded for social norms:

[8] See Table A1 for country level averages of vaccine acceptance, trust, social norms and other variables included in the analysis.

in the United States, on average individuals thought that around 55 people out of 100 in their community would accept a vaccine in November 2020. This figure increased to around 65 people out of 100 by March 2021. In Brazil the increase in believed vaccine acceptance moved from slightly below 70 people out of 100 in the community in November 2020 to around 75 people out of 100 in March 2021. In India, a small but consistent decrease in believed vaccine acceptance in the community was observed during the same period – from slightly above 70 people out of 100 to around 65 people out of 100. The fact that individual vaccine acceptance shows greater variation over time than social norms, which tend to be *stickier*, suggests that factors other than social norms may be explaining the time variation in vaccine acceptance. Cross-country differences in vaccine acceptance, however, could potentially be explained by differences in norms.

The main time variant factor which this paper is interested in is government policy. When correlating the evolution of vaccine acceptance and government policy response – as measured by the Oxford Government Stringency Index, different patterns emerge. In countries like Brazil, the evolution of vaccine acceptance mirrors the evolution of government restrictions: the more stringent measures are, the higher the level of vaccine acceptance (Figure 3, panel a). In other countries, like Pakistan, vaccine acceptance and the stringency of government response appear to be uncorrelated over time (Figure 3, panel b). Lastly, in some other countries like Argentina (panel c) or Turkey (panel d), it is a particular government action -the start of the vaccination campaign- which appears to increase vaccine acceptance.

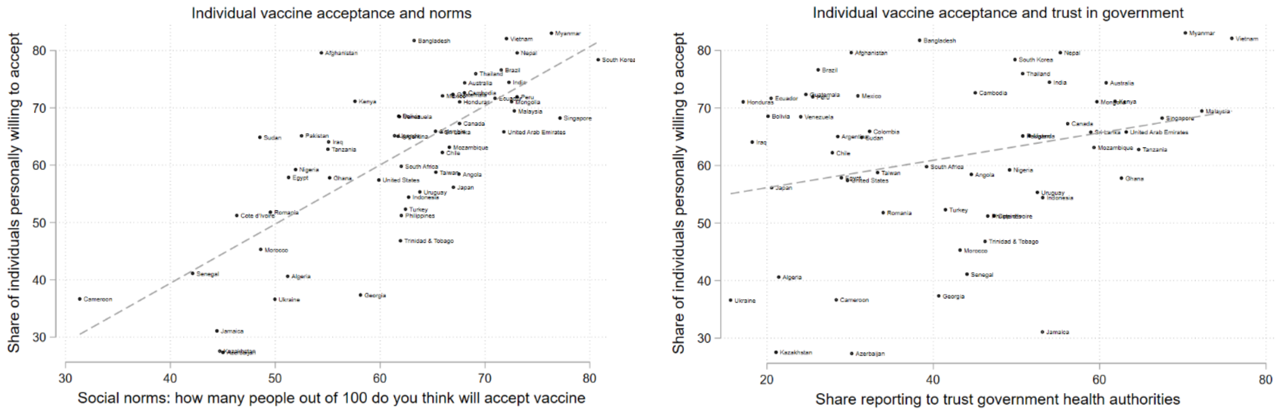
Figure 3: Evolution of vaccine acceptance and government stringency



Source: Authors calculations using the Facebook COVID-19 Beliefs, Behaviors & Norms Survey (2021). Data are weighted using sample survey weights.

The different patterns in the relationship between government stringency and vaccine acceptance suggest that factors like trust in government institutions, social norms and the evolution of the pandemic itself may be relevant mediators in how individuals react to government action. Country level correlations show that individual vaccine acceptance and descriptive norms about vaccine acceptance in the community are positively correlated but show considerable variability (Figure 4, panel a); a similar pattern is observed in the correlation between vaccine acceptance and trust in government health authorities (Figure 4, panel b).

Figure 4: Community norms, trust in government and vaccine acceptance.



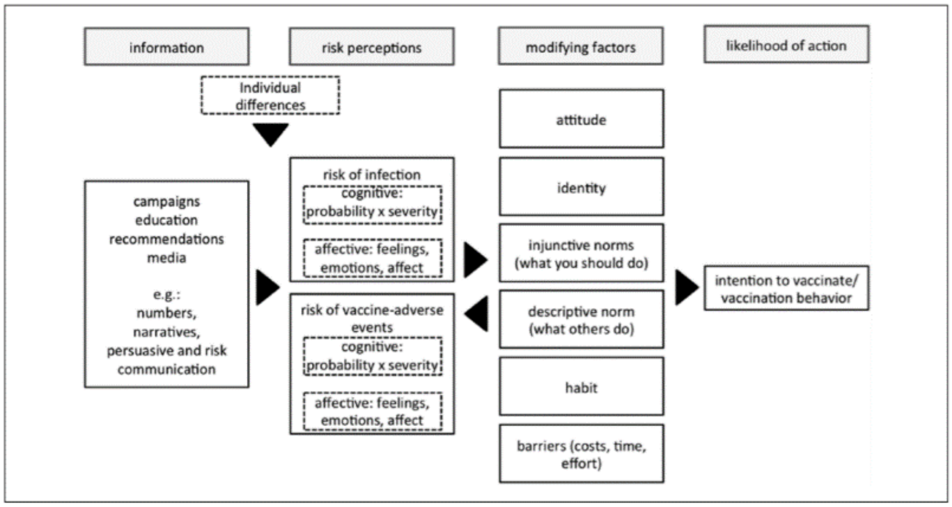
Source: Authors calculations using the Facebook COVID-19 Beliefs, Behaviors & Norms Survey (2021). Note: Data are weighted using sample survey weights. Dotted line indicates linear fitted values.

4. Methodology

Our analysis is motivated by the framework of Betsch et al. (2015) where macro-level objective variables such as health risks from the virus and government policy are filtered by individual characteristics and experiences. The final action on vaccination is further modified by prevailing norms and supply-side factors (Figure 5). While this framework is specific to vaccine acceptance, it contains the main elements that could make it adaptable to other preventive behaviors.

Within the framework presented in Figure 2, the main exogenous factors from an individual point of view are individual characteristics -like age, gender and education levels- and the information set each individual has. These factors form risk perceptions, which are in turn assessed by individuals based on *modifying factors* like norms, identity, attitudes and barriers. The result of this assessment brings about the willingness to take or not a vaccine. Government policies enter this decision process in two different stages: first, government informational policies affect the information set of individuals, as they update citizens on the epidemiological status of the country beyond individuals' immediate community. Second, government policies like vaccination campaigns also affect the costs, time and effort to vaccination, identified as barriers in the conceptual framework.

Figure 5: Framework for empirical analysis



Source: Betsch et al. (2015)

In our empirical analysis we will focus on a specific set of government policies – those related to mobility and activity restrictions (a.k.a. "lockdown policies"). Our assumption is that lockdown policies enter the vaccine decision process by way of modifying the information set of individuals, following the evidence presented by Glaeser et al. (2020).

The main, reduced form equation that derives from our analytical framework relates vaccine acceptance to the factors that are *theoretically* exogenous from an individual point of view. It uses the following regression specification:

$$A_{ict} = \alpha + \beta Policy_{ct} + \gamma X_{ict} + \delta COVID_{ct} + \mu_t + \theta_c + \varepsilon_{ict} \quad (1)$$

where A_{ict} is an indicator of whether individual *i* residing in country *c* is willing to get vaccinated during the survey period t. $Policy_{ct}$ is the government pandemic response as measured by the Oxford Stringency Index. The vector X_{ict} includes individual-level covariates such as education, employment and demographic characteristics. Because individuals' information set is not affected only by government policy but, also, by the objective epidemiological situation, we control for personal experience related to the pandemic (measured at the individual level) and for COVID-19 prevalence and death rates at the country level during the survey period. Country and time fixed effects are included by θ_c and μ_t and ε_{ict} is the idiosyncratic error term.

Causal identification relies on the assumption that the government policy response is uncorrelated with the unobserved error term. This is untestable and our results may be purely suggestive in nature rather than evidence of causation. Lockdown measures announced by different countries have been strongly influenced by the number of prevalent cases, public immunity from severe disease due to COVID-19, and other concurrent pandemic responses. Due to limitations of the data, we are unable to control for the latter two concerns. Individual access to vaccines due to financial or physical constraints and the level of immunity from the virus (either through vaccination or past infection) may be correlated with the measure of stringency. These omitted variables may be a source of endogeneity in our estimations. However, conditioning on the level of COVID-19 prevalence in the country and the timing of the vaccination campaign should nevertheless provide meaningful estimates of the association between policy and vaccine take-up.

Equation (1) is a reduced form equation derived from our analytical framework. The data at hand allows us to explore the role played by factors absent in a reduced form setting – namely, the role played by risk perceptions and *modifying factors* such as norms and attitudes. To this end, our empirical analysis will also look into the interaction of the main independent variables -like government policies or individual characteristics- with risk perceptions, norms and attitudes.

5. Results

5.a The role of government policies and individual characteristics

In order to capture country level factors, our sample is restricted to the 18 countries where the survey was carried out repeatedly, at the pace of one country-level wave per month. The variables on trust and social norms were only included in the survey starting in October 2020, therefore we restrict our sample to the period October 2020 – March 2021. These variables are nevertheless missing for about 60% of individuals interviewed during the sample period. To assess the effect of the missingness in these variables, in Table 2 we present the estimation of the baseline equation excluding trust and social norms in both the whole sample (column 1) and in the sample of observations with non-missing trust and social norms variables (column 2). For all the variables, the magnitude of the coefficients and the statistical significance are very similar between both estimations, suggesting that the missingness of trust and social norms variables is orthogonal to the statistical relationship under analysis. In the next subsections, we will describe the results using the sample which only includes observations with non-missing information on individual trust and social norms.

Individual characteristics and vaccine acceptance

The results in the baseline specification (Table 2, column 2) indicate that higher vaccine acceptance appears to be associated to being male, on average 8 percentage points more willing to take a vaccine if offered than women; being of older age, those 20 to 40 years old are on average 10 percentage points less willing to take a vaccine than those 80 years and older; and having tertiary education, around 3 percentage points more willing on average than having primary or secondary education. The correlates with age and gender match the mortality risk of COVID-19, a fact that suggests that risk perceptions appear to be a significant factor driving individual vaccine acceptance. In the case of education, the available evidence on socio-economic factors behind COVID-19 mortality risk suggests that low skill individuals tend to face a higher mortality due to the circumstances they live in and exposure to contagion through their occupations (Hawkins, Charles and Mehaffey, 2020). This positive correlation with education levels – higher vaccine acceptance for more educated people – does not seem to reflect risk perceptions, as more educated people tend to have lower COVID-19 related mortality but, rather, may be related to differences in information and knowledge about the pandemic and the vaccines. Lastly, individuals' assessment of their own health does not appear to be correlated with increased or decreased acceptance.

Epidemiological situation

Personally knowing someone who tested positive for COVID-19 is strongly associated with increased vaccine acceptance: those that know a positive case are on average 8 percentage points more willing to take a vaccine if offered than those that do not know one. However, the country level death rate in the week before the individual was interviewed bears no correlation with vaccine acceptance. This suggests the importance of the information set the individual uses to assess the risk of COVID-19 and to decide about vaccination. Rather than the overall epidemiological situation, it is the immediate experience with the pandemic that is associated with increased willingness to get vaccinated.

Government policy response

The stringency of government policy response to the pandemic appears to be positively associated with vaccine acceptance: the more stringent the measures are, the higher the willingness of individuals to take the vaccine. Each additional unit in the Oxford Stringency Index is associated to a 0.4 percentage point higher vaccine acceptance. Moving from percentile 25 in the distribution of the index within our sample (a value of 55.09) to percentile 75 (a value of 74.54) would be associated to a 7.8 percentage point increase in individual vaccine acceptance, a magnitude similar to that of personally knowing a positive COVID-19 case. Such a change in lockdown policies, however, would not be associated with an immediate increase in vaccine acceptance. The nature of the data at hand - including the exact day when the survey was carried out for each individual – allows us to assess the effect of actual *changes* in the stringency index, which is also measured daily. Columns 3, 4 and 5 of Table 2 include as additional regressors the 1-day change, 7-day change and 14-day change of the stringency index respectively. The negative coefficients associated to the change variables indicate that when government policy changes, the effect on vaccine acceptance is not immediate. In particular, the coefficients associated to the 7-day and 14-day changes suggest that during that period the overall effect of an increase of one unit in the stringency index is 0.2 and 0.3 percentage points respectively – lower than the 0.4 percentage point result in the longer term. In any case, column 6 suggests that there are diminishing marginal effects of stringency on vaccine acceptance as its squared term is negative and significant. Further, prolonged and very stringent measures seem to have an adverse effect on vaccine acceptance. Moving from the 25th percentile in the distribution of days above a stringency score of 80 (equal to 0 days in our estimation sample) to the 75th percentile (equal to 80 days, incidentally) is associated with a 9.6 percentage point *decrease* in individual vaccine acceptance.[9] This phenomenon, or diminishing effect of non-pharmaceutical interventions, is witnessed also with respect to actual spread of the disease as well and has been termed as *lockdown fatigue* in other work (Goldstein, Levy Yeyati and Sartorio, 2021).

An important aspect of government policy response to the pandemic that is not captured by the stringency index -which is focused on non-pharmaceutical interventions- is the deployment of a vaccination campaign. The first country to launch a COVID-19 vaccination campaign was the United Kingdom on December 8, 2020. In the weeks that followed, several countries -including the 18 countries in our sample- started their vaccination campaigns. The different specifications of Table 2 all show that the presence of an active vaccination campaign is associated with an increase in vaccine acceptance of around 9 percentage points, a magnitude slightly higher than the effect of personally knowing a COVID-19 positive case or the effect of an increase in the stringency index from the 25th to the 75th percentile of the distribution.

[9] This is the product of the number of days implied by moving from the 25th percentile to the 75th percentile (80 days) times the coefficient associated to the effect of the number of days at high stringency on vaccine acceptance (-0.00123): 80 X -0.00123 = -0.0984.

5.b The role of risk perceptions

Individuals form their risk perceptions about the pandemic using the information set available to them and their individual circumstances, like their age, gender or education. As our analytical framework indicates, these risk perceptions, mediated by other factors such as trust and social norms, drive vaccine behavior. While it is out of the scope of this paper to provide a detailed analysis of the formation of risk perceptions, the data allows to have a preliminary look at the relationship between vaccine acceptance and risk perceptions about COVID-19 infection. The survey we use includes a question on the likelihood that a person of the same age and in the same community as the respondent becomes sick from COVID-19. We create a dummy variable that indicates whether a respondent stated that this event was "very" or "extremely likely". We call this variable the "perception of high risk of infection". Columns 1 and 2 of Table 3 look at the correlations between this variable and individual characteristics and beliefs. Men, people living in rural areas, and younger individuals have all a perception of a lower risk of becoming sick from COVID-19. People in good health perceive their risk to be low as well. Interestingly, individual beliefs appear to be associated to risk perceptions in an unusual direction: individuals who have higher trust in government health authorities and those who believe that most individuals in their community will accept the vaccine also report *higher* infection risk perceptions (Table 3, Column 2). While this correlational analysis does not allow to establish the exact causal nature of this relationship, it suggests that individuals who do not trust health authorities and who do not believe that the community in which they live will accept the vaccine may systematically underestimate the actual spread of the disease and the severity of the pandemic. Misinformation could be a potential explanation, as Roozenbeek et al. (2020) find that individuals who distrust scientists are more susceptible to misinformation about the pandemic.

When introduced as a separate, independent regressor in equation (1), this "perception of high risk of infection" variable is associated with a 9 percentage points higher probability of accepting the vaccine (Table 3, column 3). The coefficients associated to the stringency index and the personal knowledge of a positive COVID-19 case in that same specification remain significant but decrease slightly in magnitude. A similar pattern is observed if risk perceptions are interacted with the stringency index (Table 3, column 4).

These results confirm the relevance of risk perceptions as highlighted by our analytical framework. Government policies and individual experience of the pandemic have an effect on vaccine acceptance through risk perceptions. However, the fact that both variables still have a considerable explanatory power suggests that this particular measure of risk perception does not capture fully the risk perceptions that individuals have in mind. Other dimensions of risks beyond individual infection may be driving vaccine acceptance.

5.c Trust and social descriptive norms

Information and individual circumstances form risk perceptions, which are in turn mediated by trust and social norms as individuals decide on accepting the vaccine or not. The different specifications of Table 4 explore the role that mediating factors such as social descriptive norms (the number of people in the community that the individual believes are going to get the vaccine) or trust in government health authorities play in individual vaccine acceptance. Column 1 presents a simple specification in which both variables are included as independent regressors. Both are strongly and positively correlated with vaccine acceptance. The more individuals believe vaccine acceptance to be the prevalent social norm in their community, the higher their own willingness to get the vaccine. For every additional percentage point of believed acceptance in the community, individual vaccine acceptance increases by 0.6 percentage point. Moving from percentile 25 in the distribution of believed vaccine acceptance in the community (which represents a value of about 50 persons out of 100 accepting the vaccine in the community) to percentile 75 (a value of about 87 persons out of 100) is associated with a 22 percentage points increase in individual vaccine acceptance.

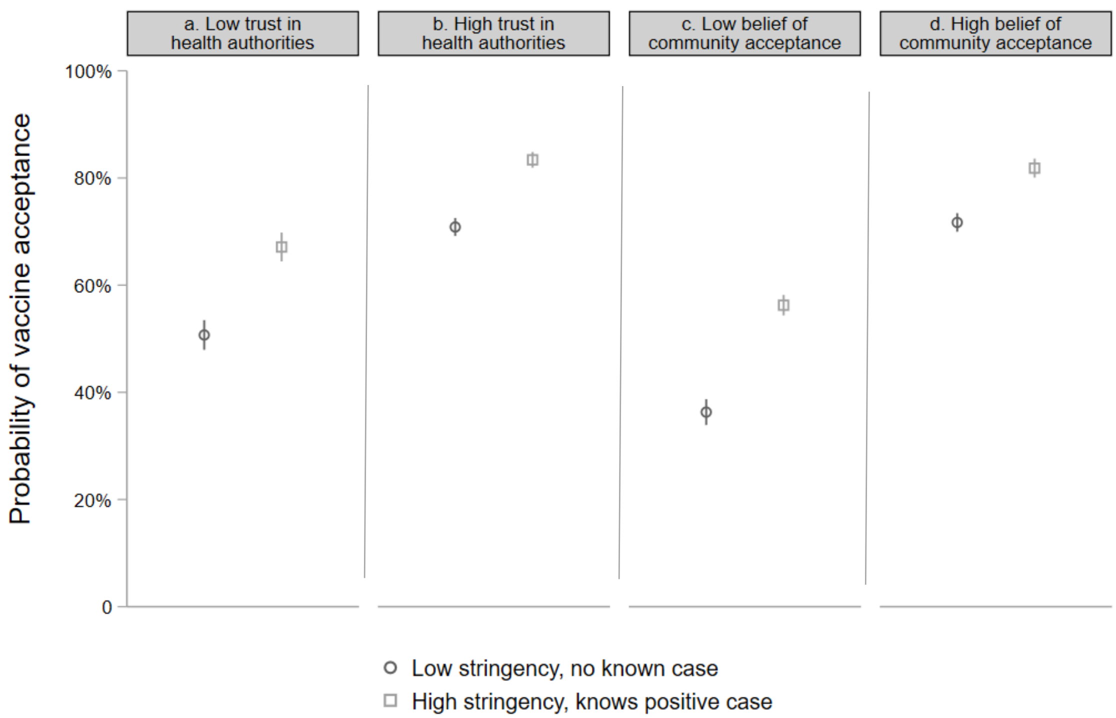
Similarly, trust in government health authorities is associated with, on average, 12 percentage points higher vaccine acceptance. It is noteworthy the fact that the effect of age on the degree of vaccine acceptance is diminished when social norms and trust are included as explanatory variables – the magnitude of the partial correlation coefficients associated to the different age group dummies is almost halved when comparing Table 2, column 2 to Table 4, column 1, and in some cases, they are no longer statistically significant. This suggests that a substantial part of the difference in vaccine acceptance across age groups can be attributed to differences in beliefs across age.

The conceptual framework we use suggests, however, that beliefs such as trust and social descriptive norms are not independent factors in the vaccine acceptance decision process, but they rather act as "filters" of the effects brought by differences in information or personal and social characteristics. Columns 2 and 5 in Table 4 present the results of an alternative specification in which trust in health authorities and beliefs on vaccine acceptance in the community are treated as interacting factors of government stringency. These interaction models do not show results that are qualitatively different from the specification in Column 1, except for the effect associated to trust in health authorities which is no longer statistically significant. Columns 3-4 and 6-7 present an alternative analysis by which the sample is split in two groups for each variable – individuals with low trust in government health authorities (column 3) or high trust in government health authorities (column 4); and individuals whose social context is one of loose social norms about vaccination (i.e. individuals believing that 50 or fewer people out of 100 in the community would take the vaccine, column 6) or those experiencing stringent social norms (i.e. believing that 50 or more out of 100 in the community would take the vaccine, column 7).

The results of the subsample analyses show that the effects of government stringency and the personal acquaintance with a positive COVID-19 case on vaccine acceptance are of lower magnitude among those who have high trust in government health authorities compared to those with low trust, while the average level of vaccine acceptance is substantially higher (columns 3-4). Individuals who do not trust health authorities appear to be more susceptible to change their minds with respect to vaccine acceptance when governments implement more strict non-pharmaceutical interventions or when they personally know someone who got infected. The age effect on vaccine acceptance -by which younger individuals are less willing to accept the vaccine than older ones- and the education effect -by which more educated individuals are more willing to take the vaccine- are only statistically significant among those that distrust government health authorities. In this sense, trust in government health authorities seems to be a powerful mediating factor: changes in the information set of individuals, either triggered by government policies or by personal experiences, and differences in individual characteristics only have an effect on vaccine acceptance among individuals who do not trust health authorities. Individuals who trust them, instead, appear to have a uniformly higher willingness to take the vaccine, irrespective of individual circumstances. This result resonates with the findings of Blair et al. (2022), who find that while individuals who trust in government tend to comply more with public health measures, they are not at the same time more knowledgeable about COVID-19 – if anything, their knowledge about the disease may be even more limited than those who distrust government.

A similar pattern is observed in the subsample analysis of the descriptive social norm on vaccine acceptance. The effects of government stringency, knowledge of a positive COVID-19 case and even the existence of a vaccine campaign are of a lower magnitude among those who believe community acceptance of the vaccine is high than among who believe that is low (column 7 versus column 6). Just as in the case of trust in health authorities, the age effect on vaccine acceptance is only present among those who believe community acceptance is low. The education effect is present in both subsamples. These results show that descriptive social norms are also a powerful mediating factor: when individuals believe that social norms about vaccination are loose, their decision to take the vaccine will be explained by differences in the information and individual circumstances which form their risk perceptions. When individuals believe that social norms about vaccination are stricter, these variables are less relevant in explaining individual vaccine behavior. These individuals also have a high vaccine acceptance conditional on their information and characteristics.

Figure 6: Trust, norms and changes in stringency and personal experience



Note: this graph plots the predicted probability (including the 95% confidence interval) of accepting the vaccine for different groups under two scenarios. In the first scenario (circle markers), the stringency index takes a value equal to that of the 25th percentile of the sample distribution (55.09) and the dummy variable indicating whether the respondent knows a COVID-19 positive case takes a value of zero; the remaining covariates are set at their sample means. In the second scenario (square markers), the stringency index takes a value equal to that of the 75th percentile of the sample distribution (74.54) and the dummy variable indicating whether the respondent knows a COVID-19 positive case takes a value of one; the remaining covariates are set at their sample means. Panel a. presents the predicted probability for the two scenarios for the subsample of individuals who report high trust in government health authorities. The estimation corresponds to the model in column 3 of Table 4. Panel b. presents the predicted probability for the two scenarios for the subsample of individuals who report low trust in government health authorities. The estimation corresponds to the model in column 4 of Table 4. Panel c. presents the predicted probability for the two scenarios for the subsample of individuals who believe vaccine acceptance in their community is low (defined as believing that 50 or fewer people out of 100 in their community will accept the vaccine). The estimation corresponds to the model in column 6 of Table 4. Panel d. presents the predicted probability for the two scenarios for the subsample of individuals who believe vaccine acceptance in their community is low (defined as believing that more than 50 people out of 100 in their community will accept the vaccine). The estimation corresponds to the model in column 7 of Table 4.

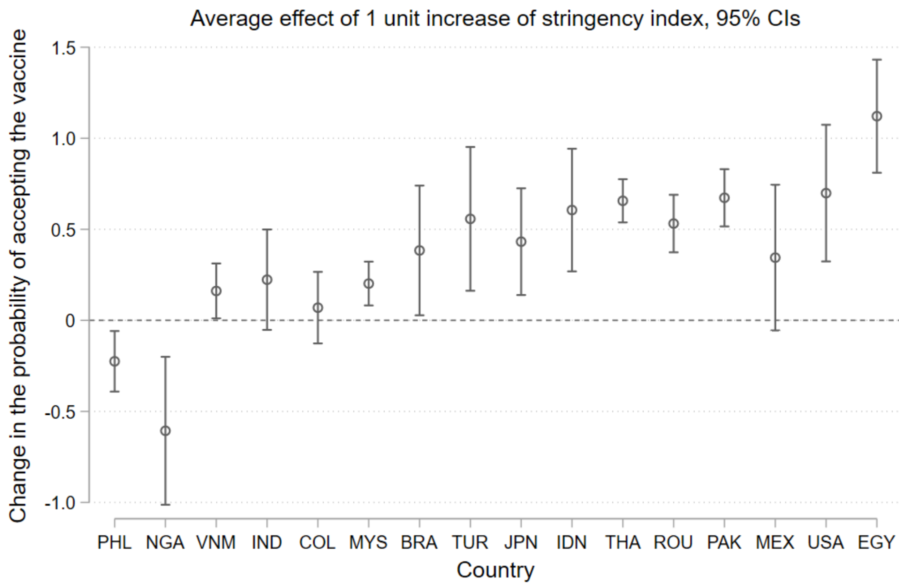
A graphic depiction of the mediating effect of trust and social norms in vaccine acceptance is presented in Figure 6. Panel “a” shows the predicted probability of accepting the vaccine for individuals with low trust in government health authorities under two scenarios – in the first one, government stringency is low (at the 25th percentile of the sample distribution) and the respondent doesn’t know personally any COVID-19 positive case; in the second scenario, government stringency is high (at the 75th percentile of the sample distribution) and the respondent knows personally a COVID-19 positive case. In the first scenario the probability of accepting the vaccine is 50.7%, while in the second scenario the probability is 67.1% - a difference of almost 17 percentage points. Panel “b” presents the same two scenarios for individuals that have high trust in government health authorities. In this case, the difference is smaller – about 12.5 percentage points, between 70.9% probability of accepting the vaccine in the first scenario to 83.4% in the second scenario.

Panels “c” and “d” repeat the same exercise, but this time distinguishing individuals between those who believe community acceptance of the vaccine is low (loose social norms) and those who believe community acceptance is high (stringent social norms). For the first group, the difference between the scenario of low stringency and no personal knowledge of a positive COVID-19 case and the scenario of high stringency and personal knowledge of a positive COVID-19 case is 20 percentage points – between a 36.3% probability of accepting the vaccine in the first scenario and 56.3% probability in the second scenario. For the group who believe community acceptance is high, the difference between both scenarios is smaller – about 10 percentage points, between 71.7% probability in the first scenario and 81.8% in the second scenario.

5.d Heterogenous effects across countries

Government management of the pandemic and public reception to lockdown policies have varied across the globe. While some countries witnessed backlash or protests to lockdowns and mask-mandates, others have not. To examine heterogeneity of impact across countries, we estimate Equation 1 (using the specification of Table 2, Column 3) including an interaction of the stringency index with country fixed effects. Figure 7 plots the marginal effects of stringency across countries. The average effect of stringency across countries shows quite some variation, particularly in the case of Bangladesh (excluded from Figure 7 so as not to distort the scale) which is the one of the few countries, along with Argentina, the Philippines, and Nigeria with a significant and negative impact of stringency. In these four countries, the effect of government stringency on vaccine acceptance appears to go in the opposite direction as the rest of the world. The reasons for this are speculative: in these countries, individuals appear to behave as believing that non-pharmaceutical interventions (NPI) are a substitute rather than a complement of vaccination campaigns, and therefore may react accordingly – becoming more reluctant to get the vaccine when stricter NPIs are in place.

Figure 7: Heterogeneous effects of stringency on vaccine acceptance across countries

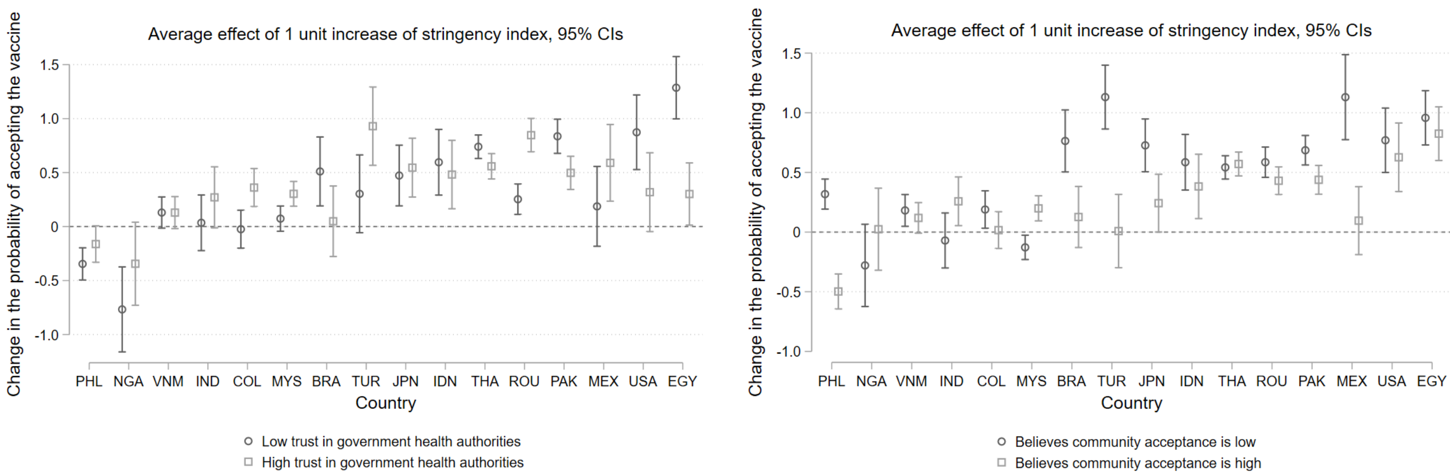


The mediating role of trust in government health authorities and beliefs about community acceptance also shows heterogeneity across countries. In Figure 8, we present the marginal effect of the stringency index on individual vaccine acceptance across countries distinguishing between individuals who have low or high trust in government health authorities (panel a) and between individuals who believe vaccine acceptance in the community is low or high (panel b). While on average the degree of vaccine acceptance of individuals who have high trust in government health authorities is less sensitive to changes in stringency index than the vaccine acceptance of those individuals who have low trust, this pattern is reversed in some countries. For instance, in Colombia, Malaysia, and Romania, the individuals who have high trust in government health authorities react more to changes in stringency. In some countries like Indonesia, Japan, the Philippines and Vietnam, there is no difference between the sensitivity of vaccine acceptance to stringency index across both groups of individuals. When looking at differences across groups of individuals based on the social norms prevalent in their communities, the general pattern of a higher sensitivity of vaccine acceptance to stringency among those living in communities with loose norms holds in most countries. In some countries, like Brazil, Mexico, the Philippines, and Turkey the differences between the two groups – those experiencing tight norms versus those experiencing loose norms – is significantly large. In others like Colombia, Egypt, Thailand, Vietnam and the US the difference is not statistically significant. In Argentina, Bangladesh and Malaysia individuals who believe community acceptance is low see their individual vaccine acceptance decrease when the stringency index increases – the opposite reaction vis-à-vis their peers in the rest of the world.

Figure 8 – The mediating role of trust and social norms across countries

Panel a. Trust in government health authorities

Panel b. Social norms about vaccination



6. Conclusion

In this paper we have analyzed the relationship between government policies, personal experience and vaccine acceptance, exploring the mediating factors of trust and social norms. We find that an increase in the stringency of government restrictions and a personal experience related to the pandemic – personally knowing someone who tested positive for COVID-19 – is associated to increased vaccine acceptance. This result goes in line with a mechanism by which government policies, just like personal encounters with the disease, change the information set of individuals and thus their risk perceptions about the pandemic and the vaccine. By signaling the criticality of the spread of the disease, the implementation of more stringent policies may induce individuals to be more willing to take a vaccine to prevent COVID-19. On average, the change in vaccine acceptance associated with an increase in government stringency from the 25th percentile to the 75th percentile of the sample distribution is about 7.8 percentage points, a magnitude larger than the difference in vaccine acceptance between individuals with primary education and those with tertiary education, and about the same size as the effect of knowing a positive case of COVID-19. The effect of government stringency on vaccine acceptance is not immediate, as it takes at least two weeks for an increase in stringency to translate fully into increased vaccine acceptance and, also, the effect becomes smaller the higher the initial stringency index is and the longer it has been at very high levels, suggesting a certain degree of "pandemic fatigue".

The effect of government policy stringency on vaccine acceptance is remarkably stronger among individuals who distrust health authorities or who live in communities with loose social norms about vaccination. These individuals appear to be more sensitive to changes in government policies or to the personal experience of getting to know a positive COVID-19 case. Individuals more trustful of government health authorities or who believe community acceptance is high are less sensitive to changes in government policies and their personal experience. We find similar results when considering the effect of government stringency on mask wearing which is globally high with around 90 percent of respondents reporting to always/often wear masks in public. Government stringency does not explain mask-wearing behavior once we control for individual risk perceptions, beliefs about mask efficacy, and social norms around mask-wearing.[10] Our results point to the importance of government policy stringency on vaccine acceptance, particularly in contexts where trust in government health authorities is low or where the prevailing social norm is for vaccine acceptance to be low. The implementation of stringent restrictions, beyond helping to curtail the spread of the disease by restricting mobility, may also contribute indirectly to reducing the circulation of the virus in another way – by increasing vaccine acceptance where it is low. The relationship between non-pharmaceutical measures and the acceptance of preventive health measures such as vaccination can be a useful lesson for other communicable diseases as well.

[10] Results on mask-wearing and government stringency are available upon request.

7. Tables

Table 1 – Descriptive statistics

	mean	sd	min	max	observations
Individual characteristics					
age 20-30 yrs.	0.248	0.432	0	1	232292
age 31-40 yrs.	0.251	0.434	0	1	232292
age 41-50 yrs.	0.205	0.404	0	1	232292
age 51-50yrs.	0.165	0.371	0	1	232292
age 61-70 yrs.	0.098	0.297	0	1	232292
age 71-80 yrs.	0.029	0.167	0	1	232292
age 80 above yrs.	0.004	0.065	0	1	232292
male	0.589	0.492	0	1	232292
urban	0.862	0.345	0	1	232292
primary edu. or less	0.045	0.208	0	1	232292
secondary edu.	0.257	0.437	0	1	232292
tertiary edu.	0.698	0.459	0	1	232292
in good health	0.766	0.423	0	1	232292
Experiences and subjective beliefs					
will accept vaccine	0.656	0.475	0	1	232292
Perception of high risk of infection	0.469	0.499	0	1	98277
know positive case	0.596	0.491	0	1	232292
trusts govt. health authorities	0.384	0.486	0	1	85392
Norms					
No. people out of 100 who will vaccinate	63.2	27.8	0	100	178581
No. people out of 100 who wear mask	74.6	29.0	0	100	226156
Country-level circumstances					
stringency index	64.0	11.78	29.6	88.0	232292
New deaths per million (7-day avg.)	2.01	2.65	0	17.45	232292

Table 2 – Main specification

	Dependent variable: Willing to vaccinate						
	Whole sample	Only with trust and norms info					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stringency index	0.003***	0.004***	0.004***	0.004***	0.005***	0.012**	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)
1-day change in stringency index (absolute)			-0.004				
			(0.002)				
7-day change in stringency index (absolute)				-0.002*			
				(0.001)			
14-day change in stringency index (absolute)					-0.002**		
					(0.001)		
Stringency index^2						-0.000**	
						(0.000)	
Days above stringency score 80							-0.001***
							(0.000)
Vaccination campaign dummy	0.104***	0.092***	0.092***	0.093***	0.092***	0.095***	0.092***
	(0.021)	(0.019)	(0.019)	(0.019)	(0.018)	(0.019)	(0.019)
Daily deaths per million (7 day avg)	0.007	0.001	0.001	0.001	0.001	0.002	0.000
	(0.007)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)
Know positive case	0.086***	0.081***	0.081***	0.081***	0.080***	0.081***	0.080***
	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Individual attributes							
male	0.072***	0.081***	0.081***	0.081***	0.081***	0.081***	0.081***
	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
urban	0.014	0.018	0.018	0.018	0.018	0.018	0.018
	(0.010)	(0.013)	(0.012)	(0.012)	(0.013)	(0.013)	(0.012)
age 20-30	-0.096***	-0.105**	-0.105**	-0.105**	-0.105**	-0.105**	-0.105**
	(0.027)	(0.046)	(0.046)	(0.045)	(0.046)	(0.045)	(0.046)
age 31-40	-0.103***	-0.113**	-0.113**	-0.113**	-0.113**	-0.114**	-0.113**
	(0.027)	(0.045)	(0.045)	(0.045)	(0.046)	(0.045)	(0.045)
age 41-50	-0.093***	-0.099**	-0.099**	-0.099**	-0.098**	-0.099**	-0.099**
	(0.027)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
age 51-60	-0.074***	-0.079*	-0.079*	-0.079*	-0.079*	-0.079*	-0.079*
	(0.023)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)
age 61-70	-0.030	-0.034	-0.034	-0.034	-0.034	-0.034	-0.034
	(0.022)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
age 71-80	0.005	0.022	0.022	0.022	0.022	0.022	0.022
	(0.015)	(0.033)	(0.033)	(0.033)	(0.034)	(0.033)	(0.033)
Primary education or less	-0.050***	-0.037**	-0.037**	-0.037**	-0.038**	-0.037**	-0.037**
	(0.017)	(0.016)	(0.016)	(0.016)	(0.015)	(0.016)	(0.016)
Secondary education	-0.030***	-0.030***	-0.030***	-0.030***	-0.030***	-0.030***	-0.030***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
in good health	-0.003	0.000	0.000	0.000	0.001	0.000	0.001
	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Constant	0.419***	0.391***	0.383***	0.353***	0.316***	0.132	0.464***
	(0.045)	(0.071)	(0.074)	(0.084)	(0.091)	(0.142)	(0.078)
Observations	232292	61760	61760	61760	61760	61760	61760
R-squared	0.058	0.058	0.058	0.058	0.058	0.058	0.058

Standard errors in parentheses clustered at country level. All estimations include country and month fixed effects.

* p<0.05 ** p<0.01 *** p<0.001

Table 3 – The role of risk perceptions

	Dependent variable			
	Perception of high risk of infection		Willing to vaccinate	
	(1)	(2)	(3)	(4)
Stringency index	0.002*	0.002*	0.003**	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
Stringency index X Perception of high risk of infection				-0.000
				(0.001)
Perception of high risk of infection			0.089***	0.103*
			(0.010)	(0.058)
Vaccination campaign dummy	-0.026	-0.028	0.096***	0.096***
	(0.018)	(0.018)	(0.021)	(0.021)
Daily deaths per million (7 day avg)	0.010**	0.010**	-0.000	-0.000
	(0.004)	(0.004)	(0.006)	(0.006)
Know positive case	0.148***	0.148***	0.065***	0.065***
	(0.014)	(0.013)	(0.014)	(0.014)
Mediating factors				
No. people out of 100 who will vaccinate		0.001*		
		(0.000)		
trusts govt. health authorities		0.048***		
		(0.013)		
Individual attributes				
male	-0.051***	-0.051***	0.080***	0.080***
	(0.014)	(0.014)	(0.019)	(0.019)
urban	0.046***	0.047***	0.009	0.009
	(0.012)	(0.012)	(0.013)	(0.013)
age 20-30	-0.173***	-0.167***	-0.105*	-0.105*
	(0.055)	(0.055)	(0.059)	(0.059)
age 31-40	-0.108*	-0.102*	-0.135**	-0.135**
	(0.052)	(0.053)	(0.061)	(0.061)
age 41-50	-0.089	-0.085	-0.103	-0.103
	(0.053)	(0.053)	(0.062)	(0.062)
age 51-60	-0.098*	-0.096*	-0.101	-0.101
	(0.050)	(0.051)	(0.058)	(0.058)
age 61-70	-0.093	-0.092	-0.057	-0.056
	(0.054)	(0.056)	(0.056)	(0.056)
age 71-80	-0.091	-0.090	-0.023	-0.023
	(0.059)	(0.061)	(0.055)	(0.055)
primary edu or less=1	-0.044	-0.046*	-0.037*	-0.037*
	(0.027)	(0.026)	(0.020)	(0.020)
secondary edu=1	-0.007	-0.007	-0.022*	-0.022*
	(0.013)	(0.013)	(0.011)	(0.011)
in good health	-0.079***	-0.082***	0.000	0.000
	(0.010)	(0.010)	(0.008)	(0.008)
Constant	0.071	0.052	0.447***	0.439***
	(0.069)	(0.078)	(0.084)	(0.097)
Observations	15237	15237	15237	15237
R-squared	0.199	0.202	0.067	0.067

Standard errors in parentheses clustered at country level. All estimations include country and month fixed effects.

* p<0.05 ** p<0.01 *** p<0.001

Table 4 – Mediating effects: trust and descriptive norms

Dependent variable: Willing to vaccinate							
	Whole sample		Low trust	High trust	Whole sample	Low belief	High belief
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stringency index	0.003***	0.003**	0.004**	0.003***	0.005**	0.005***	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Stringency index X Trust in govt health authorities		0.002					
		(0.001)					
Stringency index X No. People out of 100 who will vaccinate					-0.000		
					(0.000)		
Vaccination campaign dummy	0.068***	0.087***	0.084***	0.088***	0.071***	0.103***	0.059***
	(0.016)	(0.018)	(0.017)	(0.021)	(0.016)	(0.022)	(0.013)
Daily deaths per million (7 day avg)	-0.000	0.001	0.002	-0.000	-0.000	-0.001	0.002
	(0.005)	(0.007)	(0.007)	(0.007)	(0.006)	(0.009)	(0.004)
know positive case	0.076***	0.081***	0.091***	0.063***	0.076***	0.101***	0.061***
	(0.010)	(0.011)	(0.016)	(0.011)	(0.010)	(0.016)	(0.006)
Mediating factors							
No. people out of 100 who will vaccinate	0.006***				0.008***		
	(0.000)				(0.002)		
trusts govt. health authorities	0.123***	0.041					
	(0.016)	(0.085)					
Individual attributes							
male	0.067***	0.081***	0.082***	0.078***	0.066***	0.055***	0.079***
	(0.012)	(0.014)	(0.017)	(0.011)	(0.012)	(0.018)	(0.014)
urban	0.012	0.021*	0.027*	0.009	0.009	0.021	0.003
	(0.008)	(0.011)	(0.014)	(0.010)	(0.009)	(0.013)	(0.008)
age 20-30 yrs	-0.048	-0.095*	-0.110*	-0.066	-0.053	-0.145*	-0.023
	(0.033)	(0.045)	(0.053)	(0.054)	(0.033)	(0.069)	(0.037)
age 31-40 yrs	-0.059*	-0.105**	-0.129**	-0.061	-0.063*	-0.163**	-0.031
	(0.032)	(0.045)	(0.053)	(0.055)	(0.032)	(0.065)	(0.039)
age 41-50 yrs	-0.056*	-0.095**	-0.108*	-0.068	-0.057*	-0.153**	-0.027
	(0.032)	(0.045)	(0.054)	(0.051)	(0.032)	(0.066)	(0.039)
age 51-50yrs	-0.051	-0.079*	-0.089	-0.057	-0.050	-0.149*	-0.018
	(0.032)	(0.044)	(0.053)	(0.053)	(0.032)	(0.072)	(0.038)
age 61-70 yrs	-0.016	-0.034	-0.038	-0.023	-0.016	-0.135*	0.019
	(0.031)	(0.040)	(0.044)	(0.054)	(0.031)	(0.069)	(0.034)
age 71-80 yrs	0.034	0.022	0.027	0.014	0.034	-0.071	0.057
	(0.029)	(0.033)	(0.034)	(0.051)	(0.029)	(0.071)	(0.034)
primary edu or less	-0.046***	-0.046***	-0.061***	-0.020	-0.040**	-0.037	-0.028**
	(0.016)	(0.015)	(0.014)	(0.015)	(0.017)	(0.025)	(0.013)
secondary edu	-0.032***	-0.031***	-0.040***	-0.015	-0.032***	-0.026**	-0.028***
	(0.008)	(0.008)	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)
in good health	-0.015**	-0.006	-0.015	0.015	-0.011	-0.021*	-0.000
	(0.007)	(0.007)	(0.009)	(0.009)	(0.007)	(0.010)	(0.005)
Constant	0.039	0.390***	0.323***	0.505***	-0.080	0.186*	0.556***
	(0.060)	(0.085)	(0.100)	(0.079)	(0.168)	(0.097)	(0.063)
Observations	61760	61760	38009	23751	61760	21941	39819
R-squared	0.179	0.086	0.065	0.051	0.165	0.069	0.047

Standard errors in parentheses clustered at country level. All estimations include country and month fixed effects.

* p<0.05 ** p<0.01 *** p<0.001

References

Abaluck, J., Kwong, L. H., Styczynski, A., Haque, A., Kabir, M. A., Bates-Jefferys, E., Crawford, E., Benjamin-Chung, J., Raihan, S., Rahman, S., Benhachmi, S. & Mobarak, A. M. (2021). Impact of community masking on COVID-19: A cluster-randomized trial in Bangladesh. *Science*, eabi9069.

Allen IV, James, et al. Correcting Perceived Social Distancing Norms to Combat COVID-19 (2021). NBER working paper 28651. National Bureau of Economic Research.

Al-Mohaithef, Mohammed, and Bijaya Kumar Padhi. (2020) "Determinants of COVID-19 vaccine acceptance in Saudi Arabia: a web-based national survey." Journal of multidisciplinary healthcare 13: 1657.

Arce, J. S. S., Warren, S. S., Meriggi, N. F., Scacco, A., McMurry, N., Voors, M., ... & Mobarak, A. M. (2021). COVID-19 vaccine acceptance and hesitancy in low and middle income countries, and implications for messaging. *medRxiv*.

Argote Tironi, P., Barham, E., Zuckerman Daly, S., Gerez, J. E., Marshall, J., & Pocasangre, O. (2021). Messages that increase COVID-19 vaccine acceptance: Evidence from online experiments in six Latin American countries. *PloS one*, *16*(10), e0259059.

Benabou, Roland, and Jean Tirole. (2011) Laws and norms. NBER working paper 17579, National Bureau of Economic Research

Betsch, Cornelia, Robert Böhm, and Gretchen B. Chapman (2015) "Using behavioral insights to increase vaccination policy effectiveness." Policy Insights from the Behavioral and Brain Sciences 2.1: 61-73.

Bicchieri, Cristina (2016). Norms in the wild: How to diagnose, measure, and change social norms. Oxford University Press

Blair, R., Curtice, T., Dow, D. and G. Grossman (2022) “Public trust, policing, and the COVID-19 pandemic: Evidence from an electoral authoritarian regime.” Social Science & Medicine 305, 115045

Bundorf, M. K., DeMatteis, J., Miller, G., Polyakova, M., Streeter, J. L., & Wivagg, J. (2021). Risk Perceptions and Protective Behaviors: Evidence from COVID-19 Pandemic (No. w28741). National Bureau of Economic Research.

Campos-Mercade, P., Meier, A. N., Schneider, F. H., Meier, S., Pope, D., & Wengström, E. (2021). Monetary incentives increase COVID-19 vaccinations. *Science*, *374*(6569), 879-882.

Collis, Avinash, et al. "Global survey on COVID-19 beliefs, behaviors, and norms." (2021). Technical Report

Costa-Font, J., Rudisill, C., Harrison, S., & Salmasi, L. (2021). The Social Value of a SARS-CoV-2 Vaccine: Willingness to Pay Estimates from Four Western Countries.

Dai, H., Saccardo, S., Han, M. A., Roh, L., Raja, N., Vangala, Modi, H., Pandya, S., Sloyan, M. & Croymans, D. M. (2021). Behavioural nudges increase COVID-19 vaccinations. *Nature*, *597*(7876), 404-409.

Devasenapathy, N., Jerath, S. G., Sharma, S., Allen, E., Shankar, A. H., & Zodpey, S. (2016). Determinants of childhood immunisation coverage in urban poor settlements of Delhi, India: a cross-sectional study. BMJ open, 6(8), e013015.

Gauri, Varun, and Peyvand Khaleghian (2002). Immunization in developing countries: its political and organizational determinants. The World Bank, Washington, DC.

Gelfand, M. J., Jackson, J. C., Pan, X., Nau, D., Pieper, D., Denison, E., ... & Wang, M. (2021). The relationship between cultural tightness–looseness and COVID-19 cases and deaths: a global analysis. The Lancet Planetary Health, 5(3), e135-e144.

Glaeser, Edward, Ginger Zhe Jin, Benjamin T. Leyden and M. Luca (2020) “Learning from Deregulation: The Asymmetric Impact of Lockdown and Reopening on Risky Behavior During COVID-19”, NBER Working Paper 27650

Goldberg, M., Gustafson, A., Maibach, E., van der Linden, S., Ballew, M. T., Bergquist, P., Kotcher, J., Marlon, J.R., Rosenthal, S. and Leiserowitz, A. (2020). Social norms motivate COVID-19 preventive behaviors.

Goldstein, Patricio, Eduardo Levy Yeyati, and Luca Sartorio (2021). "Lockdown fatigue: The diminishing effects of quarantines on the spread of COVID-19." Covid Economics.

Hale, Thomas, et al. (2021) "A global panel database of pandemic policies (oxford covid-19 government response tracker)." Nature Human Behaviour: 1-10.

Hawkins, Robert B., E. J. Charles, and J. H. Mehaffey (2020). "Socio-economic status and COVID-19–related cases and fatalities." Public Health 189: 129-134.

Jabar, Melvin, et al. (2021) "Predictors of Intention To Vaccinate for COVID-19 in the Philippines: Do Trust in Government and Trust in Vaccines Really Matter?."

Jin, Ginger Zhe, and Thomas G. Koch. (2018) Learning by suffering? Patterns in flu shot take-up. NBER working paper. 25272. National Bureau of Economic Research.

Kerr, J. R., Schneider, C. R., Recchia, G., Dryhurst, S., Sahlin, U., Dufouil, C., Arwidson, P., Freeman, A.L. & van der Linden, S. (2020). Predictors of COVID-19 vaccine acceptance across time and countries. *MedRxiv*.

Lazarus, J. V., Ratzan, S. C., Palayew, A., Gostin, L. O., Larson, H. J., Rabin, K., Kimball, S. & El-Mohandes, A. (2021). A global survey of potential acceptance of a COVID-19 vaccine. *Nature medicine*, *27*(2), 225-228.

Levine, Myron M., and Orin S. Levine. (1997) "Influence of disease burden, public perception, and other factors on new vaccine development, implementation, and continued use." The Lancet 350.9088: 1386-1392.

Lin, Yulan, et al. (2020) "Understanding COVID-19 vaccine demand and hesitancy: A nationwide online survey in China." PLoS neglected tropical diseases 14.12: e0008961.

Loomba, S., de Figueiredo, A., Piatek, S. J., de Graaf, K., & Larson, H. J. (2021). Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nature human behaviour*, *5*(3), 337-348.

Mannan, D. K. A., & Farhana, K. M. (2020). Knowledge, attitude and acceptance of a COVID-19 vaccine: A global cross-sectional study. *International Research Journal of Business and Social Science*, *6*(4).

Marti, Melanie, et al. (2017) "Assessments of global drivers of vaccine hesitancy in 2014—Looking beyond safety concerns." PloS one 12.3: e0172310.

Maurer, J., Harris, K. M., Parker, A., & Lurie, N. (2009). Does receipt of seasonal influenza vaccine predict intention to receive novel H1N1 vaccine: evidence from a nationally representative survey of US adults. Vaccine, 27(42), 5732-5734.

Maurer, Jürgen (2009). "Who has a clue to preventing the flu? Unravelling supply and demand effects on the take-up of influenza vaccinations." Journal of Health Economics 28.3: 704-717.

Moehring, A., Collis, A., Garimella, K., Rahimian, M. A., Aral, S., & Eckles, D. (2021). Surfacing norms to increase vaccine acceptance. Available at SSRN 3782082.

Streatfield, Kim, Masri Singarimbun, and Ian Diamond (1990). "Maternal education and child immunization." Demography 27.3: 447-455.

Appendix

Table A1 – Descriptive statistics by country (mean)

Country	Will accept vaccine (dummy)		Perception of high risk of infection (dummy)		Knows positive case (dummy)		Trusts govt. health authorities (dummy)		No. people out of 100 who will vaccinate		No. people out of 100 who wear mask		Stringency index		N
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	
Argentina	0.635	0.481	0.782	0.413	0.833	0.373	0.256	0.437	61.7	25.5	76.1	27.7	79.8	2.0	12287
Bangladesh	0.805	0.396	0.310	0.463	0.812	0.391	0.355	0.479	62.1	29.4	63.0	31.2	80.3	0.4	12154
Brazil	0.762	0.426	0.689	0.463	0.889	0.314	0.260	0.439	71.8	25.3	68.2	29.8	64.3	5.9	13124
Colombia	0.658	0.475	0.793	0.405	0.768	0.422	0.304	0.460	65.3	26.7	79.2	26.1	69.9	8.7	11960
Egypt, Arab Rep.	0.548	0.498	0.615	0.487	0.803	0.397	0.251	0.433	51.4	31.0	55.4	32.1	61.7	6.3	12775
India	0.729	0.444	0.282	0.450	0.709	0.454	0.505	0.500	71.6	27.8	74.4	28.7	66.1	4.1	9512
Indonesia	0.571	0.495	0.545	0.498	0.431	0.495	0.504	0.500	62.6	30.9	80.6	26.4	60.9	6.6	11987
Japan	0.550	0.497	0.282	0.450	0.214	0.410	0.194	0.395	67.8	20.4	88.8	15.6	43.1	7.1	20390
Malaysia	0.672	0.469	0.297	0.457	0.274	0.446	0.672	0.470	72.2	24.9	89.2	18.9	71.7	7.5	12820
Mexico	0.758	0.429	0.813	0.390	0.859	0.348	0.293	0.455	64.9	26.6	67.5	28.7	71.0	2.9	14418
Nigeria	0.619	0.486	0.260	0.439	0.344	0.475	0.491	0.500	50.9	32.4	54.6	32.7	54.6	3.6	9661
Pakistan	0.669	0.471	0.285	0.452	0.697	0.460	0.507	0.500	51.3	31.2	56.6	32.3	57.9	6.7	10175
Philippines	0.562	0.496	0.268	0.443	0.578	0.494	0.370	0.483	63.8	26.2	85.5	22.1	65.3	5.3	10731
Romania	0.590	0.492	0.584	0.493	0.777	0.416	0.326	0.469	50.6	24.9	69.1	30.5	69.1	11.8	15417
Thailand	0.769	0.422	0.112	0.316	0.069	0.253	0.467	0.499	69.2	29.4	86.5	22.2	51.1	7.3	14061
Turkey	0.555	0.497	0.440	0.496	0.793	0.405	0.386	0.487	63.7	26.7	81.3	26.2	67.7	4.7	14317
United States	0.636	0.481	0.521	0.500	0.816	0.387	0.336	0.472	60.3	22.8	65.2	27.1	69.1	4.0	15317
Vietnam	0.802	0.398	0.471	0.499	0.156	0.362	0.735	0.442	72.0	27.6	88.5	21.4	56.6	8.8	11186

Note: This table plots the mean and standard deviation by country of different variables used in the analysis. The sample is restricted to that of individuals with information on basic individual characteristics (age, gender, education, urban/rural location and health self-assessment) and vaccine acceptance.