SCUOLA DI DOTTORATO

UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA

Dipartimento di / Department of

Sociology and Social Research

Dottorato di Ricerca in / PhD program Analysis of Social and Economic Processes (ASEP)

Ciclo / Cycle XXXVI

VACCINATION INTENTION AND TRUST IN THE EU CONTEXT (THE EUROPEAN UNION)

Cognome / Surname Kochergina Nome / Name Ekaterina

Matricola / Registration number 871086

Tutore / Tutor: Professor Marco Terraneo

Coordinatore / Coordinator: Professor Alberta Andreotti

ANNO ACCADEMICO / ACADEMIC YEAR 2022-2023

Abstract

The coronavirus vaccines played an essential role in ending the global pandemic. Their use revealed an overwhelming vaccine hesitancy caused by mistrust in vaccines, government, and health professionals. Vaccine hesitancy is rooted in history and embedded in a broad societal context, its levels vary sufficiently among countries and parts of the world. However, even countries with historically prominent levels of vaccine acceptance proved an increase in hesitancy and vaccine refusal during this pandemic. Political trust has been recently linked to civic engagement, compliance with policies and acceptance of public health interventions. Lack of public trust leads to lower compliance with public policy measures, social distancing guidelines and vaccination guidelines. This study investigates the role of trust in government and health professionals in vaccine acceptance among the European Union members.

The research is based on a pooled cross-section dataset from the Eurobarometer survey, collected in 2021, covering 27 EU nations on various socio-economic and political questions. The variables of interest are - vaccine hesitancy, institutional trust, socio-economic characteristics, internet use, political preferences and government performance approval. To assess how individual-level and country-level trust in health professionals relates to vaccine hesitancy, 2-level proportional odds regression models, including trust on individual and country levels, are fitted. Hypotheses about cross-level effects between trust, information use, and political preferences are tested.

The results confirm hypotheses about the positive and robust link between trust in health professionals and vaccination acceptance on individual and country levels. It also supports the proposition about the positive link between trust in government and vaccination acceptance. This work is one of the rare examples proving that higher levels of political trust are connected to higher levels of vaccine acceptance. For policymakers, these results signal the importance of building stable, competent, reliable public health systems to maintain people's trust in health professionals and facilitate higher civil engagement and cooperation.

Keywords: *trust in government, trust in health professionals, vaccine hesitancy, vaccines, social cohesion, public health*

Abstract

I vaccini contro il coronavirus hanno svolto un ruolo essenziale nel porre fine alla pandemia globale. Il loro utilizzo rivela però un'enorme esitazione vaccinale causata dalla sfiducia nei vaccini, nel governo e negli operatori sanitari. L'esitazione nei confronti dei vaccini è radicata nella storia e inserita in un ampio contesto sociale, il suo livello varia significativamente tra i Paesi e le parti del mondo. Tuttavia, anche i Paesi con livelli storicamente elevati di accettazione dei vaccini hanno dimostrato un aumento dell'esitazione e del rifiuto del vaccino. La fiducia politica è stata recentemente collegata all'impegno civile, al rispetto delle politiche e all'accettazione degli interventi di salute pubblica. La mancanza di fiducia politica porta a una minore osservanza delle misure di politica pubblica, delle linee guida per l'allontanamento sociale e delle linee guida per la vaccinazione. Questo studio analizza il ruolo della fiducia nel governo e negli operatori sanitari nell'accettazione dei vaccini tra i membri dell'Unione Europea.

La ricerca si basa su dati raccolti nel 2021 dall'indagine Eurobarametro, che copre 27 Paesi dell'UE su varie questioni socio-economiche e politiche. Le variabili di interesse sono: esitazione vaccinale COVID-19, fiducia nel governo e nelle autorità sanitarie, caratteristiche socio-economiche, uso di Internet, preferenze politiche e approvazione del governo. Per valutare come la fiducia negli operatori sanitari a livello individuale e nazionale sia correlata all'esitazione nei confronti dei vaccini, abbiamo applicato modelli di regressione multilevello proporzionale a due livelli, includendo la fiducia a livello individuale e nazionale. Sono state testate le ipotesi sugli effetti incrociati tra fiducia, uso delle informazioni e collocazione politica.

I risultati confermano le ipotesi sul legame positivo e robusto tra la fiducia negli operatori sanitari e l'accettazione della vaccinazione a livello individuale e di paese. Inoltre, supportano di un legame positivo tra la fiducia nel governo e l'accettazione delle vaccinazioni. Questo lavoro è uno dei rari esempi che dimostrano che livelli più elevati di fiducia politica sono collegati a livelli più elevati di accettazione dei vaccini. Per i policymakers, questi risultati segnalano l'importanza di costruire sistemi di salute pubblica stabili, competenti e affidabili per mantenere la fiducia dei cittadini negli operatori sanitari e facilitare un migliore impegno civile e partecipazione.

Parole chiave: fiducia nel governo, esitazione vaccinale, vaccini, coesione sociale, salute pubblica

Acknowledgements

I would like to thank my supervisor, Professor Marco Terraneo, for supporting me on my journey. I appreciate the communication we have built, our shared values and our common vision for life and profession. I thank Marco for letting me become a researcher on my own, at my own pace, learning from my mistakes, and always staying around for advice and support.

I am also grateful to Professor Alberta Andreotti and Professor Giuseppe Vittucci for scientific advice and consultations on various stages of my research. Their knowledge had been indispensable for this work.

My special gratitude goes to the GESIS Institute (Cologne, Germany). To Professor Alexia Katsanidou, Dr. Marlene Mauk, Kara Nerenheim. The visiting period to GESIS played a vital role in creating this thesis, it largely influenced my understanding of the topic and helped me develop sections 2 and 3.

This work employs the Standard Eurobarometer[1] dataset conducted on behalf of the European Commission under the responsibility of the Directorate-General Communication and, on occasion, requested by other departments according to the policy they deal with. From the outset, the European Commission has generously granted access to Eurobarometer primary data for re-use in social science research and training. The integrated original datasets and related materials are delivered by the respective survey research institute in charge of implementation and fieldwork coordination. Long-term access to and usability of Eurobarometer primary data and documentation is provided in a cooperative arrangement between the Inter-University Consortium for Political and Social Research (ICPSR) and the GESIS Data Archive for the Social Sciences (DAS).

I would like to acknowledge the use of AI language models – ChatGPT – developed by OpenAI to provide information about Stata software during the research process.

I dedicate this thesis to my grandmother. She was not able to go to the university as she had been married out only 17 years old to a man twice her age. Graduating from university and travelling the world remained her life dream. She always told me to get a university degree, that it would help me to stay independent and free from the power of men. I wish all women could have a chance to live up to their dreams, be free and be safe.

[1] The European Commission's Eurobarometer Surveys, [Online] https://www.gesis.org/en/eurobarometer-data-service/home [Accessed on 21 December, 2023]

I must thank my friends and family, as I enjoyed their endless friendship and support. Silvio Pagani e Paola Maria Belloni, grazie per la vostra gentilezza, intelligenza e amicizia. Mi è piaciuto molto il tempo che abbiamo trascorso insieme, quando siamo andati in gita alle montagne e alle proteste femministe, e abbiamo riparato insieme le biciclette. Siete meraviglie, sono molto fortunata ad avervi conosciuto e diventare una vostra amica.

I feel important to state here my position about the current situation. Two years ago (10 years to count the annexation of the Crimea peninsula), Russia invaded Ukraine disguising it as a *"special military operation"* aimed at protecting the Russian-speaking population from the *"Ukrainian nazist"* regime. It is a lie, Ukraine was never nazist, it never attacked Russians, it was a peaceful and beautiful country. I am against this war, and I do not support the Russian government and the political course it chose for Russia. I grieve together with my Ukrainian friends and their families. I am so sorry, please forgive me. I hope we, Russians, will someday accept our responsibility for our crimes and will seek reconciliation and forgiveness. To quote Charlie Chaplin[2]:

> *"[…] To those who can hear me, I say - do not despair […] You, the people, have the power - the power to create machines. The power to create happiness! You, the people, have the power to make this life free and beautiful, to make this life a wonderful adventure. Then - […] - let us use that power - let us all unite."*

Lastly, I would like to share the essential knowledge I learned during three years of writing a doctoral thesis: everything is possible, even if it is not.

[2] Charlie Chapli: official website, The Final Speech from The Great Dictator [Online] https://www.charliechaplin.com/en/films/7-The-Great-Dictator/articles/29-The-Final-Speech-from-The-Great-Dictator- [Date of access March 21st, 2024]

We have to be kind to each other

Table of content

Acknowledgements *4*

List of Images *9*

List Of Figures *9*

List Of Tables *10*

Section 1. Introduction *11*

1.1 Research Question and Research Methodology **15**

Section 2. Public trust *22*

2.1 Introduction **22**

2.2 Conceptual Challenges of Trust Research **23**

2.3 Conceptual Model of Public Trust **25**

2.4 Vaccination Intention and Trust in Government and Health Professionals, Approaches to Describe the Underling Mechanism **29**

2.5 Role of Trust in Previous Outbreaks **31**

2.6 Summary **36**

Section 3. Vaccination Intention, Vaccination Acceptance, Vaccination Hesitancy and Vaccination Rejection *38*

3.1 Introduction **38**

3.2 History of Vaccination **39**

3.3 Vaccine Hesitancy Determinants, a Literature Review **44**

3.3.1 Vaccine Hesitancy Concept Development 44

3.3.2 Individual and Group Determinants of Vaccine Hesitancy 48

3.3.3 Contextual Influences 51

3.3.4 Vaccine Ethics, Biopolitics, Moralization 53

3.4 COVID-19 Vaccine Intention and its Determinants **57**

3.4.1 Individual and Group Influences 58

3.4.2 Communication about COVID Vaccination 59

3.4.3 Contextual Factors 61

3.4.4 Mandatory Vaccination Policy Effectiveness 62

Section 4. Conceptual Framework and Model Development ***65***

4.1 Research Model **65**

4.2 Research Question and Hypothesis **67**

4.3 Operationalization of Concepts **69**

Multilevel Ordered Logistic Model 73

A Random Slope Cumulative Logit Model 75

Proportional Odds 75

The Intraclass Correlation 76

4.4 Model Building Strategy **76**

Step 1. Proportional Odds Test 76

Step 2. Building an Empty Model 77

Step 3. Building an Intermediate Model 77

Step 4. Building the Final Model 78

Section 5. Data Analysis and Results ***79***

5.1 Socio-demographic Characteristics and Descriptive Statistics **79**

5.2 Bivariate Correlations **87**

5.3 Regression Results **88**

Chapter 6. Discussion ***95***

Chapter 7. Conclusions ***99***

References ***105***

Appendix I. A Procedure for Multilevel Model Building ***121***

Appendix II. List of Explanatory Variables Used in the Research ***122***

Appendix III. Correlation Matrix for Individual-level Variables ***124***

Appendix IV. Main Descriptive Statistics ***127***

Appendix V. Summary Statistics of Trust in Government and Trust in Health Professionals ***129***

Appendix VI. Multilevel Regression Results, Trust in Health Professionals ***135***

Appendix VII. Multilevel Regression Results, Trust in Government ***137***

List of Images

Image 1 Percentage of adult (18+) population received the primary vaccination course 16
Image 2 Vaccination against cholera in the streets of naples, 1973. Source: blick/rdb/ullsteinbild via getty image 33
Image 3 Unknown woman undergoes vaccine inoculation, ussr. Vitaly sozinov/tas 35
Image 4 The Vaccination Monster, The Wellcome Institute 41
Image 5 Trust In Health Professionals, By Country, In Descending Order From Highest To Lowest 83
Image 6 Trust In National Government By Country And Wave Of The Survey, Descending Order From Highest To Lowest 84
Image 7 Joint Distribution For Wave 1 And Wave 2 Of The Vaccine Hesitancy 85
Image 8 By Country Distribution Of The Vaccine Hesitancy In Wave 1, February-March 2021, 95% Confidence Interval 86
Image 9 By Country Distribution Of The Vaccine Hesitancy In Wave 2, June-July 2021, 95% Confidence Interval 86
Image 10 The State Effects Are Shown In Rank Order Together 89
Image 11 The State Effects Are Shown In Rank Order By Country, Random Intercept, Random Slope And Cross-Level Effects Model 91
Image 12 The State Effects Are Shown In Rank Order By Country, Random Intercept, And Random Slope Model 93

List Of Figures

Figure 1 A Basic Model Of The Theoretical Effect Of Trust On Vaccination Intention 18
Figure 2 Conceptual Model Of Public Trust 26
Figure 3 The Continuum Of Vaccine Hesitancy, From Macdonald, 2015 46
Figure 4 "Three Cs" Model Of Vaccine Hesitancy, From Macdonald, 2015 47
Figure 5 Conceptual Model Of Vaccine Hesitancy 66
Figure 6 Unit Diagram Of A Two-Level Nested Structure; Individuals In Countries 68

List Of Tables

Table 1 Working Group On Vaccine Hesitancy Determinants Matrix, From Macdonald, 2015 48

Table 2. List Of Countries Included In The Survey And Their Respective Sample Size..... 80

Table 3 Main Descriptive Statistics Of The Pooled Dataset..... 82

Table 4 2-Level Ordinal Logistic Model, Trust In Health Professionals And Vaccination Propensity 90

Table 5 Multilevel Regression Model Random Intercept And Random Slope, Trust In Government Cluster Mean..... 92

Section 1. Introduction

Pandemics are common companions of humanity, but always very dangerous. A single wave of bubonic plague in 14th-century Europe eliminated 30 to 60% of its population (Wade 2020), reshaping the continent and changing its socio-economic and political life forever (Cowie 1972). In recent years, three viruses from the coronavirus family (SARS, MERS, COVID-19) have raised alerts from scientists as they cause severe health damage, are lethal, and are easy to spread. Finally, there are no known effective therapies against them[3].

In late 2019, the COVID-19 virus, which causes respiratory distress and cardiovascular failure, spread first in China and then worldwide. Despite scientists' warnings, society had not been ready for a global pandemic, and we have been caught off guard. Luckily, scientists have been able to create in a noticeably brief time several effective vaccines against COVID-19 in a record time. This genuinely revolutionary and remarkable achievement proves the power of science to save lives, yet many people are hesitant to get vaccinated. This work seeks to answer why the COVID-19 vaccination in the EU has been slow and inconsistent. It assumes that vaccine hesitancy plays a crucial role in slow vaccination intake. The following questions are "Why are people vaccine hesitant?" and "What could explain observed differences in vaccination intake between the European countries?"

At the time, medical professionals hypothesized that to stop the COVID-19 pandemic, it was necessary to create so-called "herd immunity" creating a set up when roughly 90% of the population is vaccinated or has immunity to the virus gained through the infection. At the time of first vaccinations, we did not know much about COVID-19, how long immunity lasts, and how strongly it protects from reinfection and/or makes reinfection lighter for the person. So, policymakers and medical professionals in all countries started their race to build herd immunity aiming at vaccinating everyone as soon as possible. Very soon, it became evident that people hesitated to vaccinate and were distrustful of new vaccines which created a huge barrier for achieving herd immunity. Data from the European Centre for Disease Prevention and Control (USA) reveal noticeable differences between countries in vaccination rates. By January 2022 (a year from when vaccines became available), the share of EU citizens who received at least one vaccine dose varied from 28.5% in Bulgaria to 90.8% in Denmark (Franic 2022).

The problem with low vaccination hesitancy had become almost anecdotal, as policymakers were desperate to create policies nagging people into vaccination facilities. Images of world leaders getting vaccinated appeared in the media. The French President, Emmanuel Macron, allowed himself a rather arrogant expression for a civil servant – saying that he will *"piss off"* unvaccinated people - sparking

[3] Coronaviruses, National Institute of Allergy, and Infectious Diseases, [Online] https://www.niaid.nih.gov/diseases-conditions/coronaviruses [Accessed on December 4, 2023]

public outrage[4]. The *carrot-and-stick* approach included vaccine mandates, information campaigns, monetary and non-monetary incentives, and even the distribution of lottery tickets for complete inoculation took place in some sites (Campos-Mercade et al. 2021). In Austria, the lottery would allow fully inoculated people the one-in-three chance to win a €500 voucher that could be then exchanged for tangible goods or services[5]. In Moscow, Russia, Mayor Sergey Sobyanin announced a similar lottery, giving every resident of the Russian capital who gets her first coronavirus inoculation a chance to win a car[6]. Vaccine enhancement policies greatly varied in their forms and strictness and included non-monetary means of support, monetary measures and even punishments, for example, the detention of those unvaccinated. At the same time as the lottery, the fine for unvaccinated people in Austria was established at 3600 euros. Italian Government, for example, restricted unvaccinated people from joining the workforce, which disproportionately affected the working population, for example, it has put undocumented migrants or unofficial workers on the verge of survival[7].

On top of health insecurities caused by the pandemic, ineffective policing and resulting crises, some radical political forces saddle the topic and created influential conspiracy theories surrounding vaccine development filled with misinformation and fearmongering. Mass media and social networks reported cases of adverse effects of vaccines even before health professionals could confirm they were caused by vaccination. False information about vaccine adverse effects flooded the Internet; misinformation about vaccine content – that it contains a 5G microchip that will spy on people (Flaherty, Sturm, and Farries 2022), or it has years of unknown side effects (for example it destroys sperm cells) (Smith 2017), or vaccines had been created to eliminate half of the world population (Cherkaev 2022), or it contains poison (Offit and Jew 2003).

As a consequence of such mass misinformation mass protests against mandatory vaccination unfolded in all EU countries, even in Germany, whose population is stereotypically believed to be obedient to the authorities. Attitudes to vaccination overnight turned into a highly charged, politically divided topic deeply rooted in socio-economic and political contexts, sensitised as personal responsibility. As such,

[4] Macron's vow to 'piss off' the unvaccinated sparks outrage, France24 [Online] https://www.france24.com/en/france/20220105-macron-says-he-wants-to-piss-off-france-s-unvaccinated [Accessed on December 4, 2023]

[5] Austria creates Covid lottery with €500 prizes to woo vaccine hesitant, The Guardian, [Online] https://www.theguardian.com/world/2022/jan/20/austria-creates-covid-lottery-with-500-prizes-to-woo-vaccine-hesitant [Accessed on December 4, 2023]

[6] The Moscow Times, Moscow Announces Car Raffle to Boost Vaccination Drive, June 13, 2021, [Online] https://www.themoscowtimes.com/2021/06/13/moscow-announces-car-raffle-to-boost-vaccination-drive-a74201 [Accessed on December 4, 2023]

[7] Blog LSE, 'If I have had the vaccine, why don't I get the Green Pass?' Undocumented migrants and vaccination in Italy, Sara Vallerani, 10.03.2022 [Online] https://blogs.lse.ac.uk/covid19/2022/03/10/if-i-have-had-the-vaccine-why-dont-i-get-the-green-pass-undocumented-migrants-and-vaccination-in-italy/ [Accessed on March 12, 2024]

vaccine hesitancy is a sociological question as it poses the question about people's connections, responsibility, fears and attitudes, liberties and trust as a basis for effective cooperation (Gambetta 1988). Based on existing evidence of the significant role of trust in facilitating cooperative behaviour and compliance with policies (Devine et al. 2021), this work is interested in understanding the role of trust in facilitating vaccination hesitancy and its role in individual decision-making about vaccination.

So, what is trust? Simply put, it is a reasonable expectation of a trustor about the future actions of a trustee who has an underlying obligation to act in the trustor's best interest (Stoneman 2008). According to Fukuyama (in Stoneman 2008), trust accounts for the better performance of institutions through enhanced cooperation and efficient organisation. Trust is central to democratic institutions as well as to democratic participation (Lenard 2008) as it stimulates human relationships, a decrease in trust leads to a decrease in voluntary compliance with policies. Consequently, decrease in trust challenges democratic regimes to make citizens comply without implementing restrictions or sanctions. Miller explores this:

> *"A democratic political system cannot survive for long without the support of a majority of its citizens. When such support wanes, underlying discontent is the necessary result, and the potential for revolutionary alteration of the political and social system is enhanced ...* (Miller 1974:951)*."*

Historical examples and more recent anecdotal cases supported by existing research emphasize the importance of trust in public health maintenance. Fukuyama argues that healthcare systems involve such a large degree of state-citizen interaction, that trust in them affects trust in the state itself (Fukuyama 1995). Consequently, high trust in healthcare systems has an instrumental value, it helps to achieve public health goals that require voluntary cooperation from the public, such as vaccination, and blood and organ donation (Lalumera 2018).

Diverse types of trust are identified as precursors of health behaviour. According to a meta-analysis by El-Krab et al., medical mistrust – beliefs that healthcare providers act against the best interest of patients – is a significant predictor of health outcomes in minority populations (El-Krab, Brousseau, and Kalichman 2023). For example, among people living with HIV, facilitating HIV testing, engagement in prevention and care services, treatment uptake and adherence (El-Krab et al. 2023). Equivalent results are obtained related to cancer screenings as medical mistrust is associated with delaying needed care, including cancer screenings (Fiala 2023). Mistrust in science is a more general concept, but it has also been shown to be a significant predictor of vaccine hesitancy in children and adults. Part of this mistrust comes from believing that pharmaceutical companies and scientists want to profit from vaccines regardless of potential adverse effects. Other people are sceptical of contemporary science because vaccine development and production are too complicated and elaborate processes. The general public

might not understand it or be suspicious about components used in vaccine production. An example of such preoccupation is the use of aluminium in vaccines as an adjuvant helping induce a stronger immune response (Laera, HogenEsch, and O'Hagan 2023). Though almost a century-long practice there is still not enough data demonstrating the safety and pharmacokinetics of these compounds, and their potential adverse effects (Tomljenovic and Shaw 2011). Although the issue is recognised among the scientific community it has not yet been properly addressed which leads to growing mistrust in the medical community. When the public mistrusts science and health professionals, they are less likely to be vaccinated (Druckman 2022), there is a number of scientific evidence demonstrating the positive effect of diverse types of trust on vaccine hesitancy (Adhikari, Yeong Cheah, and von Seidlein 2022). In fact, trust is listed as the three core factors of the commonly accepted framework of vaccine hesitancy (the 3-C model will be introduced in *Section 3.3.1 Vaccine hesitancy concept development*) (Larson et al. 2015; MacDonald 2015).

Our knowledge of the societal effect of trust is limited, not only concerning vaccination (Franic 2022) but in other fields of social interactions - scientific advances and social consensus (Sturgis, Brunton-Smith, and Jackson 2021), governance, taxation (Scholz and Lubell 1998). Earlier studies about vaccine hesitancy were mainly concerned with socio-demographic aspects of vaccine demand in the EU, while cultural, political, and economic determinants were left aside (Franic 2022; Joshi et al. 2021). This work aims to close this research gap and enrich the field of trust research by investigating to what extent individuals' actions are affected by the social environment they are embedded in by testing the societal effect of political trust on vaccination attitudes.

This study further discusses the role of trust in political institutions and health professionals as potential determinants of vaccine hesitancy in the EU. It seeks to understand why people experience vaccine hesitancy and what could help eliminate or lower it so people will vaccinate faster rather than postpone this decision. As mass vaccination campaigns are always a collective action problem (Adhikari et al. 2022; Mannemar Sønderskov 2011; Rothstein and Uslaner 2005), that is – coordinating actors to cooperate, the work rests on the proposition that trust is a fundamental element of effective vaccination campaigns by mediating vaccine hesitancy. Data from the European Centre for Disease Prevention and Control reveal noticeable differences between countries in vaccination rates, from the lowest in Bulgaria with only a third of the eligible population vaccinated to a swooping 98% in Denmark (by January 2022) (Franic 2022). Assuming even and fair coordination in the distribution of vaccines in the EU the most plausible explanation for such difference is some country-specific characteristics, we argue that part of this effect is explained by country differences in public trust in government and health professionals.

The uniqueness of the past crisis is in its almost total prevalence, which makes it a rare possibility to study social phenomena in a quasi-experimental setup as coronavirus is an external shock dominating all countries, yet the response to it is totally part of contextual social and political predisposition. In the case of vaccination in the EU, the coordination and distribution of coronavirus vaccines was unified. All countries received the needed amount of vaccines (unlike countries in the developing world) (Franic 2022). Hence, differences in the vaccination rates among the EU countries in most cases could only be explained by differences in demand factors – trust in vaccines, trust in health authorities, and hesitancy, which are highly socially contextualised. This circumstance enforces our analysis and serves as added evidence for this study.

This research introduces readers to the existing theory of public trust and its role in mediating human interaction and social actions. The thesis presents a conceptual model of public trust and vaccine hesitancy. It then discusses the history of vaccine development and, so, a history of anti-vaccination attitudes. Readers will see historical examples illustrating the role of trust in society and vaccination success. It further proceeds with an analysis of the Eurobarometer data using the multilevel proportional odds model. The analysis is based on existing studies, which have named numerous factors underlying vaccination attitudes. It controls for demographic characteristics – age, gender, and educational level. Trust is included in the equation at the individual and country levels. The work is closed by an extended discussion of results and conclusions, including advice to policymakers on the importance of trust and public performance during a health crisis.

We would like to warn the general public and policymakers, anybody who reads this work, about the stigmatization of hesitant individuals. Hesitancy is a complex phenomenon, people might refuse one vaccine but not the other, due to various reasons and at various points in their lives. Such individual decisions should not serve as a basis for discrimination, humiliation or stigmatisation. Health professionals must provide true information about vaccines' undesired effects and acknowledge people's concerns about vaccines in honest and respectful communication (Michel, Sauter, and Tanner 2021).

1.1 Research Question and Research Methodology

Vaccination helps to prevent up to 3 million deaths worldwide every year[8]. Diseases like measles and diphtheria have been reduced by up to 99.9% since their vaccines were introduced. However, vaccination coverage is unequal worldwide, demonstrating insufficient access to vaccines in low-income countries and the rising phenomenon of vaccine hesitancy in all countries. The fundamental part of vaccination

[8] The NHS UK. Why vaccination is safe and important. [Online] https://www.nhs.uk/conditions/vaccinations/why-vaccination-is-safe-and-important/ [Accessed on April 6, 2023]

attitudes is trust, the "holy trinity" of trust in vaccine safety, trust in vaccine effectiveness, and trust in the provider.

From the beginning of the COVID-19 vaccination campaign in the EU countries, earliest in December 2020, the rate of fully vaccinated population in the EU has reached 86%[9]. Data on the number of administered doses in Europe point out the high rate of vaccination coverage in Western European countries (leading are Iceland, Malta, Portugal, and Denmark, with more than 150 million doses given). In contrast, the least vaccinated countries are those from Eastern Europe – Bulgaria, Romania, and Croatia (Image 1). As we see, anti-COVID-19 vaccines proved an overwhelming success, yet we also observe a rise of anti-vaccination sentiment, alarmingly even in developed countries. Not only do low vaccination rates lead to excessive deaths, they also put health systems at substantial risk of malfunctioning and collapse. To understand what factors, contribute to the unequal rates of acceptance of COVID-19 vaccines in the EU, we had to look at all sides of the vaccination process.

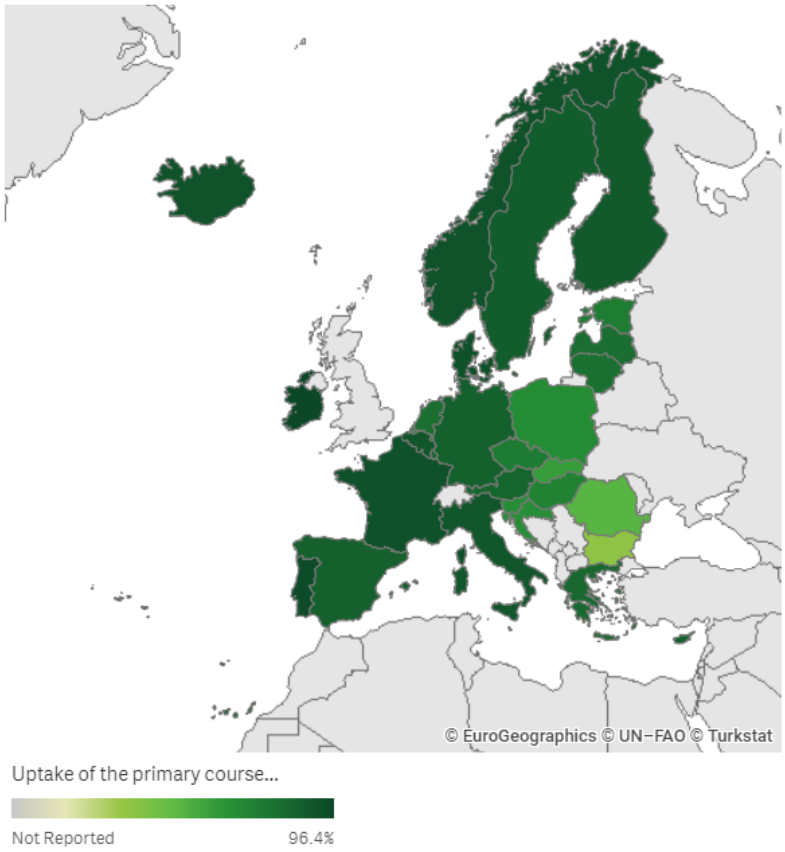


Image 1 Percentage of adult (18+) population received the primary vaccination course

Vaccination success builds on two pillars – vaccination demand and supply (Larson et al. 2015). Supply includes vaccine procurement and countries' health infrastructure for successful vaccination rollout (Deb

[9] European Centre for Disease Prevention and Control. COVID-19 Vaccine Tracker. [Online] https://qap.ecdc.europa.eu/public/extensions/COVID-19/vaccine-tracker.html#uptake-tab [Accessed on March 20, 2023]

et al. 2021). On the demand side, the most significant impact factors are - the severity of diseases and vaccination hesitancy (Deb et al. 2021). A combination of high demand and limited supply causes insufficient vaccination numbers because people simply can't access it discouraging further attempts at vaccination. Thereas high supply when met with low demand pose an arduous task of encouraging people to vaccinate, slowing vaccine intake. Finally, low demand and disrupted supply together result in a despairingly small number of vaccinated populations. For a maximum number of vaccinations, a high supply needs to meet high demand.

In the light of this study, we assume even distribution of vaccines among countries and wide availability of vaccines for populations. This assumption eliminates the possible latent influence of supply factors on vaccination and leaves us with only the effects of demand factors. Among those, the most crucial is trust in vaccine safety, trust in health authorities to deliver vaccines and trust in government to implement corresponding policies. Could these types of trust be country-specific? How good is trust at explaining individual and societal level differences in vaccination hesitancy?

For a long time, public health research has considered trust to be a fundamental element of acceptance of public health interventions (Adhikari et al. 2022). To date, attention has been focused predominantly on individual-level trust within single-country contexts, providing evidence that different dimensions of trust – political trust and trust in science – are among the key factors underpinning vaccine acceptance (Larson et al. 2015; Sturgis et al. 2021). So, does trust have a contextual effect over and above the individual-level relationship? Literature shows support for such a hypothesis. To quote Sturgis et al.:

> *"It is common in hierarchically structured social systems for a variable to have additional complementary or even divergent effects at the individual and macro levels. For example, in the United States, richer voters generally support the Republican Party within states, while wealthier states tend to lean Democrat. The importance of considering the possibility of macro-level influences in addition to individual-level relationships has also been demonstrated for attitudinal variables, with Fairbrother, for instance, finding a strong positive association between country-level political trust and support for environmental protection policies, net of the positive contribution of individual-level political trust.* (Sturgis et al. 2021:1528)*"*

As mentioned earlier, the WHO proposes the so-called 3C model to conceptualize and describe vaccine hesitancy. According to it, the three groups of factors contribute to the propensity to vaccinate: complacency, convenience and confidence (MacDonald 2015; Sturgis et al. 2021). *Complacency* forms as a result of previous vaccination programs. *Convenience* relates to practical and logistical barriers to

accessing vaccines (it largely describes the supply side of the process), such as cost, location, availability of transport hubs, and the quality of facilities, all, collectively or separately, influencing vaccine propensity. Finally, vaccine *confidence* is the extent to which people believe that vaccines are safe, effective, and consistent with their beliefs (religious, for example). This research employs only one domain of the WHO SAGE 3C-model framework – *confidence* – and understands it as an umbrella concept for three trust domains: trust in vaccines, trust in health professionals, and trust in government. The basic model could be schematically presented as follows:

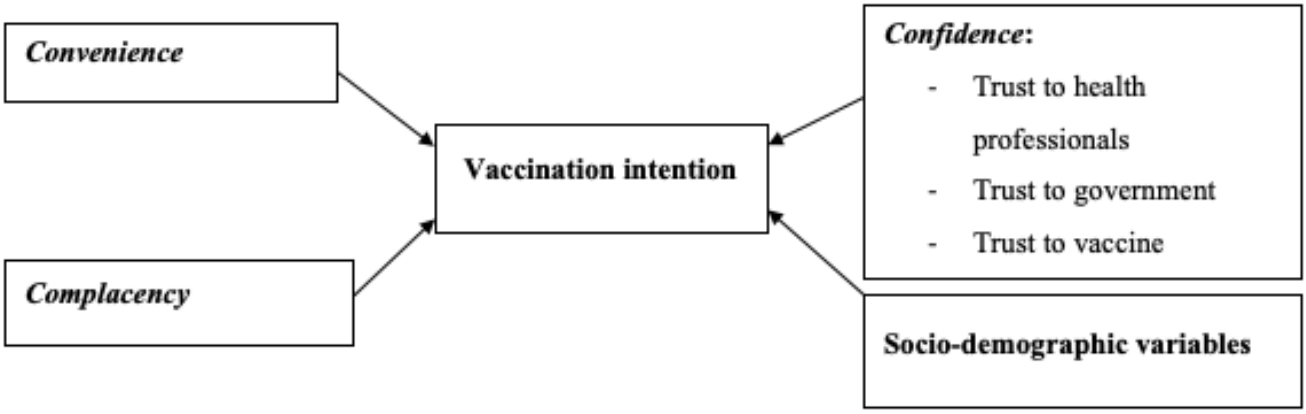


Figure 1 A basic model of the theoretical effect of trust on vaccination intention

The term "vaccine hesitancy" is used to describe the phenomenon of a *"delay in acceptance or refusal of vaccination despite the availability of vaccination services* (MacDonald 2015:4163)" coined by the WHO SAGE Working Group created by the WHO in 1999 specifically to research the phenomenon (Schuster, Eskola, and Duclos 2015) *(*see Subsection 3.4.1 *Vaccine Hesitancy Concept Development).*

Universally, scholars agree that the term hesitancy carries a negative connotation but argue that the more positive term confidence is too narrow in scope, covering only a handful of factors affecting vaccination acceptance (MacDonald 2015). Other terms such as "vaccine acceptance" and "vaccine uptake" do not capture the concept breadth, i.e., one might accept a vaccine but delay in accepting it, i.e., not following the recommended vaccine schedule. Hence, the SAGE WG experts accepted the established term "vaccine hesitancy" as universal to the discussed phenomena. This study, on some occasions, refers to vaccine attitudes or propensity to vaccinate but mainly uses the term "*vaccine hesitancy"* as the professional concept developed by medical professionals to describe the specific phenomenon.

Vaccine confidence is a direct result of the trust that individuals have in the health systems, institutions and actors that produce and deliver immunization programs, including trust in the legitimacy of the

political institutions that propose and provide the legal and regulatory frameworks for mass vaccination (Sturgis et al. 2021). Epidemiologist Heidi J. Larson agrees with the WHO framework, arguing that "*[p]ublic confidence in vaccines is, above all, a phenomenon of public trust*" (Larson et al. 2015:1). According to Larson, the trust aspects involved in vaccinations can be divided into three main parts: (1) the product (that is, the vaccine itself), (2) the vaccinator, and (3) the policymakers responsible for decisions about vaccine provision. Larson continues:

> *"Individuals may lack confidence in the safety or efficacy of vaccines for a variety of reasons. They may lack confidence because of negative experiences with the product, providers, or those making policy decisions. They may hold religious or philosophical beliefs that lead them to prefer traditional rites, prayers, or homoeopathic remedies over biomedical interventions* (Larson et al. 2015:1)*".*

A similar work by Adhikari et al. (2022) offers to distinguish similar determinants, arguing that trust in vaccines is built on:

- Trust in the vaccine as a product weighing on its safety and quality.
- Institutional trust: where vaccine comes from (institutional affiliations, organizations, and their reputations).
- Interpersonal trust: who recommends the vaccine and the nature of the recommendations.

Adhikari et al. defy trust simply as "epistemic", in the author's own words - "*trust in the competence of a person, organization or institution who promote science-related knowledge or its product*" (Adhikari et al. 2022:1), building on a past relationship, reputation, competence, expectations and experience between the trustee and the trustier. The relation between trust and vaccination acceptance is "elusive", i.e., escaping to be adequately operationalized (Adhikari et al. 2022), and is to some extent shaped by personal attributes such as "[…] *race, ethnicity and socio-demographic backgrounds also affect the perceptions related to the disease, the protective effect of the vaccines ultimately affecting the trust towards the vaccine and the decision to accept vaccination* (Adhikari et al. 2022:2)*"*.

Though the existing research provides data about many forms of trust connected to the acceptance of public health interventions, health behaviour and civil engagement, this project incorporates two types of trust – trust in government and trust in health authorities – as independent, explanatory variables. Socio-demographic variables are separated from trust variables to specify their use as control variables and not explanatory ones. The variable of interest – vaccine hesitancy – will be measured as the respondent's willingness to vaccinate against the COVID-19 virus. The limitations of our model are discussed in detail in Section 4 *Conceptual Framework and Model Development*.

The choice of focusing on trust in government and trust in health professionals had been made for several considerations. First, the government had been chosen as an institution with a direct obligation to develop regulations to counter health crises like the COVID-19 pandemic. At the same time, governments should base their political decisions and regulations on advice from the professional medical and scientific community, appointing health professionals to develop treatments and guides. It is the government that funds the development of vaccines and research regulations. It is the government that supervises the development of vaccination programs and vaccination delivery. Second, the decision to use the most common definition of trust was dictated by the desire to allow comparability between studies, ensuring similar studies using similar concept measurements could be compared and reproduced.

This research understands trust in government and trust in health professionals as a shire evaluative orientation toward these institutions based on how well the government operates according to people's normative expectations (Hetherington 1998). The proposed definition refers to approval and some expectations from thrusters about institutional performance. Trust is recognized as a critical measure of government performance (OECD 2019). Yet, approval is not the same as trust, which has been demonstrated earlier based on personal expectations, experience, mental accounting, pressure, etc.

Trust in vaccines is not part of this work because we could not find reliable cross-country data containing this variable. Hence, we decided to limit this study to two other trusts listed in the conceptual model. The exclusion of trust in vaccines might potentially influence the results obtained. To minimize this possibility, the study controls for a set of socio-economic variables, information access and political identification as mediators of mistrust in vaccines. Finally, knowing that approximately 80% of individuals use the Internet to search for health information, and relatively few discuss these findings with a healthcare professional (Smith 2017), this work includes an Internet use index, which will be then tested to interact with trust.

The primary hypothesis made in this work is about the individual effect of trust on vaccine hesitancy. In other words, the main hypotheses are:

- *People reporting high trust in government are less vaccine hesitant;*
- *People reporting high trust in health professionals are less vaccine hesitant.*

However, existing evidence hints at the possible societal effect of trust. Considering our data (cross-country), it is plausible to test other hypotheses that variation in trust is associated with country differences in vaccine hesitancy. Are people living in more trusting countries less hesitant? We can trust the following hypothesis then:

- *Citizens are more prone to having positive COVID-19 vaccination intentions in countries with higher political trust.*
- *Citizens are more likely to have positive COVID-19 vaccination intentions in countries with higher trust in health professionals.*

To investigate the association on state-level between types of trust and vaccination attitudes, a 2-level ordered logit model is applied. This approach allows testing research hypotheses about the connection between individual-level trust determinants to identify what contributes to the differences in vaccination hesitancy among the EU countries.

The data analysis will be applied to the Standard Eurobarometer 94.3 and 95.3 (EU 27) datasets. These two surveys provide the latest information on vaccination attitudes, behaviour, and trust in the EU states. The research strategy includes control for individuals' and countries' characteristics that might be correlated with both trust in government and health professionals. At the country level, researchers control for gross domestic product per capita. Models are estimated in Stata 17 using the *meologit* command (Hedeker 2008).

Section 2. Public trust

2.1 Introduction

All immunization campaigns face an inherent collective action problem - as all individuals benefit collectively from high immunization rates regardless of individual contribution, especially those with a low risk of severe COVID infection, have the incentive to decide against the (perceived) costs and risks of vaccination (Siegal, Siegal, and Bonnie 2009). Generalized social trust, i.e., a belief that people, in general, are trustworthy, is often assumed to enhance collective action (Adhikari et al. 2022; Mannemar Sønderskov 2011; Rothstein and Uslaner 2005). Overall, scholars agree that trust could be most simply defined as a reasonable expectation of a trustor about the future actions of a trustee who has an underlying obligation to act in the trustor's best interest (Stoneman 2008). Freitag and Tranquiller describe trust as the expectation that others will contribute to the well-being of a person or a group or at least refrain from harmful actions (Freitag and Traunmüller 2009). Trust is generally identified as trustworthiness (confidence) that one individual puts in another.

Similar to social trust, political trust could be defined as individual expectations that political *"institutions will function according to the established norms"* (Mishler and Rose 2001; Warren 1999). It is accepted that individuals put some sort of diligence in existing political institutions (including politicians) to act in individual interests. According to Stoneman, political trust *"lubricates"* political life as various levels of political trust *"change the nature of citizen-government relationships by alerting the capacity of government to govern and for organized groups to pursue their interests more effectively* (Stoneman 2008:49)*"*. Specifically, generalized social trust has been offered as an explanation for cooperation in social dilemmas characterized by a large number of actors, anonymity, and no repeated interaction (Mannemar Sønderskov 2011). Therefore, a high level of generalized social trust is a vital resource that every country should consider investing in.

Cultural theories argue that trust is a child of social relations, as across a lifetime, individuals learn to trust or distrust by experience (Fukuyama 1995). The causal mechanism for the development of trust is the early socialization of the individual. This assumption suggests political trust originates from social trust, by its extension, which is not necessarily true. The competing institutional approach assumes political trust to be endogenous to the existing political system, i.e., it is a sort of rationally based evaluation of political institutions (Stoneman 2008). As such, political trust has an interdependent relationship with institutions as institutions to perform better and make better reforms require high trust from citizens. Political trust itself reflects institutional performance, which creates a dependence between the two.

Several studies have found that societies with high levels of generalized social trust perform better in a wide range of areas like economic growth, policy performance, and functioning of democracy (Chuang, Chuang, and Yang 2013; Dearmon and Grier 2009; Mannemar Sønderskov 2011; Rodrik 1999; Rothstein and Stolle 2008; Younsi and Chakroun 2016). On the other hand, generalized trust has been found to negatively correlate with corruption and economic and gender inequality (Lundåsen 2010). Rothstein and Uslaner highly regard trust as a vital part of a democratic and equal society. As they recount existing studies:

> *"[a]t the individual level, people who believe that in general most other people in their society can be trusted are also more inclined to have a positive view of their democratic institutions, to participate more in politics, and to be more active in civic organizations. They also give more to charity and are more tolerant toward minorities and people who are not like themselves. Trusting people also tend to be more optimistic about their own ability to influence their own life chances and […] to be happier with how their life is going* (Rothstein and Uslaner 2005:41)*."*

This effect is believed to be a direct result of cooperative behaviour among individuals involved in a social dilemma situation. People tend to cooperate more if they expect that the other participants are trustworthy and cooperative. By contrast, concerns about other individuals acting as free riders limit the extent to which individuals act pro-socially and altruistically. Therefore, trust, cooperation, and collective interests are topics of particular importance when it comes to identifying effective responses to the COVID-19 pandemic, including vaccination rollout. Further research on trust and its relation to vaccination acceptance demonstrates an even more nuanced relationship between the two.

2.2 Conceptual Challenges of Trust Research

Trust has been conceptualized in several diverse ways (Wynen et al. 2022), which is, in fact, a significant challenge in trust research. Earlier sections of this work had used the words "trust", "confidence", "vulnerability", "generalized trust", "social trust", and "political trust" extensively without a clear-cut definition of the above. According to Lewicki and Brinsfield (2011) two dominant traditions broadly characterize the development of research on trust:

- a behavioural tradition which views trust as rational choice behaviour.
- a psychological tradition which understands trust as a complex interpersonal state associated with trust, such as expectations, intentions, affect, dispositions, and judgments.

The widely accepted definition by Rousseau et al. (Rousseau et al. 1998, p. 395) describes trust (in Wynen et al. 2022) as "*a psychological state comprising the intention to accept vulnerability based upon*

the positive expectations of the intentions or behaviour of another." Alternatively, in the behavioural approach, scientists are more interested in describing trust as action and how it affects decision-making (Wynen et al. 2022). In Möllering (2006), we find an example of such a definition - trust is "*an ongoing process of building on reason, routine and reflexivity, suspending irreducible social vulnerability and uncertainty as if they were favourably resolved, and maintaining thereby a state of favourable expectation towards the actions and intentions of more or less specific others* (Möllering 2006, p. 111)."

A competing stream of recent studies defines trust as a heuristic in the sense of an informational shortcut or simply put - a decision rule (Dinesen et al. 2022; Sturgis et al. 2021). Dinesen et al. studied political trust – trust in government institutions – and summarised what is crucial for these research points (Dinesen et al. 2022). First, political trust acts as a heuristic in that people who trust a given messenger are likelier to trust a given message. Secondly, political trust is specifically relevant to an individual's attitudes toward policies that entail a risk to them and/or a sacrifice. Finally, heuristics could be applied not only to a specific institution but to a series (group) of institutions and people's overall and/or specific confidence in those entities.

In the modern institutional approach in political science, trust is conceptualized *as individual normative expectations* that the political institutions will function according to the established norms (Mishler and Rose 2001; Warren 1999). By political institutions, the classical definition by North applies – *"humanly devised constraints that structure political, economic and social interaction* (North 1991:97)*."*

Based on the cited literature, this paper concludes the following similarities among existing trust research:

- to some extent, trust is built on previous individual experiences;
- trust helps individuals make decisions about complicated concepts that would otherwise require costly and error-prone cognitive processing;
- trust is involved in developing attitudes around health interventions;
- trust could be extrapolated from one institution to another;
- trust is embedded in a societal context.

The following section summarises existing literature from healthcare studies, political studies, sociology and philosophical literature on trust, and presents a synthetic conceptual model of public trust. It is then applied to the case of trust in health institutions and attempts to explain vaccination hesitancy as a function of varying levels of public trust.

2.3 Conceptual Model of Public Trust

Lalumera offers two distinguished types of relations between the public and institutions - *reliance* and *trust* (Lalumera 2018). Reliance could be placed on material objects to which no point of view could be attributed, and no values applied (Lalumera 2018), as the patient relies on an X-ray machine, she does not expect the machine to have values by itself i.e. to actively share values, the patient only can rely upon that the machine does what it supposed to do, what is promised by the manufacturer. The patient has no chance to prove machines' reliance unless to tries it out, she can also rely on healthcare workers using the machine. Another example of reliance comes from Annette Baier's work (Lalumera 2018) - a person continues to rely on the local food store because she has no other choice, even though she knows it happens to sell poisoned food. We can conclude that this type of relationship between the public and the state can exist when there is no trust, it is independent of trust, yet some scholars see reliance as a necessary predisposition to trust (Lalumera 2018). The major and crucial difference in this model between trust and reliance is the absence of values attribution necessary for a trustful relationship, reliance is a descriptive concept.

From the earlier literature presented literature on trust, we know that several preconditions have to be met. All theories agree that to exist trust always implies uncertainty and vulnerability – "A trusts B to do X" when A is perceived to be vulnerable (Möllering 2006). This process could be described in the following steps. At first, an individual (trustor) acknowledges her vulnerability and then defines whether she would trust somebody else with this vulnerability, which requires the trustor to evaluate her expectations from the trustee (the one to be trusted). When the trustor has overall positive expectations, she is willing to take "*the leap of faith*" (Möllering 2006). When, by contrast, negative expectations dominate, the leap of faith will not be taken, and the involved individual will not come to trust-informed actions. In the context of vaccination and this study, people accept a vulnerable position concerning the risk of getting infected with COVID-19 and vaccine hesitancy. The individual needs to be able to trust the government and the health professionals to give reliable and truthful information needed for a proper vaccination decision (Wynen et al., 2022). This trust-based relation assumes that a) the trustee has the expertise and competence expected of them; b) the trustee is benevolent (cares for the trustor needs); c) and adheres to a set of principles that the trustor finds acceptable (Wynen et al. 2022).

Below the conceptual model of public trust is schematically outlined (Figure 2). The model is a synthesis of existing studies of trust in psychology, philosophy, political studies and sociology. At the centre of it is trust - a special type of relationship between citizens and institutions. The model further distinguishes vulnerability and authority as crucial determinants for trust to be established. Public trust is born out of real or perceived vulnerability, which motivates citizens to seek for institution with a perceived epistemic

authority to address this vulnerability (Lalumera 2018; Möllering 2006). Finally, trust is mediated by processes of values attribution and values sharing (Jentsch, Anand, and Bauch 2021; Lalumera 2018).

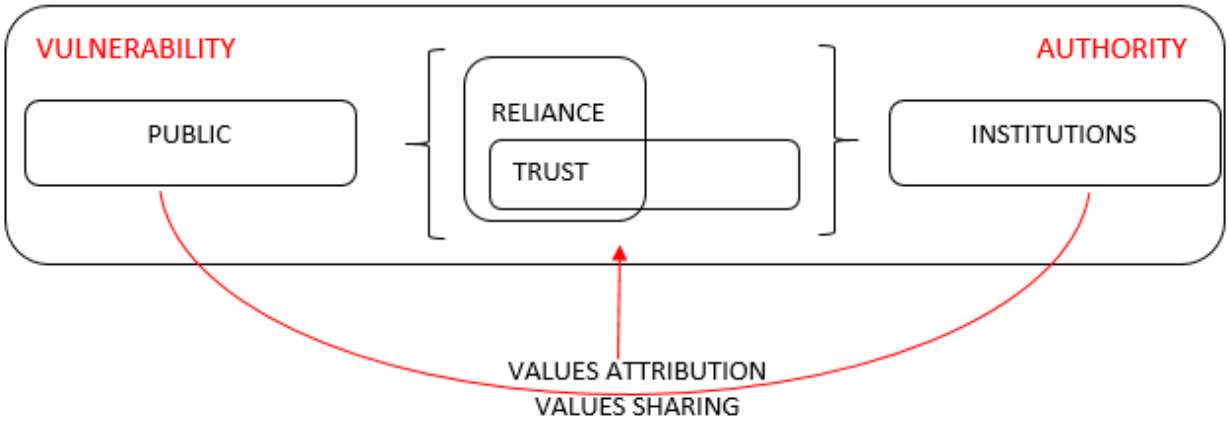


Figure 2 Conceptual model of public trust

For an example of a healthcare system, the model suggests that citizens should perceive the existing healthcare system as potent to satisfy their vulnerability. To be deemed trustworthy the system should be seen as benevolent and knowledgeable (Lalumera 2018). This makes such institutions paternalistic as they are allowed to make decisions on behalves of others as if they know better as if they are the only source of expertise. In addition, healthcare systems around the world are seen through the *"do no harm"* principle. According to the WHO, it is a fundamental principle for any healthcare system – *"no one should be harmed in health care*[10]*"*. Such attribution results in a particular implication about the citizen–healthcare system relationship, it endows the healthcare system with superficial epistemic authority to make decisions on behalf of the patient claiming to not harm patients. Trust as a relation between citizens and public institutions comes into existence when we add evaluative judgment about institutional performance. In the case of healthcare, it is observed with clarity in cases of voluntary healthcare behaviour.

Healthcare systems vary across countries in many respects, depending on parameters such as overall income, availability of medical knowledge and technology, political organization, funding source, and so on. Arguably, despite the differences, all health systems aspire to quality health care, affordability, and choice, they share the commitment to undertake policies to maintain and restore people's health and

[10] The World Health Organizations, Patients safety, [Online] https://www.who.int/news-room/fact-sheets/detail/patient-safety#:~:text=%E2%80%9CFirst%2C%20do%20no%20harm%E2%80%9D,and%20developing%20health%20care%20systems [Accessed on March 6, 2024]

health-related behaviour, and a principle of *"do no harm"* (Lalumera 2018). They involve numerous stakeholders including governments, insurance companies, policymakers, medicine agencies, health practitioners, pharmaceutical companies, manufacturers, managers of hospitals, patients, and the public.

Works in healthcare studies point out various relationships between different stakeholders involved in healthcare – patients, carers, public officials, clinicians, and pharmaceutical companies - between and within each other, including the institutional relationship between patients and particular healthcare institutions, or the country's healthcare system as a whole (Lalumera 2018). Healthcare trust is set between the public and the healthcare institution and is applied to a specific field in question. The public here is defined broadly as a varied group of consumers, seekers, and providers of health. In the case of the healthcare system the "public" can coincide with the total country population. The institution in question – the healthcare system as a whole, including caregivers, policymakers, clinicians, and so on. The field of application is what the public trusts the health system to care for - information, prevention, therapy, hospitalisation, rehabilitation, nutrition - virtually anything that relates to health (Lalumera 2018). The vulnerability here could be understood as some area of a person's health that she cannot take care of on her own, for example. Based on this assumption we state the following – public trust in the healthcare system is an expectation that the system will act at every level with a view of promoting, maintaining and restoring people's health. At the same time, healthcare trust is granted based on the perceived trustworthiness and benevolence of the institution, what Lalumera call an "epistemic authority". This authority of *"health care practitioners, and of health systems collectively taken, over the public means that they know more than we do about our health* (Lalumera 2018:111)*"*. By attributing the healthcare system such authority individuals perform epistemic trust in this institution. The last and ultimate ingredient of trust in institutions – values, and the process of values attribution that enable the institutions as acting agents, not solely knowing agents. Individuals trust the healthcare system by attributing to it *"those values that they share"* and individuals expect *"that it would act on the same convictions"* as individuals would act on (Lalumera 2018:112–13).

How can the presented conceptual model explain the case of vaccine hesitancy? Firstly, we had to identify vaccine hesitancy as a type of voluntary health behaviour. Secondly, we understand it as a socially crucial behaviour as the refusal to vaccinate in some cases puts the broader public and not only the refuser at a higher risk of health damage. Thirdly, hesitancy is a case of declining trust in the healthcare system as hesitant individuals negate the epistemic authority of the healthcare system to recommend vaccination. Hence, individuals might be seeking other institutions/organisations/places/experts that have this epistemic authority that they can trust for health-related knowledge. In addition, erosion of trust is accompanied by public disappointment with the healthcare system as the one that shares its values with them and is trustworthy and benevolent. Finally,

not only does the attribution of negative values come into play but the conflict of values. Fear of vaccine adverse reaction rises vulnerably raising the demand for trusting relations. Yet, it counterintuitively might lead to erosion of trust. Healthcare officials might appeal to altruistic values of protecting the weakest, whereas some people act from individualistic positions (opportunistic at times), others might prefer the so-called “free-riding” strategy, and some are acting from the point of protecting their agency and autonomy in making health decisions. The conflict of values can lead to greater vaccine hesitancy and erosion of trust. In some cases vaccine hesitancy is merely an issue of misinformation or lack of knowledge, it is a question of mismatched values or attribution of negative values to the healthcare system (Lalumera 2018).

Similarly, we can apply the conceptual model to other institutions, in the case of this study, to trust in government. As we demonstrated earlier when citizens (diverse groups of people from policymakers to unregistered migrants, which can coincide with the entire country's population) experience any type of vulnerability, they turn to the government to resolve it as they deem the government to have authority to care for citizens, i.e., the government is deemed to be trustworthy and is attributed some values. Alternatively, we can imagine a situation when citizens rely upon the state because they have no other choice and do not trust the government at all. In this work, public trust in government is understood as a shire orientation toward the government based on how well the government is operating according to people's normative expectations and prescriptive values (Hetherington 1998; Lalumera 2018). Similarly, trust in health professionals is seen as a mental evaluation of the health professionals as a broad group representing the political institution in charge of making decisions and recommendations about health provision (Lalumera 2018; Möllering 2006; Skirbekk, Magelssen, and Conradsen 2023).

In conclusion, the proposed conceptual model has several advantages. It grants the two entities the agency, the public has its agency in deciding what institution to turn to and if they can develop trustful relations, just as institutions are deemed by the public as agents who act in some ways responding to public vulnerability. Secondly, the model can be applied to various sets of public institution setups and demonstrates potency to explain voluntary behaviour, for example, vaccine hesitancy. Finally, it allows different levels of scales to be applied (to country-level institutions, economic level, specific groups; specific vulnerabilities, and so on), as it can account for entire population behaviour, but also explain trust expressed by smaller populational groups in any institution in question. The following sub-section focuses on existing evidence of trust and propensity to vaccinate connection.

2.4 Vaccination Intention and Trust in Government and Health Professionals, Approaches to Describe the Underling Mechanism

Earlier research by Sturgis et al. showed how societal-level trust in science is related to vaccine confidence and explained the trust-vaccine intention connection. The author's primary interest was to discover how societal-level scientific trust is associated with vaccination uptake - is the average level of trust in science in a country positively related to vaccine confidence, over and above the individual-level relationship? The study demonstrates that countries with a high aggregate level of trust in science are the ones with higher confidence in vaccination safety. Additionally, authors have been able to show that societal consensus around trust in science moderates individual-level and country-level relationships, i.e., in countries with a high level of consensus regarding the trustworthiness of science and scientists, the positive correlation between trust in science and vaccine confidence is more robust than it is in comparable countries where the level of social consensus is weaker.

According to the WHO's 3C model (MacDonald 2015), vaccination intention is derived from individuals' trust in a vaccine, health institutions, and the government. This includes trust in the legitimacy of the political institutions that propose and provide the legal and regulatory frameworks for mass vaccination, healthcare systems and workers delivering vaccines to people, and science behind vaccine development and testing for effectiveness and safety (Larson et al. 2015). One of the recent approaches to understanding vaccination attitudes is analyzing it in the collective action approach. Eisnecker et al. argue that:

> *"[t]he decision to receive or refuse a particular vaccine is made in relation to the subjective benefits and costs of vaccination. Subjective benefits are large if the likelihood of infection is estimated as high and the disease is seen as severe, while the vaccine is deemed effective in preventing infection and severe illness. While everyone can enjoy the societal benefits relatively equally, the strength of the individual benefits varies depending on how threatening the disease appears to the individual* (Eisnecker, Kroh, and Kühne 2022:2)".

COVID-19 bear different individual risks. While some will have it very rough (risks are getting higher with age and preexisting medical conditions), most people will probably notice that they are sick, which means that vaccination has different benefits for different people. Individuals are incentivized to "free ride" on the benefits connected to an immunized population rather than discounting the (perceived) risks and costs of vaccination themselves. Reaching high national or even global vaccination rates can further be characterized as a large-scale collective action problem involving many individuals distributed over vast areas that are typically anonymous to each other and thus lack accountability.

There are theoretical arguments that peers affect the propensity to vaccinate positively, negatively, or not. On the one hand, a neoclassical economic perspective is that vaccination is a public good, where the more others are vaccinated, the smaller the individual incentive to get vaccinated (this behaviour often is labelled as free-riding). This reduces vaccination coverage, leading, in the worst case, down to a zero-take-up equilibrium. Nevertheless, if the basic public good model accounts for a peer effect, the result of a game is not always negative. If the peer effect is conforming, i.e., peers are pro-vaccination, it leads to positive effects. Empirically, increased peer vaccination coverage does not reduce individual vaccination coverage but often increases it. Sato and Takasaki (2019) conducted an experimental study in rural parts of Nigeria to establish peers' causal effect on vaccination decisions among young women using randomized cash incentives for tetanus vaccine take-up (Sato and Takasaki 2019). Study results show a clear causal effect of personal vaccination acceptance, as peers' vaccination status strongly increases women's vaccine take-up (from 15 to 19 percentage points). This study also supports the hypothesis about the effectiveness of sharing medical information about vaccine effectiveness and safety among women.

Nevertheless, why is the societal level of trust consequential for individual and societal responses to the perception and assessment of risks? A possible explanation for demonstrated effects is that people look to the attitudes and behaviours of others to determine what is expected, beneficial and accepted, and when the normative principle about the positive or negative value of an agent or institution such as scientists and science is widely held, there will be a more decisive social influence on individual assessments of what is and is not socially acceptable or appropriate (Reynolds 2019; Sturgis et al. 2021).

An alternative explanation for the contextual effect of trust on vaccination propensity is a so-called bandwagon effect. Explanations that induce the bandwagon effects are groupthink, a desire to be right, and a need to be included. This metaphorical terminology is closely tied to social norms. Social norms are commonly split into descriptive and injunctive norms (Chung and Rimal 2016): descriptive norms describe observable behaviour, while injunctive norms describe what other individuals ought to do. While descriptive social norms implicitly or explicitly explain vaccination coverage, fewer inroads have been made at the intersection of injunctive norms and vaccination demand. Finally, other peer vaccination mechanisms that can influence the propensity to vaccinate are - information spillovers, social learning, reduced costs through peer assistance, a preference to coordinate decisions with friends and compositional change (Hoffmann, Baggio, and Krawczyk 2023). Consequently, Wynen et al. argue that "*in a context of low trust to the government, however, citizens tend to turn their trust to experts",* arguing that experts' credibility rests on independence from the government (Wynen et al. 2022:1880). It is commonly assumed that individuals with greater trust in experts are likelier to express intent to be vaccinated (Dubé et al. 2018; Wynen et al. 2022).

Healthcare professionals, including physicians, nurses, aides, helpers, laboratory technicians and other health-related professionals, are at the frontlines of health crises, such as the COVID-19 pandemic. They are the ones to implement what had been granted to them by the government; they have a responsibility to the citizens to develop treatment and vaccines and ensure their effectiveness and safety. Some people in specific setups are role models for the population, and their behaviour might be imitated by everyone else. Beyond peer effects from healthcare professionals, they have the authority and task to provide vaccination recommendations. Trust in physicians is generally perceived to be incredibly important (Sapienza and Falcone 2022). Therefore, trust in those professionals is essential. There are several ways in which healthcare professionals can influence the vaccination coverage behaviour of the population.

To summarize, empirical research supports theoretical predisposition about the positive link between political trust and trust in health professionals and the propensity to vaccinate (Rönnerstrand 2014; Wynen et al. 2022) and demonstrates that willingness to vaccinate altruistically is higher among trusting individuals while low-trusting individuals require reciprocal cooperation of others to vaccinate altruistically. This project distinguishes several mechanisms under the trust effect on vaccination propensity based on literature analysis. First, the individual mechanism, as trust itself, elaborates three distinguished parts – (1) the assessment of trustworthiness, (2) the actual decision to trust, and (3) trust-informed actions – people make their assessment of the trustworthiness of vaccine and act accordingly (Wynen et al. 2022). In the case of trust in health professionals, individuals revoke informal impressions of how health professionals or the government is valued or contested through local social interactions, media representations, and cultural and political debate, and these factors combine to shape individual assessments of the trustworthiness (Sturgis et al. 2021). On a societal level, trust in health professionals might act through societal pressure.

2.5 Role of Trust in Previous Outbreaks

History of the 20th century knows successful examples of mass vaccination campaigns that helped prevent epidemics in big cities. This success stands on two major components. One is a strict and prompt application of public health measures. The second is the availability of vaccines and their fast distribution within the population. The following section uncovers two historical examples of successful vaccination campaigns. Although the results were positive and the epidemic in these cases was successfully evaded, the two cases had completely different scenarios and active actors, as well as demonstrated the role of governing and civilians.

Case 1. Naples, the year 1973

"A cholera outbreak in the Naples area
and some suspect cases of severe gastrointestinal disorders
elsewhere in Italy have touched off an *infection scare*[11]"

The New York Times on August 30, 1973.

During this research, two documented outbreaks of dangerous infectious diseases outbreaks in the 20th century that are like the current pandemic were discovered – both dealt with severe disease, and both examples required mass vaccination in the shortest time possible, and both succeeded. These examples highlight the importance of trust for a) building reciprocal relationships in times of pandemic and b) understanding vaccination hesitancy in various contexts. The section starts with the cholera outbreak in Naples in 1973.

Naples is a large coastal city with marine connections to the entire Mediterranean region. Infectious outbreaks have happened many times in the city's history. A famous plague outbreak in the 16th century is believed to have taken from 150,000 to 200,000 people (Alfani 2013), including the famous Italian Renaissance painter Artemisia Gentileschi[12]. The epidemic had a severe impact on the economic and social structure of Naples and some other affected areas. Hence, the city population has lived to experience the devastating effects of infectious diseases (McNeill 1997; Roberts 2021). Then cholera arrived in 1973, and the course of events took a surprising turn – filled with a deep mistrust of the government and dissatisfaction with its response to the epidemic, citizens flooded the streets, rallying for the immediate start of vaccination against cholera.

[11] 7 Dead of Cholera In Naples, August 30, 1973 [Online] https://www.nytimes.com/1973/08/30/archives/7-dead-of-cholera-in-naples-italyacts-to-prevent-spread.html, [Accessed on May 1, 2023]

[12] Artemisia Gentileschi: the Woman, the Artist [Online] https://www.getty.edu/news/artemisia-gentileschi-the-woman-the-artist/ [Accessed on December 18, 2023]

Image 2 Vaccination against cholera in the streets of Naples, 1973. Source: Blick/RDB/UllsteinBild via Getty Image

The cholera outbreak in Naples began in late August. The last confirmed case was registered on September 19, with a total of 12 confirmed deaths (in Naples) and 127 laboratory-confirmed cases (Lorenzo et al. 1974). The route by which the infection was introduced has not been tracked down with certainty, but it seems likely that it reached Naples via infected mussels imported from Tunisia. The response to the outbreak involved several measures implemented by local and national health authorities, including the distribution of clean water and food to the affected areas, the disinfection of contaminated areas, and the restriction of the sale of seafood. However, unsatisfied with the government response, the Neapolitans demanded a mass vaccination campaign:

> "*In Naples and its congested province, where nearly three million people live, rioting erupted on four consecutive days when the vaccine was lacking. Antibiotics quickly disappeared from pharmacies and turned up on the ever-flourishing black market*[13]." The New York Times, September 9, 1973, Page 209.

The outbreak had been promptly taken under control and stopped. The city was saved after a mobilization effort that saw almost 80 per cent of the city's population — some 900,000 people — vaccinated within five days, and only 24 people were reported to have died in all of Italy from cholera. It was a significant public health crisis that impacted the city and the surrounding areas.

[13] Italy's Cholera, Paul Hoffman, September 9, 1973 [Online] https://www.nytimes.com/1973/09/09/archives/a-microbe-that-wont-give-up-italys-cholera.html [Accessed on May 1, 2023]

This example highlights one crucial feature of trust, to be precise mistrust, coupled with dissatisfaction with government actions, it has an immense mobilizing potential. According to Craig "persistent feelings of discontent will cause citizens to participate in or otherwise endorse regime-challenging activities which, ultimately, will pose a threat to the social and political order (Craig 1980:190)". Examples from Naples and recent protests against coronavirus vaccination support this observation and broaden social spheres that are susceptible to citizen discontent, i.e. sanitary restrictions and public health governance.

Case 2. Moscow, year 1959

The second example comes from the USSR. In December 1959, a renowned Soviet painter, Alexey Kokorekin, returned from his trip to Moscow from Delhi, India. As it was established after his death a week late, he came back to the USSR infected with smallpox. Smallpox, vanquished worldwide thanks to a vaccine, is a highly infectious disease with a mortality rate of 30%. The Soviet Union officially eradicated smallpox in 1936, but a Kokorekin brought it back to Moscow from India in the final days of 1959. It took 21 days before authorities finally recognized the infection, unfortunately, Kokorekin died[14]. From the moment of a definitive diagnosis, the state machine started to work – "immediately mobilized all the resources of Moscow hospitals, clinics, police departments and the KGB. A search for potential carriers of the dangerous virus went on round the clock. Everyone whom Kokorekin had met and spoken to, whom his relatives had been in contact with, who had received his gifts from India were quarantined. Thus, 150 students from the university where the artist's daughter was studying were taken to hospitals directly from lectures. From primary contacts, the search progressed to secondary contacts and so on until the whole chain was established. People were taken off trains, and aeroplanes that carried potentially infectious people were ordered to turn back mid-air." Most importantly, the Soviet Government had been able to organize a rapid mass vaccination campaign. Within weeks of Kokorekin's death, smallpox vaccines were shipped to Moscow from across the Soviet Union. In Moscow and the region, at a time that hosted a little more than seven million people, the vaccination took just one week (the New York Times archive, from Feb. 3, 1960). This outbreak caused three deaths[15], with a total of 46 people infected[16] and a total of 9,342 people were placed under quarantine. By February 3, the disease

[14] Smallpox outbreak in Moscow *(In Russian, Вспышка оспы в Москве)* (1959—1960). (2022, December 12). In *Wikipedia*. [Online] https://ru.wikipedia.org/wiki/%D0%92%D1%81%D0%BF%D1%8B%D1%88%D0%BA%D0%B0_%D0%BE%D1%81%D0%BF%D1%8B_%D0%B2_%D0%9C%D0%BE%D1%81%D0%BA%D0%B2%D0%B5_(1959%E2%80%941960) [Accessed on May 1, 2023]

[15] Coronavirus lockdown is nothing new for some Moscow residents, Polina Ivanova, Reuters, [Online] https://www.reuters.com/article/us-health-coronavirus-moscow-smallpox-idUSKBN21P1N3, [Accessed on May 1, 2023]

[16] Soviet smallpox outbreak confirmed, Debora Mackenzie, New Scientist, 17 June 2002, [Online] https://www.newscientist.com/article/dn2415-soviet-smallpox-outbreak-confirmed/, [Accessed on May 1, 2023]

had been eradicated. A timely and well-coordinated response from Moscow law enforcement and medical services helped stop the deadly virus in just 19 days[17].

The examples described earlier have several common features and one drastically different. Firstly, both cases deal with highly virulent and deadly diseases (cholera, if untreated, has 25-50% mortality (Clemens et al. 2017); smallpox has around 30% mortality (Ellner 1998)). In both cases, the authorities acted in a proper and scientifically adjusted way, implementing a series of actions to identify the clusters, isolate individuals, vaccinate the public and prevent future outbreaks. What is different – essential in the light of this project – is the mode of relationship between the state and the population. The vaccination campaign had been demanded in Naples by its population. Government feeling the tension, responded by providing the vaccination, the witnesses recount:

> *"In Naples, the fear of cholera is ancestral. The mere word evokes mass panic," Paolo Cirino Pomicino, then a city councillor and later a national minister ", There was no queue jumping ... A very disorderly city suddenly became very ordered."* (Roberts 2021)

In Moscow, the Soviet Government kept the outbreak a secret from the public; the population had been vaccinated without even knowing what they were getting a vaccine against, and nobody had a right to refuse.

Image 3 Unknown woman undergoes vaccine inoculation, USSR. Vitaly Sozinov/TAS

[17] How the USSR defeated a smallpox epidemic in a matter of 19 days, History, March 19 2020, Boris Yegorov, [Online] https://www.rbth.com/history/331857-how-ussr-defeated-black-smallpox, [Accessed on May 1, 2023]

These historical examples demonstrate diverse approaches to establishing control over infectious diseases. In Naples, population distrust in the government resulted in speedy citizen rallies and riots, causing the government to respond. In Moscow, the population did not know anything and did not have a chance to respond in any manner, including social mobilization. The author speculates that tight government control over information (including information about disease outbreaks) and possibilities for citizens to engage with the political system led to hidden distrust among citizens, disrupting the link between the political attitudes and political actions of individuals. The author further proposes that such a relationship between the state and citizens will lead to greater mistrust, causing citizens to evade any actions and engage with the government as little as possible. The low vaccination rate in Russia was probably partly caused by this low political trust and a consequent civil disengagement with state recommendations and policies.

These historical examples speak to us about the importance of vaccination acceptance in the success of vaccination campaigns, trust in authorities, and the importance of social and political context. It is interesting to question whether post-Soviet countries keep leading positions among the most vaccine-hesitant in the E.U. due to the history of mistrustful relationships with the Soviet state. The hypothesis needs further investigation.

Finally, to sum up the section, religious beliefs, non-religious norms, ethics, and attitudes to personal freedom can mitigate vaccination uptake. People concerned about bioethics and the power the state has over pupils' bodies, as well as individual autonomy to make medical decisions regarding individual health, have gained significant attention during the COVID-19 pandemic.

2.6 Summary

Trust fundamentally depends on perceptions of competence and motive. It is a widely recognized precursor of social cooperation. In accepting vaccination, the public relies on the integrity, competence, and good faith of public health and government authorities to recommend vaccines appropriately and of health providers to administer them safely. Both trust and confidence in vaccines are dynamic and contextual concepts and depend on perceptions of competence and motive of vaccine producers and health professionals (Larson et al. 2015). It is necessary to point out that despite trust being a critical factor in vaccine-related decision-making (vaccine refusal, hesitancy, or vaccine acceptance), the decision of whether to be vaccinated may occur without a deliberate investment in trust (or lack thereof). For instance, a person may get vaccinated when obliged by government regulations such as a vaccine mandate. History of vaccination program implementation, health policies, and incentives to promote vaccination (including the current COVID-19 vaccine programs) have repeatedly implied the need to build and sustain trust relationships between the public and vaccine for a sustainable solution. It is,

therefore, critical to explore the relevance of trust in vaccines, specifically COVID-19 vaccines, to inform the tailoring of vaccination programs for current and future pandemics.

This research proposes that in a country with high trust in health professionals and the government, vaccination confidence will be high and vice versa. In other words, levels of trust applied at the macro level are expected to manifest at the individual level, that is, people's optimistic assessments of the trustworthiness of government and health professionals will have a stronger positive association with vaccine confidence in countries with an elevated level of trust. One of the specific hypotheses states that in high-trust societies, individual trust is not a significant predictor of vaccination propensity, as societal pressures encourage one to accept shared beliefs about the benefits of vaccination. On the other hand, a sceptic environment will enforce individual vaccination scepticism, and this study tests potential cross-level interactions between trust in government, trust in health professionals and political preferences and use of information.

We aim to contribute to rapidly emerging knowledge of vaccination intention by assessing the role of societal-level trust in government and trust in health professionals. To date, scholarly attention has focused predominantly on individual-level generalized trust within single-country contexts. This study proposes to look at other dimensions of trust – trust in government and trust in health professionals – as there are hints that they affect vaccine acceptance. The ultimate research goal is to demonstrate how societal-level trust in government and health professionals is associated with vaccination uptake. Using the Eurobarometer survey, it is possible to build a pooled cross-sectional dataset and test simultaneously the effect of trust in government and trust in health authorities on COVID-19 vaccination intention.

Section 3. Vaccination Intention, Vaccination Acceptance, Vaccination Hesitancy and Vaccination Rejection

3.1 Introduction

This chapter presents the reader with the current state of the art in vaccine hesitancy research. It starts with a brief description of vaccine development and the later emergence of vaccine hesitancy as a response to this type of medical advance, i.e., with a history of vaccine development. It is followed then with a story of the development of the concept of vaccine hesitancy. The subsection overviews current research about vaccine hesitancy determinants and discusses the relationship between hesitancy and bioethics, moralization of human behaviour, game theory, and trust in public institutions as well as trust in science. Two distinct historical examples of infectious disease outbreaks in the 20th century are presented and discussed in connection to the main public response strategies and the role of trust. The analysis reflects on differences and similarities with historical evidence and earlier observations and concludes with some preliminary research hypotheses. The chapter is summed up by a literature overview of individual and social factors contributing to vaccination hesitancy towards COVID-19 vaccines.

Vaccine scepticism is a recurring phenomenon throughout the history of vaccination. Ever since the first vaccine was introduced, the fear of it led to continuous resistance to vaccines evolving into a social phenomenon of vaccine hesitancy. Despite the success that vaccines bring to humanity by preventing deadly pandemics and saving countless lives, vaccine hesitancy is far from being eradicated (Bazin 2001). Addressing this phenomenon requires joint effort by public health officials, policymakers, and the media to educate the public about the safety and benefits of vaccines (Dubé et al. 2018).

In contemporary public health literature, vaccination scepticism coined the term "vaccine hesitancy" to describe modern forms of social resistance and reluctance concerning vaccines (Wynen et al. 2022). The WHO Vaccine Hesitancy Working Group defines vaccine hesitancy as "*delay in acceptance or refusal of vaccines despite availability of vaccine services*" (MacDonald 2015:4163). By the term *vaccine hesitancy,* literature recognizes a continuum from full support - rarely active demand - for vaccination (sometimes referred to as *vaccine acceptance*) to solid opposition to any vaccine (sometimes referred to as *vaccine refusal*) (Dubé et al. 2018; Joshi et al. 2021). Alternative classifications include multiple typologies of vaccination behaviour and attitudes. The propensity to

vaccinate can vary depending on the vaccine-related characteristics such as vaccine type, vaccine manufacturer, and way of administration. Hesitant individuals may potentially refuse some vaccines but accept different vaccines, delay vaccines, or be unsure about receiving vaccines.

The research about attitudes to vaccination before the current pandemic has been relatively modest, with understandable bursts of interest in years of infectious disease outbreaks (MERS or Zika for example). In the "*calm years*", the topic mainly attracted the attention of specialists in vaccination and in public health concerning various diseases from seasonal influenza, HPV, or Hepatitis B, with particular attention to vaccination hesitancy among parents. Since the start of the COVID-19 pandemic, the number of articles exploring determinants of vaccination attitudes, hesitancy, and intention has exploded. Google Scholar, a popular web search engine, indexes 923 scholarly entries concerning vaccination hesitancy in the period from 1900 to 2019[18]. For the three years, from 2020 to 2023, the search indexes 4820 entries. An increase of almost three times, the majority of which are devoted to the COVID-19 vaccination hesitancy. The topic has attracted much attention among the broader social science community. An avalanche of studies is now available in economics, psychology, public administration, anthropology, sociology and more worldwide.

3.2 History of Vaccination

It is believed that the first immunizations had been in use in medieval India and China (Bazin 2001). In its essence, immunization was a direct transmission of a sample (bodily substance for example) from the infected subject to the non-infected which would inflict an immune response (most probably) leading (Wiedermann, Garner-Spitzer, and Wagner 2016) to the subsequent immunity to this pathogen[19]. In Europe, immunization first came to known as variolation, the procedure of transmitting smallpox from infected individuals to healthy ones to build immunity in them. Variolation against smallpox was built on a similar approach and was essentially a deliberate contamination of someone with the infectious material of a patient infected with smallpox (Bazin 2001). It coins its name from the word *Variola* (smallpox). In Great Britain and New England, variolation was introduced in the XVIII century (Brimnes 2004). Edward Jenner, a British health practitioner, is believed to be the first

[18] The search had been performed on the webpage scholar.google.com, key words were "vaccine hesitancy", we restricted the search for 1900 – 2019 time period and to "reviewed articles". Similarly the search for the time period of 2020-2023 was implemented.

[19] Sometimes vaccines fail to produce immune response. According to Wiedermann et al., about 2–10% of healthy individuals fail to mount antibody levels to routine vaccines. It is incorrect to state that vaccination always lead to immunity. The reasons for vaccine failures are numerous, they might be specific to a vaccinated person and her immune response, or pathogen specific, or vaccine specific.

vaccine inventor as he proposed and empirically tested a new vaccine based on cowpox, making variolation much safer yet effective against smallpox.

The extension of the principle of vaccination by Pasteur and his successors led to the development of vaccines for diseases such as diphtheria, measles, mumps, rubella, and influenza. to the complete eradication of some infectious diseases, including smallpox (Hammond 2007). Contemporary children's vaccination programs include immunization against dangerous diseases of measles, mumps, rubella, diphtheria, pertussis and tetanus (Bazin 2001). In adults, seasonal vaccination against influenza is a widespread practice in the industrialized world (Bazin 2001).

Not surprisingly vaccination met public resistance as the procedure was believed to be dangerous and ineffective (Bazin 2001; Kaufman 1967). Reasons for scepticism were numerous, from concerns about individual freedom to religious misconceptions and other personal beliefs (fear, mistrust, heredity). It was the time when misinformation and anti-vaccination propaganda began. The first organized resistance to mass vaccination was triggered by the British Government's decision to make children's vaccination against smallpox mandatory. The first formal anti-vaccination movement was established in 1853 (adopting the name "Anti-Vaccination League"), soon spreading its influence overseas to the United States, where it gained broad public support in the late 19th century (Kaufman 1967). To gain popularity the League spread misinformation about vaccination, spreading false or exaggerated messages about the dangers of vaccines, such as that vaccines cause diseases but do not prevent them. The League also argued that vaccines were unnecessary because the diseases they were designed to prevent were not widespread or severe, as well as arguing that compulsory vaccination constrains individual liberty. The messages evolved around children's safety; vaccination had been pictured as "children-eating dreadful monsters" (Image 4) calling for direct opposition and militant resistance to vaccination. Wolfe and Sharp give an example of the League pamphlet issued in the early 18th century.

> *"A mighty and horrible monster, with the horns of a bull, the hind of a horse, the jaws of a krakin, the teeth and claws of a tyger, the tail of a cow, all the evils of Pandora's box in his belly, plague, pestilence, leprosy, purple blotches, foetid ulcers, and filthy running sores covering his body, and an atmosphere of accumulated disease, pain and death around him, has made his appearance in the world, and devores mankind - especially poor helpless infants - not by sores only, or hundreds, or thousands, but by hundreds of thousands (vide* Vaccinae Vindicia: *413, 423).*
>
> *This monster has been named vaccination; and his progressive havoc among the human race has been dreadful and most alarming.*

Yet, strange to tell, this monster has found not only a multitude of friends but worshipers, who prostrate themselves before him, and encourage his voracious appetite.

Do not the men, the heroes - who first dared to stand forth to arrest the progress, and stop the fatal havoc of this most dreadful and destructive monster, and at length have bravely subdued and put him to flight with all his mighty host, merit an obelisk created to their fame, with their names inscribed upon it, in indelible characters, to be held in grateful remembrance through all future generations?

And are not these names MOSELEY, ROWLEY, BIRCH, SQUIRREL, LIPSCOMB?

London, 1807" from Global - critical unity[20].

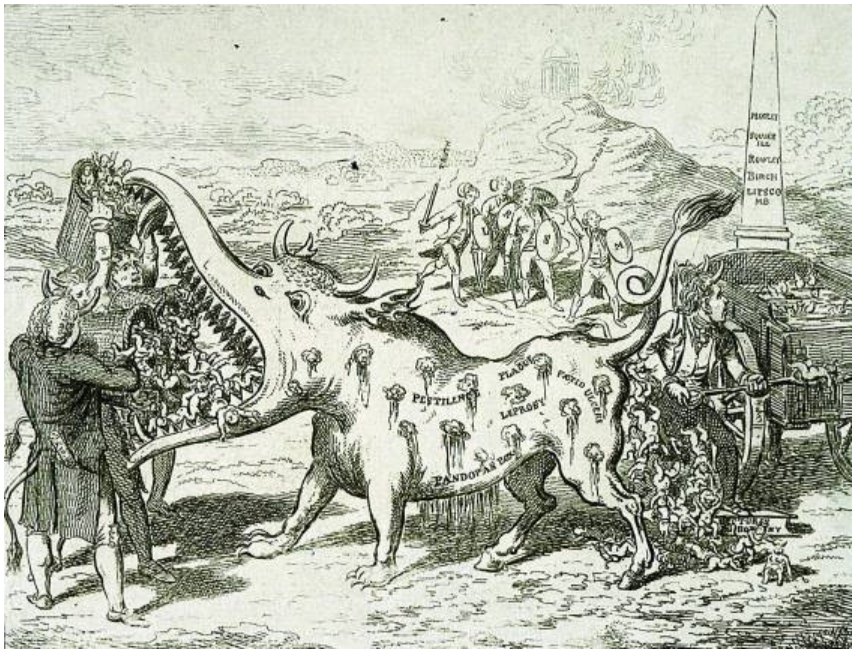


Image 4 The Vaccination Monster, The Wellcome Institute[21]

Finally, the League succeeded in Britain in 1898, under continuous public pressure the Government changed earlier vaccination legislation allowing children to be exempt from immunization (Wolfe and Sharp 2002). Similarly, in the U.S., the battle transferred from the health dimension to the legal sphere as the American anti-vaccinationists waged court battles to repeal vaccination laws in several

[20] Mandatory Flu Vaccination in Greece, [Online] https://criticalunity.org/news/world-alerts/35-global?start=20 [Accessed on August 3, 2021]

[21] Photo taken from Wolfe and Sharp, Anti-vaccinationists past and present. BMJ. 2002 Aug 24; 325(7361):430-2, [Online] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1123944/ [Accessed on August 3, 2021]

US states (Wolfe and Sharp 2002). In 1902, the Boston city resident Henning Jacobson refused to be vaccinated, as he believed that such a law violated his right to care for his own body in the way he knew best. In turn, the city filed criminal charges against him. After losing his court battle locally, Jacobson appealed to the U.S. Supreme Court. In 1905, the Court found in the state's favour, ruling that the state could enact compulsory laws to protect the public in case of an infectious disease (Gostin 2005), making this case one of the first examples of the state regulation of public health in the USA.

The development of the anti-vaccination movement and vaccination controversies are not limited to the past, they well continued in the 20th century with minor changes. The basic concern about vaccine safety is still the major one. In the mid-1970s, an international controversy over the safety of DTP immunization (a combination of vaccines against diphtheria, pertussis, and tetanus[22]) erupted globally in reaction to a published report alleging 36 children suffered neurological conditions following DTP immunization (Kulenkampff, Schwartzman, and Wilson 1974). Television documentaries and newspaper articles drew public attention to the case. An advocacy group, the Association of Parents of Vaccine Damaged Children (APVDC), also piqued public interest in DTP's potential risks and consequences. Though the Joint Commission on Vaccination and Immunization (JCVI) confirmed the safety of immunization, public confusion continued, consequently immunization numbers plummeted. It is believed that this report not only affected the general public's opinion but also planted seeds of doubts among British health practitioners making them reluctant to recommend vaccination as a completely safe procedure (Baker 2003). Simultaneously to this crisis, an outspoken physician and vaccine opponent, Gordon Stewart, published a series of case reports linking neurological disorders to DTP, sparking even more debate. The JCVI launched the National Childhood Encephalopathy Study (NCES) in response. The NCES results indicated the neurological risk for children was shallow. Later, this research lent support to a national pro-immunization campaign.

These two cases led to significant developments in vaccine pharmacovigilance, a medical field that detects, assesses, and prevents adverse effects or other medicine/vaccine-related reactions[23] (adverse event following immunization (AEFI) (Budhiraja and Akinapelli 2010)). Vaccine pharmacovigilance aims to detect and respond on time to adverse events following immunization, minimize negative

[22] DTP vaccine [Online] https://en.wikipedia.org/wiki/DPT_vaccine, [Accessed on August 23rd 2023]

[23] The WHO, Regulation and Prequalification , [Online] https://www.who.int/teams/regulation-prequalification/regulation-and-afety/pharmacovigilance#:~:text=Pharmacovigilance%20is%20the%20science%20and,other%20medicine%2Fvaccine%20related%20problem [Accessed on August 10, 2023]

effects on the health of individuals, and lessen the potential negative impact on the population's vaccination. On a country level, it is performed by the country's health authorities. In the U.S., the Center for Disease Control and Prevention created the Council for International Organizations of Medical Sciences (CIOMS) that aids national agencies with surveillance of vaccine safety and the evolving need for a harmonized view on terminology and case definitions used in vaccine pharmacovigilance.

Any medical intervention has side or adverse effects, vaccines are not exempt from this rule. Luckily, the majority of AEFIs are transient and located in the injection site. The risk and intensity of side effects vary from one vaccine to another. In general, adverse effects are grouped into three branches:

- Adverse reactions, most often local (injections site pain, redness or swelling) or systemic (fever, headache, body aches, fatigue, etc.).
- Unrelated health problems following vaccination.
- Health problems with an unknown cause.

Several reported cases of vaccine AEFI led to vaccines being withdrawn from use:

- 1976 U.S. swine flu vaccination stopped after 362 cases of Guillain–Barré syndrome among 45 million vaccinated people, four times higher in vaccinated people than in those not receiving the swine flu vaccine.
- Dengvaxia, the only approved Vaccine for Dengue fever, was found to increase the risk of hospitalization for Dengue fever by 1.58 times in children of 9 years or younger, suspending a mass vaccination program in the Philippines in 2017.
- Pandemrix – a vaccine for the H1N1 pandemic of 2009 given to around 31 million people – was found to have a higher level of adverse events than alternative vaccines, resulting in legal action.

During the COVID-19 crisis, the U.S. government collected information about adverse reactions to vaccines through the VAERS (the Vaccine Adverse Event Reporting System) national reporting system. Similar systems are in place in other countries. Reports about adverse events are classified as non-serious or severe. Serious negative event report — these reports meet the definition of “serious” specified by the Code of Federal Regulations because one of the following is reported: death, life-threatening illness, hospitalization or its’ prolongation, permanent disability, congenital anomaly, or congenital disability. A non-serious adverse event report does not meet the regulatory definition of a severe adverse event report.

Consequently, in response to reported vaccines' AEFI, compensation programs for caused health damage were introduced by governments around the world. According to Walter Orenstein, the associate director of the Emory Vaccine Center in Atlanta, vaccination is not a "*per-individual benefit, it's for societal benefit, and when that vaccine injures someone, society owes that individual compensation*"[24]. National programs are retributing for the damages caused by vaccination in the E.U. - the E.U. Vaccine Injury Compensation Programme (D'Errico et al. 2021), in the U.S. – National Vaccine Injury Compensation, in the U.K. – the Vaccine Damage Payment, in Canada – the Vaccine Injury Support Program. Despite the existence of these funds, they are not always available. There are many reports of compensation denial, which puts people in difficult life situations.

3.3 Vaccine Hesitancy Determinants, a Literature Review

This section presents readers with approaches implemented to understand and cope with vaccine hesitancy, it delves into the development of the term, presents a literature review on determinants of vaccine hesitancy, and concludes with analyses of relevant public policies. It is plausible to analyze the broad concept of hesitancy and its development within the pandemic background to understand how and why the population might develop vaccine hesitancy and what strategies health authorities and policymakers can employ to understand the phenomenon better and develop counterstrategies.

3.3.1 Vaccine Hesitancy Concept Development

The first subnational institutional approach to understanding vaccination attitudes was made in 1999 when the WHO created the Strategic Advisory Group of Experts (SAGE) on Immunization (Schuster et al. 2015). The group is active to this day. According to the group's official statement, its primary objective is to guide the work of the WHO concerning vaccines and immunization, and it is the principal advisory group to the WHO in this field. It advises the WHO on overall global policies and strategies, covering a wide range of topics from vaccines and technology, research and development, to implementation of immunization and its linkages with other health interventions.

Concerned with a continuous increase of vaccine hesitancy and its global devastating impact on vaccination intake, the SAGE group established the SAGE Working Group on Vaccine Hesitancy (W.G.). As a result of profound research, the W.G. proposed an official definition of vaccination hesitancy, which did not exist before, this allowed for the creation of informational campaigns to

[24] National Geographic, Science, Why is it so hard to compensate people for serious vaccine side effects? [Online] https://www.nationalgeographic.com/science/article/why-is-it-so-hard-to-compensate-people-for-serious-vaccine-side-effects [Accessed on August 20, 2023]

mitigate hesitancy and develop a vaccination hesitancy framework (briefly discussed in Sections *Research Question and Research Methodology* and *Conceptual Framework and Model Development*) two years later (MacDonald 2015; Schuster et al. 2015).

According to MacDonald, the W.G. expert had a lengthy discussion of the term *hesitancy* as it has strong negative connotations. An alternative term, *confidence* had been offered, but while *"... confidence covers a range of issues such as trust in vaccines including concerns about vaccine safety, and trust in healthcare workers delivering the vaccine and in those making the decisions to approval of vaccines for a population, confidence is still narrow in scope covering only one category of factors that affect vaccination acceptance decisions* (MacDonald 2015:4161)*."* Other terms like *"acceptance"* and *"uptake"* do not seem to capture the concept breadth, as one might accept a vaccine, but delay its administration, not accept it according to the vaccine schedule. Hence, the W.G. accepted the term hesitancy and then explored potential factors needed for its definition.

Finally, the W.G. discussed the difference between *vaccine hesitancy* and *vaccination hesitancy* was also raised. According to the W.G. experts, vaccination hesitancy covers a much more comprehensive range of factors, such as immunization services, time and place, fear of needles, and lack of knowledge about vaccine-preventable diseases, compared to vaccine hesitancy revolving around a given vaccine. The W.G. nevertheless chose to adopt the term vaccine hesitancy but defined it in the broader sense, and this term has become more widely accepted in practice (MacDonald 2015). To remind a reader of the concept, the official definition of vaccination hesitancy refers *"to delay in acceptance or refusal of vaccination despite the availability of vaccination services. Vaccine hesitancy is complex and context-specific, varying across time, place and vaccines. It is influenced by factors such as complacency, convenience and confidence* (MacDonald 2015:4163)*."*

Thus, vaccine hesitancy is a behavioural phenomenon that is context-specific and measured against an expectation of reaching a particular vaccination coverage goal, given the available immunization services. The SAGE Group proposes to measure hesitancy on the continuum (Figure 3) between high vaccine demand and complete vaccine refusal, i.e., no demand for available and offered vaccines. However, demand and hesitancy are not entirely congruent. An individual or community may fully accept vaccination without hesitancy but may not demand vaccination or a specific vaccine.

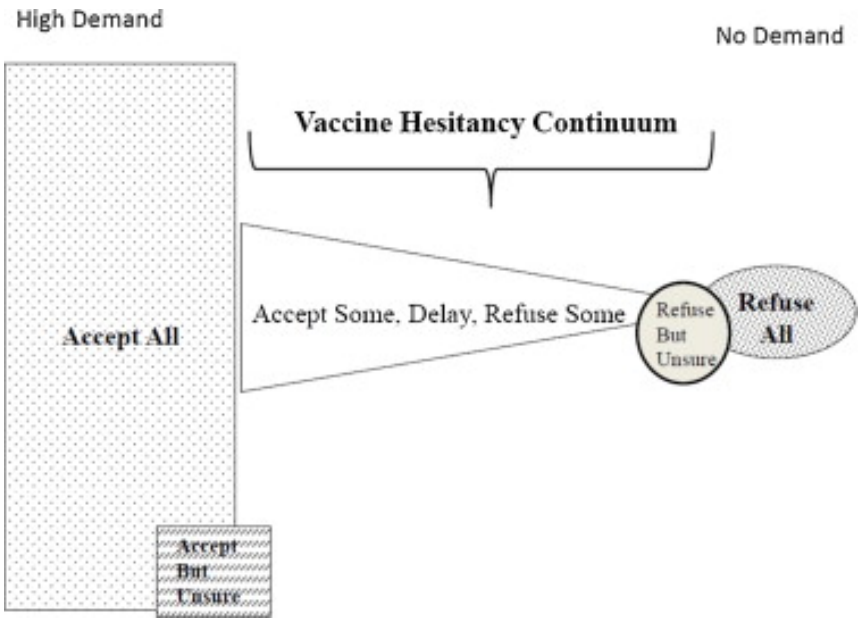


Figure 3 The continuum of vaccine hesitancy, from MacDonald, 2015

The next step the W.G. took was to defy the model of factors determining vaccine hesitancy. The W.G. understood acceptance of vaccination is an outcome of a complex decision-making process that a wide range of factors can potentially influence. In developing the definition, the W.G. reviewed several conceptual models for grouping vaccine hesitancy determinants and finally chose the "3 Cs" model. It coined its name from the three pillar concepts it encompassed - Complacency, Convenience, and Confidence (Figure 4) (MacDonald 2015).

According to the model, *confidence* is based on three major factors: (i) trust in the effectiveness and safety of vaccines; (ii) the system that delivers them, including the reliability and competence of the health services and health professionals; and (iii) the motivations of policymakers who decide on the needed vaccines.

Vaccination *complacency* exists where perceived risks of vaccine-preventable diseases are low, and vaccination is not deemed a necessary preventive action. Complacency about a particular vaccine or vaccination in general is influenced by many factors, including other life/health responsibilities that may be seen as more important at that point in time. Immunization programme success may, paradoxically, result in complacency and, ultimately, hesitancy. As individuals weigh the risks of vaccination with a particular vaccine against the risks of the disease the vaccine prevents, that disease is no longer common. Self-efficacy (the self-perceived or actual ability of an individual to act to be vaccinated) also influences the degree to which complacency determines hesitancy. In a meta-analysis study of around 500 articles on the topic of influenza vaccine hesitance, Schmidt et al. demonstrated

that the most frequently reported reasons for influenza vaccine hesitancy were complacency reasons (Schmid et al. 2017), as it occurred due to low perceived risk and worry about the disease, and a lack of confidence in vaccines (Schmid et al. 2017).

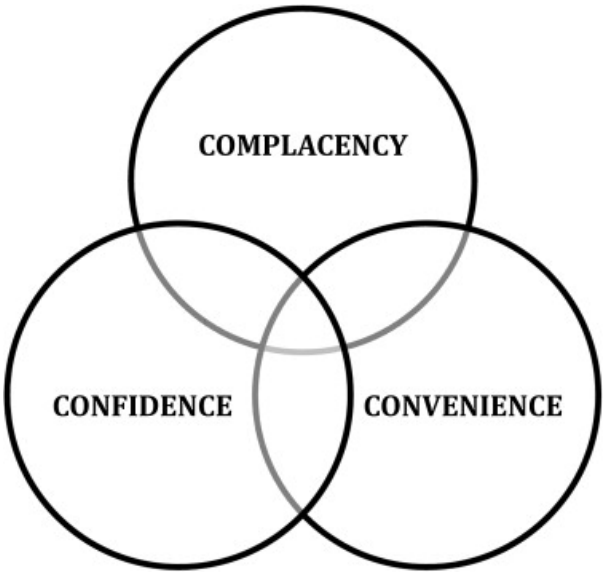


Figure 4 "Three Cs" model of vaccine hesitancy, from MacDonald, 2015

Vaccination *convenience* is a significant factor when physical availability, affordability and willingness-to-pay, geographical accessibility, ability to understand (language and health literacy) and appeal of immunization services affect uptake. The quality of the service (real and/or perceived) and the degree to which vaccination services are delivered at a time and place and in a cultural context that is convenient and comfortable also affect the decision to be vaccinated and could lead to vaccine hesitancy.

The final result of the W.G. activity was the development of the Vaccine Hesitancy Determinants Matrix with factors grouped in three categories: *contextual*, *individual and group* and *vaccine/vaccination-specific influences* (Table 1). The Matrix includes determinants identified from research studies, experiences of the W.G. members in the field, and discussions with experts in the area. It should be noted that vaccine hesitancy determinants like education and socio-economic status do not influence hesitancy in only one direction. For example, higher education may be associated with lower and higher vaccine acceptance levels (MacDonald 2015).

Table 1 Working Group on Vaccine Hesitancy Determinants Matrix, from MacDonald, 2015

Contextual influences Influences arise due to historical, socio-cultural, environmental, health system/institutional, economic or political factors.	a. Communication and media environment
	b. Influential leaders, immunization programme gatekeepers and anti- or pro-vaccination lobbies
	c. Historical influences
	d. Religion/culture/gender/socio-economic
	e. Politics/Policies
	f. Geographic barriers
	g. Perception of the pharmaceutical industry
Individual and group influences Influences arise from the personal perception of the vaccine or social/peer environment influences.	a. Personal, family and/or community members' experience with vaccination, including pain
	b. Beliefs, attitudes about health and prevention
	c. Knowledge/awareness
	d. Health system and providers – trust and personal experience
	e. Risk/benefit (perceived, heuristic)
	f. Immunization as a social norm vs. not needed/harmful
Vaccine/vaccination specific issues Directly related to vaccine or vaccination.	a. Risk/benefit (epidemiological and scientific evidence)
	b. Introduction of a new vaccine or new formulation or a new recommendation for an existing vaccine
	c. Mode of administration
	d. Design of vaccination programme/mode of delivery (e.g., routine programme or mass vaccination campaign)
	e. Reliability and/or source of supply of vaccine and/or vaccination equipment
	f. Vaccination schedule
	g. Costs
	h. The strength of the recommendation and/or knowledge base and/or attitude of healthcare professionals

3.3.2 Individual and Group Determinants of Vaccine Hesitancy

The earlier section demonstrated vaccine hesitancy to be a complex phenomenon having different determinants that vary within context, setting and time. This chapter aims at a profound investigation

of existing literature on vaccine hesitancy determinants. The study assumes that hesitancy to the COVID-19 vaccine has similar causes amplifying vaccine hesitancy and is based on overall attitudes to vaccination, this is why it is necessary to conduct such an analysis addressing all known determinants of hesitancy.

Factors shaping attitudes to vaccination vary by vaccines and are highly context-specific (Peretti-Watel et al. 2013; Schuster, Eskola, e Duclos 2015), complex and multidimensional. Vaccine hesitancy results from influences at many levels: providers' knowledge, attitudes and beliefs about vaccination, which interact with a broader set of organizational, political, cultural, or historical factors. We start our analysis by presenting socio-demographic characteristics attributed to higher levels of vaccine hesitancy.

In a meta-analysis performed on 22 studies Joshi et al., demonstrated the list of most relevant socio-demographic determinants. Authors conclude that higher vaccine acceptance is associated with a) high income, male gender, b) older age, c) marital status, d) parenthood, e) high education attainment, and f) health insurance coverage (Ayhan et al. 2021; Brandt 1978; Fridman, Gershon, and Gneezy 2021; Joshi et al. 2021; Saleska and Choi 2021; Savoia et al. 2021). On the contrary, lower vaccine acceptance is associated with factors such as retirement, unemployment, younger age, black race, lower educational attainment, rural settings, low income and no health insurance (Joshi et al. 2021). The same study shed light on the importance of health professionals in shaping positive attitudes to vaccine acceptance, concluding that "higher acceptance of vaccines among healthcare professionals can aid in gaining public confidence in the safety of the vaccine (Joshi et al. 2021:18)".

Another significant set of predictors includes personal beliefs and views ranging from religious denominations to political leaning. For many people around the world, it is important to live following their religious principles, and this is specifically relevant to children's vaccination. Religious objections to vaccines are generally based on 1) the ethical dilemmas associated with using human tissue cells to create vaccines and 2) beliefs that the body is sacred, should not receive certain chemicals or blood or tissues from animals and should be healed by God or natural means. Roman Catholics expressed their concern about cell lines used to produce vaccines[25]. In Judaism and Islam, it is vital to use "clean" components aligned with *Halal* rules (Alsuwaidi et al. 2003). Some Christian parents expressed strong opposition to children's vaccination as proposed vaccines had been developed using cell lines coming from an aborted fetus. The problem arises around informed

[25] Immunisation and religion, Vanderbilt University Medical Center, [Online] https://www.vumc.org/health-wellness/resource-articles/immunisations-and-religion [Accessed on 31 October 2023]

consent from the cell line donor (Grabenstein 2003; Rudd 2003). As is explained by the National Catholic Bioethical Center (NCBC)[26]:

> *"In most cases, the use of these cells is not controversial … since informed consent could be obtained from the [cell donor] to use the cells for research. On the other hand, using cell lines derived from fetuses after an induced abortion raises vexing moral problems. Informed consent cannot be validly obtained.*
>
> *It's clearly not possible to ask fetuses themselves whether their tissues may be used after they are terminated, and the parents cannot give valid consent either. […] Parents who choose abortion prove by that very fact that they no longer have the best interests of their child in mind, and they consequently lose the ability to give valid informed consent for the use of their own child's organs or mortal remains."*

In Catholicism, the issue with the usage of the human cell line arising from the ethical principle of consent is core to Christianity. It is understood that an embryo chosen to be a cell line donor cannot give full consent for being used as a donor, therefore, the principle is violated (Haire et al. 2018; Williamson 2021). It has to be said that not all vaccines use cell lines during their production[27], though all viral vaccines use cell lines in which they are grown, these tissues are of mammalian, avian or insect origins (Vlecken et al. 2013).

Similar concerns about products used during vaccine development are expressed by Muslims and Judaists. In Muslim-populated countries, *Halal* certification administrators use the Holy *Al-Quran* as a guide for granting the *Halal* certificate to applicants (Mardian et al. 2021). During this process, special personnel evaluate the cleanliness of premises and equipment used to produce a vaccine, selection of ingredients, and cross-contamination between "*Halal"* and "*non-Halal"* products as "*Halal"* products can only contain ingredients permitted by "*Sharia"* law.

As explained by Mardian et al.,:

> *"Swine are amongst the animals declared as Haram by Sharia law. Using their parts and derivatives in pharmaceuticals will render them non-permissible for consumption*

[26] Making Sense of Bioethics: Column 002: The Morality of Vaccinating Our Children, National Catholic Bioethical Center, August 30, 2005, [Online] https://www.ncbcenter.org/making-sense-of-bioethics-cms/column-002-the-morality-of-vaccinating-our-children?rq=The%20Morality%20of%20Vaccinating%20Our%20Children [Accessed on 31 October 2023]

[27] The COVID-19 mRNA vaccines (Moderna (Spikevax) and Pfizer-BioNTech (Comirnaty)) are not based on cell lines (Zimmerman 2021), the adenoviral vaccine, Janssen (Johnson & Johnson) vaccine and the AstraZeneca (Vaxzevria) use foetal cell lines.

by Muslims. However, swine derivatives are commonly used in vaccine production, including porcine trypsin and porcine gelatine (Mardian et al. 2021:2)*."*

Another popular reason for refusal among the Muslim population relates to sacred periods of fasting, like Ramadan or similar religiously significant periods. During this time, believers must abstain from eating, drinking, perfuming or having sexual relationships from sunrise to sunset. Some believers are concerned that vaccine adverse effects can lead to breaking the fast (Kibongani Volet et al. 2022), so they prefer to abstain from vaccination or taking new medicines to avoid unforeseen risks.

The ultimate individual factor affecting vaccination is fear of needles or any medical manipulation of one's body. In a recent study, Freeman et al. (2021) estimated that up to 10% of COVID-19 adult vaccine hesitancy might be explained by fear of injection and anticipation of pain (Freeman et al. 2023).

3.3.3 Contextual Influences

According to McDonald, contextual influences are the ones that arise due to historical, socio-cultural, environmental, health system/institutional, economic or political factors (MacDonald 2015). Medical providers studying vaccine hesitancy also consider the broad body of contextual determinants, including - historical, social, cultural, environmental, economic, political, and institutional factors influencing vaccine-hesitant populations. For some communities, suspicion towards vaccines is best understood in a social and historical context of inequality and mistrust. For example, several studies have found that the legacy of racism in medicine and the Tuskegee Syphilis Study, a clinical trial conducted with African Americans denied appropriate treatment opportunities, are key factors underlying African Americans' distrust of medical and public health interventions, including vaccination, in the USA (Brandt 1978; Corbie-Smith 1999).

According to the European Centre for Disease Prevention, the most common contextual influence reported is the spread of political conspiracy theories, which revolve around false statements about vaccine safety and effectiveness and or vaccines are the instrument to reduce world population (European Centre for Disease Prevention and Control. 2015). The frequent appearance of negative information about vaccination is an important contextual factor. This includes hearing, reading, or seeing negative information (misinformation, rumours, and myths) about vaccines in the general media (Carrieri, Madio, and Principe 2019). There is evidence that the major disruption to the rollout of a new vaccine is fear of modern technologies used during vaccine development (Saleska and Choi 2021).

The misinformation tends to target different groups with false messages specific to these groups' concerns. This tactic is used, for example, among muslim populations in Pakistan and Afghanistan (Warraich 2009), and Nigeria (Sato and Takasaki 2019), where the muslim fundamentalist groups spread misinformation about the polio vaccine, claiming it to be incoherent with Islam teaching. In another attempt to reduce children's vaccination, the Taliban in Southern Afghanistan have called polio vaccination an American ploy to sterilise Muslim populations and an attempt to avert Allah's will (Warraich 2009). Internationally, in parts of Asia and Africa, mistrust of vaccines is often tied to the so-called "Western plot" theories, which suggest that vaccines are ploys to sterilise or infect non-Western communities. One of the most striking cases of vaccine hesitancy in Africa has evolved around the same controversial polio vaccine. In 1999, British journalist Edward Hooper wrote *The River: A Journey to the Source of HIV/AIDS* (Hooper 1999), in which he speculates that the virus that causes AIDS transitioned from monkeys to humans via a polio vaccine. Although scientists and medical scholars have provided plentiful evidence to discount Hooper's ideas, media attention has sparked conspiracy theories and concerns globally (Gellin, Modlin, and Plotkin 2001). A consonant myth about a "golden billion" plan is popular in post-Soviet space (Cherkaev 2022). Developed by Russian nationalist writer Sergey Kara-Murza[28] conspiracy theory poses that a powerful group of global elites is pulling strings to amass wealth for the world's richest billion people at the expense of the rest of humanity. This theory was once again brought to the public during the COVID-19 pandemic claiming that both the virus and the vaccine are the instruments developed by world elites to eliminate millions of people and create a new world order.

Another influential contextual factor is political identification (Pavić et al. 2023). Recent studies found that conservative political orientation is related to higher vaccine refusal. Conservative political ideology was negatively correlated with pro-vaccination attitudes toward flu, pertussis, and measles vaccines. As for COVID-19 vaccine hesitancy, the relationship with political identification is mediated by political trust (Cowan, Mark, and Reich 2021; Kossowska, Czarnek, and Szwed 2021), and trust in science (Cadeddu et al. 2021; Carrieri, Guthmuller, and Wübker 2023; Carrieri et al. 2019). Santirocchi and colleagues studied a sample of a politically engaged population, the authors were interested in understanding the associations of political orientation with vaccine hesitancy (Santirocchi et al. 2023). Results suggest a mediating effect of trust in science and belief in misinformation in the COVID-19 vaccination intention. Most interestingly, results showed that

[28] Kara-Murza, Sergei 1999. "Concept of the 'Golden Billion' and the New World Order", *(in Russian)* ["Kontseptsiia 'Zolotogo Milliarda' i Novyi Mirovoi Poriadok."], [Online] https://www.kara-murza.ru/books/articles/oro1.html [Date of access March 11, 2024]

political orientation *"had both direct and indirect associations with vaccine hesitancy and vaccine intention, mediated by trust in science and belief in misinformation"* (Santirocchi et al. 2023). Authors remark that right-wing-oriented voters were less trustful of scientists and distrustful of COVID-19-related information compared to their left-wing counterparts.

3.3.4 Vaccine Ethics, Biopolitics, Moralization

Vaccination has more than just a strictly medical dimension. It deals with a potential conflict of power over one's body and individual decision to vaccinate (and or vaccinate children). For some people, the question of personal freedom is more valid than medical need and or desire to succumb to the collective power of others. In the field of bioethics – the subfield of applied ethics addressing the ethical concerns in the context of medical research – the COVID-19 crisis has actualized with additional force long-running debates about the conflict of "individual freedom" versus "common good" (Parmet, Goodman, and Farber 2005).

Traditionally, autonomy is understood in an atomistic sense – an individual agent acts freely of her own volition (Haire et al. 2018; Williamson 2021). Informed consent plays a vital role in the concept of bodily autonomy (Haire et al. 2018). A person cannot make informed consent if she is not fully informed, mentally competent, and voluntarily able to decide (Williamson 2021). Such an approach undermines the social structures the agent is embedded in, isolating her from the reality of human interactions. This critic of the traditional view helps to imagine another view of autonomy, in which the individual is inseparable from the relational contexts in which she is embedded. Concerning vaccination, these two approaches can be understood in two ways.

First, the fully atomistic view implies that individual decisions about vaccination should be made based solely on independent individual decisions (Williamson 2021). If the agent chooses to vaccinate, it is irrelevant for what reason, and vice versa. It is irrelevant for what reason the agent refuses to vaccinate, and her decision is independent of others. Another approach implies that when making a vaccination decision, an agent must think about the effect her decision has on others, considering the context in which she is embedded (Williamson 2021).

This overplay of body autonomy reasoning is easy to find in real life. For example, Denu et al., report that the main objection the Italian population had against COVID-19 vaccines was concern about the right to choose whether to get vaccinated or not. These concerns are strongly associated with unwillingness to get vaccinated among those who have not received the shot (Denu et al. 2022). Consistently with other studies, authors demonstrate that people who believed in the right to choose were less likely to accept the COVID-19 vaccine regardless of their age, sex, education, and risk

perception of contracting and transmitting the disease. Authors argue that belief in personal freedom is underpinned by many factors, including political orientation, religion, socio-cultural beliefs, a set of lifelong beliefs that develop over an individual's lifetime for multiple reasons and can be considered as characterizing traits that are unlikely to change drastically even in the face of a deadly pandemic (Denu et al. 2022; Sindoni et al. 2022).

An essential factor that vaccine scepticism brings to the picture is power hierarchy, as governments could mandate vaccination for citizens. On the other side of equilibrium are political institutions and their desire to regulate an individual's health behaviour and attitudes. This phenomenon was articulated in the mid-20th century by French philosopher Michel Foucault (1926-1984). According to Foucault, political power, through the means of modern technologies, including medical achievements, tries to control life itself (Foucault and Senellart 2008). Foucault introduced the concept of "biopolitics" to describe the emergence of new political strategies in Europe in the second half of the 18th century (Sarasin 2020). Modern societies have created the technical and political possibilities to regulate the life of the species as such.

Attempts to apply Foucauldian concepts of "biopower" and "governmentality" to the COVID-19 crisis have been made recently. Several authors argue that it can serve as an analytical tool in the analysis of different countries' management of the coronavirus pandemic (Højme 2022; Sarasin 2020). As coronavirus spread across the countries, it underwent a significant transformation from a local health crisis to a global pandemic, affecting the political decision-making processes of countries with its economic and security dimensions. According to Højme (2022), Foucault distinguished between the right of the sovereign and the right of the social body to maintain and develop life. The change from the right of the sovereign to the right of the social body greatly impacted how the legal system functions. In the previous social period, the law had a punitive function, and today, this function has transformed into a disciplinary one. Højme further argues that law went from punishing wrongdoers to seeking to correct individuals' divergent behaviours to enforce dominant social norms (Højme 2022). For example, during this pandemic, the state exercised its power by issuing orders and decrees forbidding/limiting certain activities, requiring others, and passing laws to ensure that these measures are legally and constitutionally legitimate. Police, national guards and the military have been called upon to enforce restrictions. The disciplinary character of some of these measures is likewise reasonably straightforward, especially in the case of (total or partial) quarantine (Hannah, Hutta, and Schemann 2020). Hence, biopolitics aims to secure *"the biological existence of a population and do so by attempting to correct anti-social behaviour and physical or mental illnesses* (Højme 2022)*"*.

Philosophy offers another point of view on health norms development that might be interesting to consider in application to vaccination. One such work deals with the development of health-related values through the mechanism of moralisation. The theory is owned by Paul Rozin, who defined moralisation as "the process through which preferences are converted into values, both in individual lives and at the level of culture" (Rozin 1999:218). Rozin researches health-related behaviours, such as smoking, drug use, and alcohol consumption; he describes the moralisation process that occurred in most Western countries in the second half of the twentieth century. These types of behaviour acquire moral properties of being bad not only because of their instrumental properties – smoking, alcohol consumption, and opioid use over a long period can cause irreversible health damage – by itself. Some behaviours and our attitudes toward them vary over time, for example, meat-eating steadily shifted from a preference to morally bad behaviour with time (Feinberg et al. 2019; Rozin 1999).

Rozin illustrates his thought through the evolution of the moralisation of smoking. In fact, in the middle of the 20th century smoking had been considered *"a mere preference . . . [but] it is now a morally laden act.* (Rozin 1999)*".* In a short period attitudes to smoking have changed from morally neutral to morally condemning due to public efforts to demonstrate the health harm of passive smoking (Rozin, Markwith, and Stoess 1997), and as we in contemporary Western societies hold as common ground – harming others is immoral (Thomas 2019). This process is explained by Thomas (2019):

> *"[…] the collective perception of the relevant moral principles involved in cigarette smoking effectively shifted away from the principle of autonomy toward the harm principle. The principle of autonomy suggests that rational agents are free to direct their lives as they see fit, while the harm principle holds that the rational agent's autonomy is limited by the harm her freely directed actions may cause to others. To the extent that second-hand smoke represents a serious danger to the health of passive bystanders, it falls clearly under the scope of the harm principle, and the moralization of cigarette smoking on these grounds is easily understandable* (Thomas 2019:216)*".*

According to moralization theory, the processes of moralisation could be historically and culturally specific, what it often applies to are behaviours that matter to individuals and, arguably, to public health, and this link allows this behaviour to acquire moral properties. According to Rozin, moralized entities are more likely to receive attention from governments and institutions, to encourage supportive scientific research, to license censure, to become internalized, to show enhanced parent-

to-child transmission of attitudes and, in at least some cases, to recruit the emotion of disgust (Rozin 1999).

What behaviour or concepts can be moralized? As it demonstrates Thomas (2019) anything can be moralized, from fridges to biscuits (Lalumera 2023), as Lalumera jokingly notes - "if you can moralise a refrigerator, then you can also moralise a medicine or medical intervention", this includes vaccination. Vaccines often are portrayed as lifesaving health interventions with limited and transient unwanted effects, yet the moralization of vaccines works in divergent directions. Pro-vaccine people build their moralisation discourse not only around the positive effects of vaccines but also around congenital effects – lower risks of spreading infection, for example. Some people might use vaccination as an instrument to insult, stigmatise, socially ostracise or punish somebody who, for any reason, did (or did not) vaccinate. According to existing research anti-vaccination discourse is built not only around perceived health harm caused by vaccination, but also is driven by underlying moral beliefs. In a 2010 review of anti-vaccination web content Anna Kata demonstrated that almost one-third of internet vaccination content mentioned immoral acts in connection with vaccination programs, linking vaccines to *"viruses being cultured in the tissue of aborted fetuses; animals being tortured in the process of vaccine manufacturing; and experimenting on children in developing countries when testing vaccines* (Kata 2010:1713)*."* In recent years the movement gained its momentum by appealing to the moral values of liberty and purity over fairness and prevention of harm (Thomas 2019). Liberty is understood as infinite individual freedom, personal responsibility, property rights, and resistance to state intervention. Thus, the anti-vaccination movement in the USA has condemned widespread vaccination as unwarranted paternalism, not only based on misguided practical beliefs about the safety of vaccines but also based on strongly held moral beliefs focused on freedom of choice, bodily integrity and sacredness. As a result, vaccination acceptance is immoral because it promotes constriction of liberty, and violation of bodily purity (Lalumera 2023; Thomas 2019). On the contrary, those in favour of vaccination may tend to judge it to be not only beneficial to one's health, but also morally good, for reasons that include protection of the weakest, solidarity, and contribution to health as a common good. They may also tend to believe that not being vaccinated is harmful to others and that harming others is morally bad. Anti-vaccination attitudes are seen as selfish and irresponsible because they are moralised as dangerous and harming others by compromising the "herd immunity" of the general population. Thomas concludes that the anti-vaccination attitudes are routinely moralized like those of the smoker; they are not generally treated as morally neutral preferences (Thomas 2019).

Rozin's works have several important implications (Lalumera 2023). Firstly, on the individual level, what is morally laden becomes internalised. Internalized behaviour becomes a part of internal individual representation, a self-portrait. Following the smoker example, we argue that for non-smokers being one may become central to who the person is, and therefore become existentially important to preserve, defend, and justify. Same for people rejecting vaccination, as it can become part of their identity routed in their beliefs about what is moral and what is not. As such, moralized behaviours are transmitted and reinforced through generations (from parents to children and so on). Secondly, moralization promotes "over-justification", for example, *"moral vegetarians, compared to health vegetarians, tend to discover and present more non-moral reasons against eating meat* (Lalumera 2023:16)". Moralisation of behaviours makes people feel entitled to attitudes of blame and stigma, or pride and admiration, reinforcing in-group cohesion and outgroup exclusion *"with moralisation, new virtues and vices are born, such as being a non-smoker, a vegetarian, or an anti-vaxxer if you have certain background beliefs about purity or liberty* (Lalumera 2023:16)*"*.

Moralisation has equally powerful institutional effects. When a behaviour becomes moralised, governments and other institutions act with the prevention, education, or prohibition, more than they would have done were the behaviour just unhealthy (Rozin 1999). Moralisation also influences research topics by mobilising public interest to said moralised entities. It therefore happens that research funding is motivated by morally hot topics and diverted from others. Consequently, it is plausible to suppose that moralisation (or the study of highly moralised charged topics) can directly or indirectly affect the structure of knowledge acquisition at many points (Anderson 2004). This research is a proper example of scientific enquiry partly motivated by the moral sensitivity of the research in question, it seeks to understand vaccination hesitancy, a type of attitude gaining substantial moral dimension.

3.4 COVID-19 Vaccine Intention and its Determinants

Research on COVID-19 vaccine hesitancy is happening in real-time, with most published works focusing on perceived willingness to be vaccinated, not on the actual behaviour. Some evidence is already available. Joshi and colleagues made a research attempt to create a comprehending framework that accounts for all significant factors of vaccine hesitancy related to COVID-19 (Joshi et al. 2021). Researchers analyzed a body of studies about COVID-19 vaccine attitudes. The resulting framework is similar to the previously introduced 3-C model but has several differences. Similarly to the W.G. framework, Joshi understands vaccine hesitancy as a continuum of choices from "complete acceptance" to "complete refusal". They list four key groups of factors: the socio-demographic group

of factors, communication about the COVID-19 pandemic and vaccination, the COVID-19 vaccine and related issues, and COVID-19 infection and related issues. Although this framework is similar to the 3-C model and reinforces all the possible factors that influence COVID-19, it is fair to conclude that this framework represents a case-specific situation. The significant difference is the mention of trust and satisfaction as in the 3-C model these factors are not specified. What is essential about this framework is the pronounced role of trust and satisfaction as predictors of vaccine intake in the early stages of immunization campaigns. The following subsection summarizes the literature about factors related to the COVID-19 vaccine, COVID-19 infection itself, and the socio-demographic group of hesitancy determinants.

3.4.1 Individual and Group Influences

On the eve of the pandemic Freeman et al., studied the British population in an online survey concluding that vaccination hesitancy is spread evenly in the general population – "it is not circumscribed to specific groups" (Freeman et al. 2020:12). One of the pieces of evidence suggests that prior experiences with vaccinations can influence forthcoming decisions regarding COVID-19 vaccination (Joshi et al. 2021), for example, individuals currently vaccinated against seasonal influenza have a strong inclination to accept a COVID-19 vaccine when available (Dror et al. 2020; Goldman et al. 2020).

The other common family of hesitancy factors are the perceived risk of infection and the risk/benefit analysis of vaccination. Literature suggests that perceiving COVID-19 infection as a danger to the country and/or to oneself is a strong predictor of vaccine acceptance (Guidry et al. 2021). Existing studies demonstrate that people with higher perceived susceptibility to the severity of COVID-19 were more likely to accept the vaccine. Risk perception regarding the COVID-10 infection, vaccines, and vaccine acceptance is intricately linked with trust in health professionals, government, or public health institutions (Joshi et al. 2021; Solís Arce et al. 2021). Equivalent results are reported by Denu et al., who studied the Italian population at the beginning of the vaccination program in May 2021. Authors claim that only 1 out of 6 individuals reported having refused vaccines in the past and that the refusal to get the COVID-19 vaccine was disease-specific for most of the respondents (Denu et al. 2022).

Among important individual determinants of hesitancy we meet once again a lack of trust in vaccines; and vaccine producers. An emerging phenomenon is a lack of trust in science. To further understand the influence of trust in science Carrieri et al., made an overwhelming observation of more than 35,000 individuals in the EU (Carrieri et al. 2023). Trust in science is negatively correlated, while

trust in social media and the use of social media as the main source of information is positively associated with vaccine hesitancy. High trust in social media is found among adults aged 65+, financially distressed and unemployed individuals, and hesitancy is largely explained by conspiracy beliefs among them. Finally, the authors report that the *"temporary suspension of the AstraZeneca vaccine in March 2021 significantly increased vaccine hesitancy and especially among people with low trust in science"* (Carrieri et al. 2023).

It is a quite noteworthy task to conceptualize what trust in science is. We could use the previously introduced conceptual model of public trust and first immerse ourselves in the situation of vulnerability. The growing complexity of the world around us and our light-speeding achievements in many sectors might make us feel vulnerable. Pandemic, new unknown diseases, and lack of therapy might make us feel vulnerable. Looking for reassurance and answers people look for trusted sources, one such source is a contemporary (Western, positivist) science. Trust in science develops when the public recognizes the scientific community as a social actor, whose activity is governed by some social values, and most importantly, these values are humanistic, i.e. science pursues to undercover the *"truth"* and seeks to *"make humanity better"*. When these fail to be true people tend to distrust science, distrust scientific institutions, and scientific information.

3.4.2 Communication about Vaccination

Communication about vaccines is key to success during any vaccination program (Dubé et al. 2018). This pandemic became notorious for the amount of misinformation spread about the virus and vaccines that led to the rise of mistrust in vaccines and health professionals, subsequently resulting in larger societal polarization. The pandemic has been heavily politicized from the very beginning (from the investigation of which country is responsible for its spread and conspiracy theories of the origins of the COVID-19 virus). Some countries used vaccination as propaganda weapons, literally measuring which vaccine is "better", forgetting that it is all about human life, not political ambitions (Peng 2022). The same is true for vaccination certificates, their politisation brought a new societal division: vaccinated VS unvaccinated (Storer and Sarafian 2022) limiting the civil rights of the last group.

A survey poll performed at the beginning of the vaccination campaign demonstrates that the significant disruption to the rollout of a new vaccine is fear of modern technologies applied to develop new vaccines (Saleska and Choi 2021). As the Kaiser Family Foundation calculated, only 59% of USA citizens are worried about vaccination side effects (59% of poll respondents), another 55% do not trust government assessment and a lack of trust in vaccines' safety and effectiveness (55% of poll

respondents)[29]. This concern prompted people to choose a "wait and see strategy" to postpone vaccination and see how it will go, if vaccines are effective or if they have any adverse reactions (particularly severe ones, including lethal ones). This strategy had been mentioned by 53% of poll respondents. Individuals agree to accept the vaccine if it is a requirement by their employer; there is clear and consistent communication on the infection and vaccine; these people are provided with official information regarding the safety and effectiveness of the vaccine; or the vaccine is recommended by their doctor or the health professional (Joshi et al. 2021; Qian, Chou, and Lai 2020).

Haase et al. showed that even when a small sample of single-case narratives is given to people together with a statistical base rate of vaccine adverse events, this one event largely influences vaccination risk perceptions and vaccination intentions, irrespective of various content characteristics (Haase, Schmid, and Betsch 2020). Comparable results were obtained by Loomba et al. through a randomized controlled trial in the U.K. and the USA. Authors show how exposure to online misinformation around COVID-19 vaccines affects the intent to vaccinate (Loomba et al. 2021). In both countries - as of September 2020 - recent misinformation induced a decline in intent to vaccinate of 6.2 percentage points in the U.K. and 6.4 percentage points in the USA among those who stated that they would "definitely accept" a vaccine.

One of the novelties brought about by the COVID-19 pandemic is an increase in political polarization in Western countries. Several USA studies showed that political ideology is a pronounced determinant of vaccine-related attitudes and behaviours (Fridman et al. 2021; Ward et al. 2020; Włodarska et al. 2021). Traditional conservatives and liberals (in the U.S. political system) lean toward anti-vaccination attitudes. Their beliefs are based on the ideas of free choice and extreme body autonomy, as well as belief in false information about vaccine side effects and being more prone to conspiracy theories (Fridman et al. 2021). According to Franic, "*resistance to vaccination appears to have a lot to do with reliance on unverified sources of information (e.g. online social networks), and in particular with susceptibility to conspiracy theories* (Franic 2022:2)".

In some works, two recurrent and sometimes intertwined factors are linked to both vaccine hesitancy and trust – information use and political leaning (some works refer to political ideology) (Baumgaertner, Carlisle, and Justwan 2018; Haase et al. 2020; Joshi et al. 2021; Loomba et al. 2021; Wu, Crespi, and Wong 2012). Because vaccination decisions are made in a situation of informational complexity and/or lack of information, it is reasonable to assume that information use affects

[29] Kaiser Family Foundation. KFF health tracking poll, 2020. [Online] https://www.kff.org/coronavirus-Covid-19/report/kff-health-tracking-poll-september-2020/ [Accessed on August 31, 2021]

hesitancy. Just as the frequent appearance of negative information about vaccination could negatively impact vaccine acceptance, positive information from trusted medical providers can significantly reduce hesitancy. Additionally, trust is contextual to the information available to individuals (Franic 2022). Similarly, literature on trust in Government shows a negative connection between populist parties and trust in knowledge-based institutions (Saarinen, Koivula, and Keipi 2020), as much as USA data show significant dominance of right-wing among no-vax (Klymak and Vlandas 2022).

3.4.3 Contextual Factors

Political orientation and religion are significant contextual determinants, as anti-vaccination sentiment was found to be more ingrained among conservative voters and highly religious people (Franic 2022). Cowan et al. detected that politically conservative US citizens were less likely to express willingness to receive the COVID-19 vaccine, where institutional trust mediated the relationship only in the first phase of the pandemic (Cowan et al. 2021). Comparable results are reported by Kossowska et al. by confirming that political orientation had an indirect impact on beliefs and attitudes toward vaccines through distrust and negative perceptions of scientists, both in the pre-COVID-19 era and during the COVID-19 health crisis (Kossowska et al. 2021)

Finally, we present several overlooked contextual factors of vaccine hesitancy that are closely related to specific conditions people find themselves. These people are referred to as marginalized communities, they often exist on the borders of societies, are involved in illegal or undocumented activities, or are simply undocumented themselves. For them, COVID policies represent existential danger disproportionately damaging their lives and survival. The "Ethnographies of (Dis)Engagement" Project[30] reports that many undocumented individuals experience significant barriers in accessing public health services. In Italy, the project reports that undocumented individuals need a special code (STP) to access health services (Storer and Sarafian 2022). However, in the first few months of the vaccination campaign, there was a lack of clear, timely institutional communication on how people with STP codes could access the vaccine and obtain the Green Pass. This was combined with a lack of communication even on the existence of the STP code and its use for accessing public services, including health services outside of the Emergency Room (Storer and Sarafian 2022). Finally, employers of undocumented people often require a Green Pass for job continuity, no matter whether the work is illegal or even dangerous. The report continues *"[…] as undocumented workers in illegal employment are vulnerable to being blackmailed by employers […]*

[30] LSE, Ethnographies of (Dis)Engagement, Understanding Vaccine Rejection in Chronically Neglected Communities across the G7 [Online] https://www.lse.ac.uk/africa/research/Ethnographies-of-Disengagement [Accessed on March 13, 2024]

many have been forced to obtain vaccination to ensure their livelihoods (Storer and Sarafian 2022:11)*"*. Attitudes to vaccination among Italian migrants are frequently characterized by frustration, anxiety, and a widespread feeling of having been coerced to obtain one (Storer et al. 2022). The same report highlights a similar situation among illegal migrants who want to cross the French/Italian border. For them, COVID containing policies pose an existential question of survival. There is no evidence to suggest these people are vaccine hesitant, many have been vaccinated in transit countries, Turkey or Bosnia, yet their vaccination certificates are not recognised in Italy (Storer and Sarafian 2022). Vaccination is a crucially important issue for these groups is it can interrupt their journey – *"migrants had accepted or rejected vaccines depending on how easily vaccines allowed them to travel, a decision-making process that took the possibility of side effects into account"*. Many migrants on the move refuse vaccination based on pragmatic considerations regarding common adverse reactions the vaccine can cause. They are concerned that fewer or physical weakness can stop them from moving fast, they might lose their track, their peer group, or simply would not be able to find shelter to wait till they feel better (Storer and Sarafian 2022). It is not only COVID-19 that poses danger to these people's lives, but our societal response that paradoxically instead of helping brings even more harm.

3.4.4 Mandatory Vaccination Policy Effectiveness

Faced with low vaccination acceptance, many governments issued policies mandating citizens to get vaccinated (van Kessel et al. 2023). The goal was to cover as many people as possible and reach a so-called "herd immunity" when 90% or more of the population is immune to the pathogen. None of the goals was achieved (van Kessel et al. 2023). We know now that coronavirus can re-infect immune people, so herd immunity is impossible to succeed in the case of coronavirus. Yet, the estimations of mandates' effectiveness differ from study to study (Campos-Mercade et al. 2021). Several newly published works have investigated the effectiveness of implemented policies to augment vaccination intake.

Most of the EU countries introduced measures to increase vaccination intake, which vary from strictly monetary interventions (payments for getting vaccinated, monetary lotteries) to non-monetary (non-monetary lotteries, mandates, text communications, etc.). One such measure – a so-called "green pass" certificate (Italy) or vaccination passports in other countries (Australia) – is proof given to people who have recently recovered from COVID-19 infection or had been vaccinated against the virus or had been tested negative in the last 24-48 hours. Vaccination certificates are not a new policy; they exist in many countries for various infections and diseases (for example, meningitis, polio, and yellow fever). Some countries require tourists to vaccinate themselves to visit specific territories

endemic to exotic viruses, yet vaccination certification has never been used as permission to participate in social life. The Italian immunization plan, introduced in December 2020, offered a prioritization strategy that will first be available to healthcare workers, nursing home residents, people over 80, and so on, depending on the person's health and social status. By April 2021, the Italian government had issued a compulsory vaccination mandate for all doctors, dentists, and health professionals. The following summer, it imposed a health certificate (i.e., Green Pass) for vaccination status or negative swab test results (the validity of the Green Pass with the swab test is 48 h) to access public and private venues in August 2021. Yet by fall 2021, more than 2 million people aged 40–49 years have still not booked a first-dose appointment (76.9%), with some marked differences at the regional level. The Italian government started requesting a Green Pass certificate in all private and public workplaces beginning on October 15. Employees without a valid Green Pass were not allowed to attend their workplace and were deemed unjustifiably absent. The effects of such certifications on a large scale have not yet been evaluated. However, some theoretical support for claims about the effectiveness of vaccine policies comes from game theory and experimental studies, we discuss them further.

Vaccination mandates give additional motivation to overcome “lazy hesitancy”. Research by Mills and Reutennauer suggests that vaccination certificates a) have no effect when introduced during short vaccine supply, and b) are not effective in average or high uptake setup, but effective in countries with low vaccine intake (Mills e Rüttenauer 2022). As Thomas Hale, the head of the Oxford COVID-19 government response tracker, said in an interview with CNN[31] , some people are "*vaccine lazy*", i.e., a little bit hesitant or simply too busy (Mackintosh 2021). In the same article, CNN claims that since the announcement of Green Pass in mid-September 2021, vaccination coverage grew by about 5% in Italy. If it is true, 5% of the Italian population (roughly 60 million) equals 3 million people, twice the population of Milan – could be considered a good result for policy measures (Mackintosh 2021).

Game theory is a field of mathematics that models competitive and cooperative human interactions, where a “game” is composed of players, their actions, and the resulting payoffs (Augsburger et al. 2023; Chapman et al. 2012), often applied to competitive economic and political contexts. Game theory attempts to predict individual behaviour in such a setting, where the payoff to strategies chosen by individuals depends on the strategies adopted by others in the population (Bauch and Earn 2004).

[31] Making Covid-19 vaccines mandatory was once unthinkable. But European countries are showing it can work, CNN, [Online] https://edition.cnn.com/2021/11/30/europe/Covid-vaccine-mandates-austria-europe-cmd-intl/index.html [Accessed on October 02, 2023]

In the context of healthcare, game theory models individuals' decision-making processes when accessing health services. In recent years it has been applied to real-life situations to explain and predict human decision-making concerning vaccination (Augsburger et al. 2023; Bauch and Earn 2004; Chapman et al. 2012). One such example is the work of Bauch and Earn who modelled parental hesitancy to vaccinate children in England. According to the authors when deciding whether to vaccinate their children, parents consider the risk of morbidity from vaccination, the probability that their child will become infected, and the risk of morbidity from such an infection. Parental decision is indirectly influenced by the decisions of other parents because the sum of these decisions yields the vaccine coverage levels in the population and hence the course of epidemics. Considering this setup authors integrate epidemic modelling into a game theoretical framework which allowed them to demonstrate how risk perception influences vaccine uptake (Bauch and Earn 2004). Results suggest that an increase in perceived vaccine risk will tend to inflict higher hesitancy for vaccines. An important result to consider is that after a vaccine scare, it will be difficult to restore previous vaccine coverage levels. Similar works in the field look to relevant research questions - whether herd immunity could be achieved (Lim and Zhang 2020), potential vaccine accessibility (Heier Stamm et al. 2017), changes in vaccine demand (Reluga, Bauch, and Galvani 2006), perfect and imperfect vaccine (Augsburger et al. 2023), as well as optimal strategies for countries whether they shall share vaccines or no (Klepac et al. 2016), or model altruistic vaccination of low health risk population to protect high-risk populations (Chapman et al. 2012).

To conclude, this section provides a rich review of existing studies done on the topic of vaccine acceptance. It demonstrates that hesitancy evolves around topics of personal freedom, autonomy, trust, and religious or spiritual beliefs. It was born and developed alongside the development of vaccines and remained relatively consistent since E. Jenner introduced vaccination. Factors affecting people’s COVID-19 vaccination choices are numerous and often are related to societal inequalities and mistrust of political actors rather than mistrust in vaccines.

Real-life data support theoretical implications, reminding us that the effectiveness of mass vaccination programs is governed by the public perception of vaccination (Reluga et al. 2006). To contain the spread of vaccine scepticism, governments and medical professionals must solve several tasks - build confidence in vaccine safety and effectiveness, and develop support systems for people who have rare adverse reactions.

Section 4. Conceptual Framework and Model Development

4.1 Research Model

Vaccine hesitancy is a complex research phenomenon supported by a well-developed literature on supply factors concerning vaccine development, manufacturing, and distribution, yet less systematically developed research on factors of demand. The literature review indicates several key associations between vaccine hesitancy and sociological constructs, such as trust or policy compliance (Franic 2022). To control for these and other factors known to affect COVID-19 vaccine uptake, the analyses included age, gender, place of residence, migrant status, and history of previous vaccinations as explanatory variables in the research model. To do so, this research developed the research framework presented below.

Figure 5 summarizes the research conceptual model by considering the literature findings and illustrates the research approach to answering the research question. The independent variables are 1) trust in government and 2) trust in health professionals. Control for alternative explanations is included to test whether we can see an effect of political trust on vaccination intention. The choice of controls is based on the literature review of factors affecting trust and vaccine hesitancy (see Sections 2 and 3).

This research tries to distinguish trust from the similar but distinct concept of approval of the government by using a separate variable – government approval. The idea is that approval is a result of performance based on cognitive evaluation of government, which is substantially different from trust (discussed in Section 2), i.e., the two-measure different concept, though it could be covariate. The government approval variable is included at the individual level in the model to distil the effect of performance from the effects of trust (defined as approval of government restrictions to stop the spread of the coronavirus). In similar works, it is argued that *"there is good reason to assume that the same factors that likely affect trust in government also affect a government's response to the COVID-19 pandemic, this does not necessarily determine how governments respond or (even more importantly) how that response is perceived"* (Törnblom 2022:18). To conclude, the two (meaning institutional trust and performance-based trust) are different concepts that are measuring different phenomena.

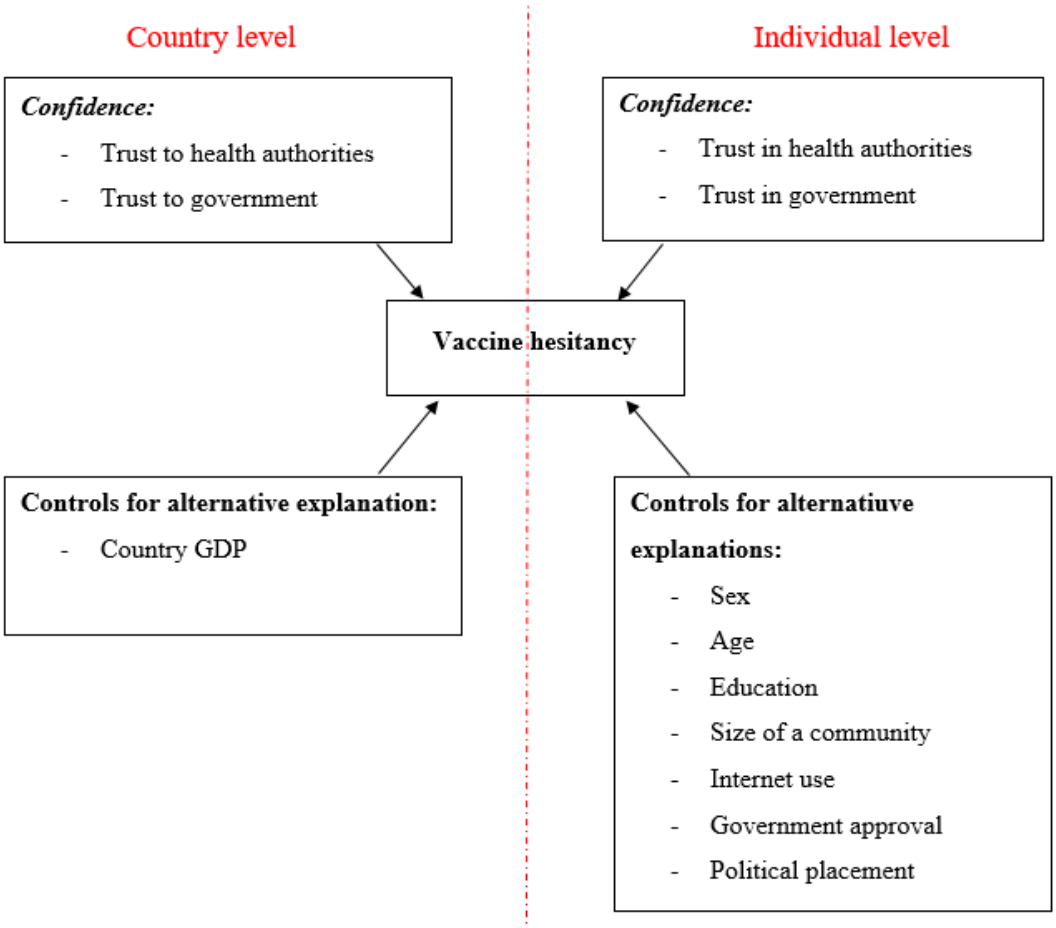


Figure 5 Conceptual Model of Vaccine Hesitancy Based on the SAGE 3-C Framework

Secondly, because vaccination decisions happen in a situation of informational complexity and/or lack of information, it is reasonable to include controls for the information consumption of respondents. Additional support for including informational consumption comes from trust research – trust is contextual to the information available to individuals (Franic 2022). The only available variable in the Eurobarometer dataset about information consumption is the Internet use index, which measures how often an individual has access to the Internet.

Thirdly, this model tries to account for the ongoing politicization of vaccination (though part of the vaccine sceptic movement for centuries had been political). It is plausible to include measures of political identification at the individual level in the data analysis. The dataset contains a variable describing self-reported individual political placement on a scale from the left political scale to the right.

Finally, the interaction hypothesis between trust and the use of information, trust and political identification will be tested.

4.2 Research Question and Hypothesis

The research aims to investigate the relationship between vaccination hesitancy and trust in government and health professionals and how this relationship varies across the EU countries, controlling for a set of contextual factors. Following a literature review and theoretical predisposition presented earlier, this research targets to test four main hypotheses:

- *People reporting high trust in government are less vaccine hesitant*
- *People reporting high trust in health professionals are less vaccine hesitant*
- *Citizens are more prone to having positive COVID-19 vaccination intentions in countries with higher political trust.*
- *Citizens are more likely to have positive COVID-19 vaccination intentions in countries with higher trust in health professionals.*

Second, this research posits several cross-level interaction hypotheses formulated as follows:

- *There is a cross-level effect between the political identification of citizens and trust in government on vaccination intention.*
- *There is a cross-level effect between political identification and trust in health professionals on vaccination intention.*
- *There is a cross-level effect between citizens' internet use and trust in the government on vaccination intention.*
- *There is a cross-level effect between citizens' internet use and trust in health professionals on vaccination intention.*

The analysis is grounded in the Eurobarometer data - the Standard Eurobarometer 94.3 and the Standard Eurobarometer 95.3 - the two were collected three months apart on behalf of the European Commission in the year 2021. Both datasets contain questions about respondents' vaccination attitudes, trust, and approval of the government's COVID-19 pandemic containment strategy. The two pooled cross-section datasets are analyzed together by building a united dataset. The countries included in the analysis are limited to the 27 current EU member states (see *Appendix I* for a list of countries and summary statistics). It includes united Germany as a single state and Ireland but excludes Great Britain from the analysis. Unfortunately, the Eurobarometer 95.3 does not have a question about trust in vaccination safety, so this variable has been excluded.

As the vaccination process unfolds in time, vaccination hesitancy changes too, as it is an attitude describing a continuum from agree to disagree with a middle – neither. Having included the wave as a time point in the analysis, we can detect changes in vaccination intention connected to time. Figure 6 demonstrates a basic two-level nested structure describing the underlying theoretical structure of the research problem. The dataset has one node per classification (or level). Nodes joined by a single arrow indicate a nested (strict hierarchical) relationship between the classifications. Individuals in each wave are the first-level units, while at the second level, we have specified contextual units with a specific space-time connotation, i.e., defined by the countries to which individuals belong and by the time of the interview (in terms of three-month periods beginning from March 2021; for example, a contextual unit is Italy March 2021 and Italy June 2021, and so on for other countries).

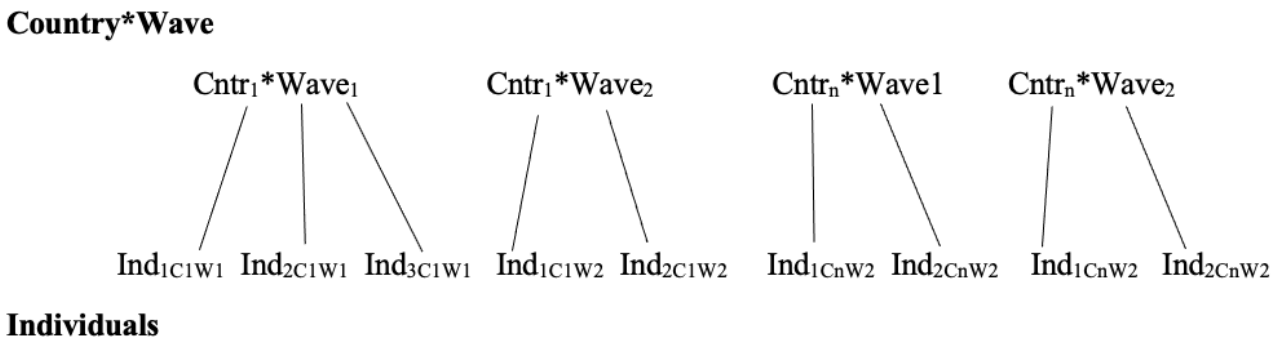


Figure 6 Unit diagram of a two-level nested structure; individuals in countries

The developed specification allows us to consider simultaneously both cross-country and temporal variations (Barone, Lucchini, and Sarti 2007). The influence of these contextual units on vaccination hesitancy can be additive for the individual effects (i.e., it shows up in the fixed values of the intercept), but it may also vary according to the individual features.

To implement this project, a 2-level mixed proportional odds model with a random slope for clustered data following Hedeker (2008) is used. Observations are nested in two levels – individual (or 1st level) and country-level (or second level); countries also could be referred to in this research as clusters. The dependent variable – is COVID-19 vaccination intention, and the independent variables – are trust in health professionals and trust in government (see Chapter 4, *Section 4.3 Operationalization of Concepts*). All three variables are measured at the individual level; however, to test the hypothesis of country-level trust effect on the individual intention to vaccinate against COVID-19, variables measuring trust have been transformed into cluster mean centred on easing the coefficient interpretation (Sommet and Morselli 2017).

The set of socio-demographic variables is identified as *control variables* (age, gender, age when finished education, social class, type of settlement, approval of government, political placement, and internet use). As second-level variables, this analysis employs GDP per capita in the year 2020 and previous attitudes to vaccination (safety and effectiveness) by country.

To answer the proposed research question and test the research hypothesis, this work follows a three-step "turnkey" procedure for multilevel logistic regression modelling (summarized in Figure 1, *Appendix I*) proposed in a "Keep Calm and Learn Multilevel Logistic Modeling: A Simplified Three-Step Procedure Using Stata, R, Mplus, and SPSS" by Nicolas Sommet and Davide Morselli (Sommet and Morselli 2017). The procedure introduces four steps:

- Preparing the data (including making decisions about centring independent variables).
- Building an empty model to assess the variation of the log-odds from one cluster to another.
- Building an intermediate model to assess the variation of the lower-level effects from one cluster to another.
- Building a final model to test the hypotheses.

4.3 Operationalization of Concepts

In this research, vaccination propensity is understood as acceptance of the COVID-19 vaccine in the following year and is measured as self-reported agreement to vaccinate. For this purpose, the question "*When would you like to get vaccinated against COVID-19 (coronavirus)*?" has been chosen in the Eurobarometer survey.

Vaccine hesitancy

Vax – Propensity to vaccinate against COVID-19 disease in the following year. The variable measures individual responses to a question: "*When would you like to get vaccinated against COVID-19 (coronavirus)*?". It takes values from:

1 – Never;

2 - Later;

3 - As soon as possible;

4 - I have already been vaccinated.

Political trust and trust in health professionals

trsthlth – Individual level trust in health professionals is measured as trust in health and medical staff in each country based on the question "*How much trust do you have in health and medical staff in (OUR COUNTRY)?*" where:

0 – tend not to trust;

1 – tend to trust.

govtrust – Individual trust in government, the index calculated as the mean average of two questions: "*How much trust do you have in the (NATIONALITY) Government?*" and "H*ow much trust do you have in the (NATIONALITY PARLIAMENT)?* Takes values:

1 – tend not to trust;

1.5 – median;

2 – tend to trust.

Control variables, individual level

A selection of typical individual-level control variables from the Eurobarometer surveys includes:

Sex – individual sex, the variable takes values:

0 - male,

1 - female.

Age - this variable represents the age group in which the respondent falls. The variable takes values:

18-24 years old;

25-34 years old;

35-44 years old;

45-54 years old;

55-64 years old;

65+ older.

Education - represents the age when the respondent obtained the highest education degree (continuous).

Community - type of settlement: this variable represents the type of settlement where the respondent lives. The variables take values from:

1 - rural area or village;

2 - small or middle size town;

3 - large town.

Netuse - Internet use index, measures how often the individual has access to the Internet, takes values:

1 - No Internet;

2 – Weekly;

3 – Everyday.

Placement – measures of self-reported political placement on a scale from left political ideology to the right political ideology. It is aggregated into three categories from:

1 – leaning toward the political left;

2 – leaning toward the political centre;

3 – leaning toward the political right.

Restrictions – represents approval of anti-COVID-19 restrictions in the country. The variable takes values:

0 - Not justified;

1 – Justified.

Control variables, second level

Gdp20 – the second-level variable, represents a yearly country value of Gross Domestic Product in the year 2020. A complete list of used variables and their specifications is presented in *Appendix II*, table 1. The analysis is conducted in Stata 17.0, and the null hypotheses that the estimated slope coefficients are equal to zero are rejected at the standard significance level of 0.05. In the Stata software version 17, the command used for the multilevel ordered logistic modelling will be *meologit*[32] (Stata, 2022).

4.4 Mixed Proportional Odds Model for Clustered Data

Whether the outcome variables are measured in a categorical way or as a series of ordered categories (Hedeker 2008), such outcomes are termed "ordinal" and can represent a variety of graded responses

[32] Stata.com, Multilevel mixed-effects ordered logistic regression. [Online] https://www.stata.com/manuals/memeologit.pdf, [Accessed on February 29, 2024]

such as ratings of severity (e.g., none, mild, moderate, and severe), agreement ratings (disagree, undecided, and agree), and Likert scales (e.g., strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree) (Bauer and Sterba 2011).

Outcomes like the Likert scale could be analyzed by 1) assuming a normal (continuous) distribution for the outcome or 2) being deliberately dichotomized from ordinal to a binary outcome. Treating the ordinal variable as a normally distributed continuous variable is a dubious assumption, often not standing normal distribution test (Hedeker 2008). As pointed out by McKelvey and Zavoina (1975), models for continuous data do not adjust for a so-called "ceiling and floor effect" (asymmetries caused by predominant lowest or highest category responses often derived from the truncation of the scales) of the dependent variable, which may lead to biased estimates of the regression slopes and incorrect conclusions (Bauer and Sterba 2011). Hence, ordinal models offer the advantage of accounting for the "ceiling and floor effects" of the ordinal variable if the outcome of interest is skewed, which is often the case in attitude studies where many of the responses are observed in the lowest and/or highest category of the ordinal outcome.

Alternatively, deliberate reduction of ordinal scale to bivariate leads to significant losses of precision and power, resulting in poorly estimated regression coefficients (Hedeker 2008). Assuming that power is a critical issue in small data sets, researchers should analyze ordinal outcomes as they are without scale reduction.

The ordinal logistic regression model, described as the proportional odds model by McCullagh (Hedeker 2008), provides a valuable approach to analyzing ordinal outcomes. For multilevel data, where observations are nested within clusters (e.g., classes, schools, and clinics) or are repeatedly assessed across time within subjects, mixed effects regression models (multilevel or hierarchical linear models) are often used to account for the dependency inherent in the data.

Models for ordinal outcomes often include the proportional odds assumption for model covariates. For an ordinal response with C categories, this assumption states that the effect of the covariate is the same across the $C-1$ cumulative logits of the model (or proportional across the cumulative odds). The idea is that if one did dichotomize the ordinal outcome and used a (binary) logistic regression model, the regression slopes would be equal, regardless of how one has done the dichotomization (e.g., for an ordinal variable with three categories, there are two possible dichotomizations: 1 vs 2 and 3, and 1 and 2 vs 3). An extension of this model exists – non-proportional odds for the covariates (Hedeker 2008).

Multilevel Ordered Logistic Model

In this research, a multilevel ordered logistic model (same as the mixed proportional odds model for clustered data) is used (Hedeker 2008). First, the cumulative response probabilities are introduced. Consider response variable *y*, which takes values 1, 2... *C*. Then *response probabilities* for each category are defined as:

Consider response variable *y*, which takes values 1, 2... *C*. We define *response probabilities* for each category as

$$Pr\ Pr\ (y = k)\ = \pi_k \quad (1)$$

where $\pi_1 + \pi_2 + \ldots + \pi_C = 1$

The cumulative response probabilities which reflect the ordering of the values of *y*, defined by γ_k the cumulative probability of being in category *k* or lower:

$$y_k = Pr(y \leq k) = \pi_1 + \pi_2 + \ldots + \pi_k \qquad (2)$$

where $\gamma_1 = \pi_1$ and $\gamma_C = 1$.

Equation (2) shows how cumulative probabilities are based on the response probabilities. We can also work backwards to derive response probabilities from cumulative probabilities using:

$$\pi_k = Pr(y = k) = Pr(y \leq k) - Pr(y \leq k - 1) = y_k + y_{k-1}$$

We begin by considering models for a single-level ordinal response. The cumulative logit model sometimes called the ordered logit model, is based on the cumulative response probabilities defined in (2) above. Suppose we have one continuous or binary explanatory variable *x*, then the model for the cumulative response probability for individual *i* (*i* = 1, . . ., *n*) can be written as:

$$log(\frac{Pr(y_i \leq k)}{Pr(y_i \leq k)}) = logit(y_{ki}) = \alpha_k + \beta x_i \qquad (3)$$

k=1, …, C-1

where α_k are referred to as threshold parameters (analogous to the intercept in a binary response model, and explained below), and β is the coefficient of *x*. The coefficient β is interpreted as the effect of a 1-unit change in *x* on the log odds of being in a lower category of *y* rather than a higher category. In this model, the effect of *x* is assumed to be constant wherever the lower category is fixed (this is the proportional odds assumption discussed below.) Thus, $\beta > 0$ implies that higher values of *x* are associated with lower values of *y*. This interpretation is counterintuitive because we are used to interpreting a positive regression coefficient as implying a positive

relationship between x and y. For this reason, (9.3) is sometimes written with a negative sign in front of β so that a positive value for β then implies a positive relationship. In this module, however, we will continue to write down models with positive signs for all coefficients, as in (9.3), but note that software packages differ in whether they output β or - β.

Model (3) also includes parameters α_k, which are referred to as cut-points or thresholds and can be interpreted as intercept terms. For example, α_2 is the log-odds of being in either category 1 or 2 (rather than three or above) for an individual with $x = 0$. While only one intercept is needed for a binary response (C=2), C-1 intercepts are required for an ordinal response with C categories. Furthermore, because we are modelling the logits of the cumulative response probabilities, which must necessarily increase with k, the intercepts must also be ordered with $\alpha_1 < \alpha_2 < \ldots \alpha_{C\text{-}1}$

Next, consider cumulative logit models for two-level structures where a total of n individuals (at Level 1) is nested within J groups (at Level 2) with n_j individuals in group j.

Begin in this section with a random intercept model. If we denote by y_{ij} the ordinal response for individual i in group j and x_{ij} an individual-level explanatory variable, a random intercept cumulative logit extension of (3) is

$$log(\frac{Pr(y_{ij} \leq k)}{Pr(y_{ij} \leq k)}) = logit(y_{kij}) = \alpha_k + \beta x_{ij} + u_j \qquad (4)$$

$$k=1, \ldots, C\text{-}1$$

where $u_j \sim N(0, \sigma^2_u)$ is the level 2 random effect or residual.

As in the single-level model, the thresholds, or intercepts α_k, allow the response probabilities $\pi_{kij} = \Pr(y_{ij} = k)$ to vary across response categories k. The parameter α_k is interpreted as the log odds that an individual with $x = 0$ and $u = 0$ has a response of k or lower.

The parameter β is the effect of a 1-unit change in x on the log odds that $y \leq k$, after adjusting for (or holding constant) the group effect u. We can think of β as the effect of x for individuals in the same group, so, as in the binary case, β is the cluster-specific effect of x.

The threshold α_k is the overall intercept in the linear relationship between the log odds that $y \leq k$ and x, where we have a different intercept for each category k (except for the last one C). In the random intercept model, the addition of the group-level residual u_j allows these intercepts to vary from group to group according to a normal distribution. This, in turn, allows the cumulative response probabilities, $\gamma_{kij} = \Pr(y_{ij} \leq k)$, and response probabilities, $\pi_{kij} = \Pr(y_{ij} = k)$, to vary across groups. This between-group variation is due to unobserved group-level influences on y (after

accounting for the effects of x) represented by u_j. We estimate $\text{var}(u_j)=\sigma^2_u$, which is the residual between-group variance in the log odds that $y \leq k$.

It is usual to have the same group residual affecting the log odds that $y \leq k$ for all categories k, which is consistent with the proportional odds assumption made for the effect of x. We could relax the proportional odds assumption by including a different random effect u_{kj} for each k, in addition to allowing the effect of x to depend on k, and the resulting model is equivalent to a multilevel multinomial logit model for a nominal response.

A Random Slope Cumulative Logit Model

The group-level random effect u_j in the random intercept model (4) allows the response probability for each category to vary from group to group. However, this model assumes that the effect of explanatory variable x is the same across all groups. Random slope models relax this assumption by allowing the effect of one or more x to vary randomly across groups. In this section, we describe a random slope extension of the cumulative logit model for ordinal responses.

A random slope cumulative logit model with a single explanatory variable x can be written:

$$log(\frac{Pr(y_{ij}\leq k)}{Pr(y_{ij}\leq k)}) = logit(y_{kij}) = \alpha_k + \beta x_{ij} + u_{0j} + u_{1j}x_{ij} \qquad (5)$$

$$k=1, \ldots, C-1$$

As in the continuous and binary case, we have added a new term $u_{1j}x_{ij}$, to the model and a '0' subscript to the intercept residual. Also, as before, the random effects u_{0j} and u_{1j} are assumed to follow a bivariate normal distribution with zero means, variances σ^2_{u0} and $\sigma^2_{u1,}$ respectively, and covariance σ_{u01}.

The slope of the linear relationship between x and the log-odds that $y \leq k$ is now $\beta + u_{1j}$ for group j. The covariance between the group intercepts and slopes is σ_{u01}. A positive covariance implies that groups with above-average probabilities of being in a low category of y ($u_{0j} > 0$) tend to have above-average slopes ($u_{1j} > 0$).

Proportional Odds

Another important point about model (3) is that β does not have a k subscript. Therefore, it does not specify a particular category when interpreting β as the effect of a 1-unit change in x on the log-odds of being in a lower category rather than a higher category of y: the effect is the same whether we compare category 1 versus categories 2, . . ., C or categories 1 and 2 versus categories 3, . . ., C.

The above property is known as the proportional odds assumption, and model (3) is often referred to as a *proportional odds model*. This assumption is commonly made, but it can and should be tested (Williams 2016).

In general, the extension of the proportional odds model is not problematic; however, one caveat should be mentioned. For the explanatory variables without proportional odds, the effects on the cumulative log odds, namely $(x*_{ij})' \beta_c$, result in $C - 1$ non-parallel regression lines. These regression lines inevitably cross for some values of x^*, leading to negative fitted values for the response probabilities (Hedeker 2008).

Tests of the proportional odds assumption can be performed by running and comparing models: (a) assuming proportional odds vs (b) relaxing proportional odds assumption. Comparing the model deviances (i.e., $-2log$ likelihood values) that are obtained from these two analyses provides a likelihood ratio test of the proportional odds assumption for the set of covariates under consideration.

The Intraclass Correlation

For a random-intercepts model (i.e., $z_j = 1_{nj}$), it is often of interest to express the level-2 variance in terms of an intraclass correlation. For the ordinal logistic model assuming normally distributed random effects, the estimated intraclass correlation equals:

$$ICC = \frac{\widehat{\sigma^2}}{(\widehat{\sigma^2} + \pi^2/3),} \qquad (6)$$

where the latter term in the denominator represents the variance of the underlying latent response tendency. As mentioned earlier, for the logistic model, this variable is assumed to be distributed as a standard logistic distribution with a variance equal to $\pi^2/3$.

The intraclass correlation (ICC) quantifies the degree of homogeneity of the outcome within clusters. It represents the proportion of the between-cluster variation in the total variation (Wu et al. 2012). The ICC may range from 0 to 1. ICC = 0 indicates perfect independence of residuals, i.e., the observations do not depend on cluster membership. When the ICC is not different from zero or negligible, one could consider running a traditional one-level regression analysis. However, ICC = 1 indicates perfect interdependence of residuals - the observations only vary between clusters.

4.4 Model Building Strategy

Step 1. Proportional Odds Test

Before performing the mixed proportional odds ordinal logistic model, the proportional odds assumption is tested using the Wald test. It performs a hypothesis test of the significance of the

difference in model coefficients, producing a chi-square statistic (McNulty 2021). A low p-value in a Brant-Wald test is an indicator that the coefficient does not satisfy the proportional odds assumption. In the Stata, the model with the dependent variable *vax* and the complete set of control and dependent variables (separately each) will be tested using Wald statistics in the *ologit* package.

Step 2. Building an Empty Model

The first step of the analysis requires us to run an empty model, that is, a model containing no predictors and calculate the intraclass correlation coefficient (ICC). This will allow us to estimate the proportion of variability in the vaccination intention that lies between countries. The empty two-level ordinal logistic regression model can be written as

$$\text{logit } \{\Pr(y_i > s)\} = u_j - \kappa_s, \; s = 1,2,3,4$$

$$u_j \sim N(0, \sigma_u^2)$$

Where u_j is a normally distributed state random effect with mean zero and variance σ_u^2 , a model parameter to be estimated.

Step 3. Building an Intermediate Model

After examination of ICC, this analysis proceeds to calculate the effect of the lower-level variables. In the first step, the random variations are tested to estimate the variation of the effect of the individual political trust and trust in health professionals on the odds of getting vaccinated between the EU countries, expecting it to depend on country characteristics. To do so, (a) the constrained intermediate model is run first, (b) an augmented intermediate model (AIM) is performed and (c) compared against the constrained model.

The intermediate model contains controlling variables, all level-1 variables, and all level-2 variables but does not contain cross-level interactions since the model precisely aims to estimate the *unexplained* variation of lower-level effects. This model equation is shown below

$$\text{logit } \{\Pr(y_i > s|x_{ij})\} = \beta_0 x_{ij} + \beta_1 x_{ij} + u_j - \kappa_s, \; s = 1,2,3,4$$

$$u_j \sim N(0, \sigma_u^2)$$

The augmented intermediate model equation is shown below:

$$\text{logit } \{\Pr(y_i > s|x_{ij})\} = \beta_0 x_{ij} + \beta_1 x_{ij} + u_{0j} + u_{1j} x_{ij} - \kappa_s, \qquad s = 1,2,3,4$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim N\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{01} & \sigma_{u1}^2 \end{pmatrix}\right\}$$

Where u_{0j} and u_{1j} denote the state intercept and slope random effects assumed bivariate normally distributed with zero means variances σ^2_{u0} and σ^2_{u1} and covariance σ_{u01}.

In other words, the goal is to determine whether considering the cluster-based variation of the effect of the lower-level variable improves the model. To do so, after gathering or storing the deviance of the CIM and AIM, a likelihood-ratio test will be performed, noted LR χ^2.

It should be noted that the two dimensions of trust evolved in this research – trust in government and trust in health professionals – and will be evaluated separately to avoid over-parametrization of the model and make it easier to interpret.

Step 4. Building the Final Model

At this step, it is possible to assess the effect of the relevant lower-level variable varying from one cluster to another, and it is possible to test the discussed earlier hypotheses. Hence, the final model includes all controls, predictors, and cross-level interactions. The model can be written as:

$$\text{logit}\ \{\Pr(y_i > s|x_{ij})\} = \beta_1 \text{sex}_{ij} + \beta_2 \text{age}_{ij} + \beta_3 \text{edu}_{ij} + \beta_4 \text{netuse\_c}_{ij} + \beta_5 \text{polit\_c}_{ij} + \beta_6 \text{typecmty}_{ij} + \beta_7 \text{ebid}_{ij} + \beta_8 \text{restrap}_{ij} + \beta_9 \text{gdp20}_{ij} + \beta_{10} \text{vaxsafe}_{ij} + \beta_{11} \text{vaxeffect}_{ij} + \beta_{12} \text{trsthlth}_{ij} + \beta_{13} \text{trust\_cmc*netuse\_c}_{ij} + \beta_{13} \text{trust\_cmc\#\#polit\_c}_{ij} + u_0 + u_j \text{trsthlth}_{ij} - \kappa s,\ s = 1,2,3$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim N\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{u0} & \\ \sigma_{01} & \sigma^2_{u1} \end{pmatrix}\right\}$$

This model incorporates random intercept, a random slope for cluster-centered trust, and two cross-level interaction variables to test the hypothesis about the connection between a) trust and Internet use and b) trust and political placement from left to right on a scale.

Section 5. Data Analysis and Results

5.1 Socio-demographic Characteristics and Descriptive Statistics

The multilevel modelling has been implemented as described in Subsection 4.4 *Model Building Strategy*. Before presenting multilevel regression results, the main socio-demographic characteristics of the sample and correlation analysis of the variables are discussed. The goal of this section is to acquaint readers with the dataset and to study its prior main analysis to discover unusual patterns or outliers that could potentially alter results or tested hypotheses.

This research employs two datasets – the Standard Eurobarometer 94.3 (ZA No. 7780) and the Standard Eurobarometer 95.3 (ZA No. 7783). The Eurobarometer is a regular series of biannual sociological surveys that started in 2007. The survey is focused on monitoring key trends relevant to the European Union as a whole, European Commission priorities, and contemporary socio-political events. The Standard Eurobarometer surveys are generally conducted in a face-to-face interview format in all EU Member States and some additional countries and territories[33].

To guarantee the representativeness of results, the Eurobarometer surveys rely on a randomly selected sample of at least 1000 persons aged 15 years and more per country or territory reported. A sample size of 500 persons is used in countries or territories with a population of below one million inhabitants. In most cases, respondents for Eurobarometer surveys are selected randomly, and the total sample is weighted to ensure demographic and geographical representativeness.

Eurobarometer surveys may employ different methodological approaches, depending on the type or topic of the survey. Each survey publication contains technical specifications and explanations on the methodology and sample size used in each of the countries or territories surveyed, as well as information on confidence levels. For face-to-face mode, computer-assisted personal interviewing (CAPI) is performed. It relies on a random selection of participants who are interviewed in their homes in the national language(s) of the country they are being interviewed in.

The Eurobarometer 94.3 and 95.3 were collected three months apart in the year 2021. They were designed and implemented as described above, and both datasets were accessed through GESIS. The countries included in the analysis are limited to the 27 current EU member states – it includes united Germany as a single state and Ireland but excludes Great Britain from the analysis (Table 2).

[33] European Union. Eurobarometer. About the Eurobarometer, [Online] https://europa.eu/eurobarometer/about/eurobarometer [Accessed on September 25, 2023]

Table 2. List of countries included in the survey and their respective sample size

	February-March 2021	**June-July 2021**	**Total number of observations**
France	988	981	1969
Belgium	1046	999	2045
The Netherlands	988	1028	2016
Germany	1062	1001	2063
Italy	992	992	1984
Luxembourg	596	508	1104
Denmark	1006	997	2003
Ireland	1084	1015	2099
Greece	1037	994	2031
Spain	985	967	1952
Portugal	109	974	2064
Finland	1097	997	2094
Sweden	1098	1005	2103
Austria	1004	987	1991
Cyprus	490	494	984
Czech Republic	1097	1074	2171
Estonia	1048	1013	2061
Hungary	1037	1011	2048
Latvia	1034	1039	2073
Lithuania	1034	990	2024
Malta	524	488	1012
Poland	1027	995	2022
Slovakia	1118	990	2108
Slovenia	1025	996	2021
Bulgaria	1003	1002	2005
Romania	990	1016	2006
Croatia	1017	1004	2021
Total	26517	25557	52074

As was described in Subsection 4.2 *Research Question and Hypothesis,* the joint dataset of the two surveys has been created, for which each dataset has been cleaned from missing values (recorded in a unified code – .m). All variables of interest have been harmonized to make comparison possible. After harmonization, the two datasets were unified at once through append command by an individual identification number in Stata 17 software. After that, the contextual data about the country's per capita GDP in the year 2020 was added to the dataset using the country name as an identification variable.

Data preparation resulted in a unified two-time point two-level dataset, allowing the test of the research hypothesis. Individuals are located in the first-level units, while at the second level, we have specified contextual units with a specific space-time connotation, i.e., defined by the countries to which individuals belong and by the time of the interview (in terms of three-month periods beginning from March 2021; for example, a contextual unit is Italy March 2021 and Italy June 2021, and so on for other countries). This specification allows us to consider simultaneously both cross-country and temporal variations (Barone et al. 2007). The influence of these contextual units on vaccination hesitancy can be additive for the individual effects (i.e., it shows up in the fixed values of the intercept), but it may also vary according to the individual features.

The main descriptive statistics of variables used in the survey are presented in Table 3. The total number of observations is 51,496 (with a total of 26233 in Wave 1 and a total of 25,263 in Wave 2). Women account for 53% of the total sample, leading age group – 55-64 years old, the least populated group is the youngest from 18 to 24 years old, it constitutes only 7% of observations. Most of the sample had at least finished high school. The internet usage index shows little to no variation as almost all respondents use the internet every day or at least 2 times a week (89%), and 10% do not have access at all.

According to Table 3, we conclude that political self-placement is skewed to the left, with the majority identifying as a centre (41%), 30% on the left of the political scale, and about 29% on the right side of the scale. Similar distributional patterns are observed in singled-out samples (the Eurobarometer 943 and the Eurobarometer 953, tables 1 and 2 in *Appendix IV* accordingly).

Table 3 Main descriptive statistics of the pooled dataset

Variable	**N. Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Intention to get vaccinated	51496	3.179	1.092	1	4
Sex					
Male	52030	0.469	0.499	0	1
Female	52030	0.531	0.499	0	1
Age groups					
18-24 years	52.072	0.731	0.260	0	1
25-34 years	52.072	0.134	0.340	0	1
35-44 years	52.072	0.167	0.373	0	1
45-54 years	52.072	0.189	0.392	0	1
55-64 years	52.072	0.191	0.393	0	1
65+ years	52.072	0.247	0.431	0	1
Years spent obtaining current educational level					
No/still studying	49228	0.069	0.254	0	1
Up to 15	49228	0.096	0.294	0	1
16-19 years	49228	0.389	0.488	0	1
20+ years	49228	0.446	0.497	0	1
Internet use index					
No Internet access	52074	0.096	0.295	0	1
Weekly	52074	0.011	0.103	0	1
Everyday	52074	0.893	0.309	0	1
Political placement					
Left	48458	0.303	0.460	0	1
Center	48458	0.409	0.492	0	1
Right	48458	0.287	0.453	0	1
Type of community					
Rural area or village	52068	0.314	0.464	0	1
Small or middle size town	52068	0.367	0.482	0	1
Large town	52068	0.318	0.466	0	1
Trust in health professionals	51229	0.8	0.4	0	1
Trust in government	51028	-0.218	0.902	-1	1
Restriction approval	51724	0.728	0.445	0	1
GDP in 2020	52074	46020.12	17938.2	25293.7	118961.5

Trust in health professionals is remarkably high in the total sample; it has a mean value of 0.8 and a standard deviation (S.D.) of 0.4, meaning there is variation between countries, but even in a country with the lowest trust in health professionals, it is still higher than the scale mean. Trust in government has been centred on a scale with a mean of 0 and standard deviation of 0.5, yet data show trust in government is skewed to the left (mean = -0.22) and great S.D. (0.9), which signals a larger variation between countries compared to trust in health authorities. Finally, restrictions approval is skewed to the right (mean = 0.73, and S.D. = 0.4), indicating that this variable is potentially significant enough to be included in the regression equation as an independent predictor to account for its effects. Summary statistics of the variables measuring trust are in tables 1 – 6 in *Appendix V*, showing the distribution of a total sample.

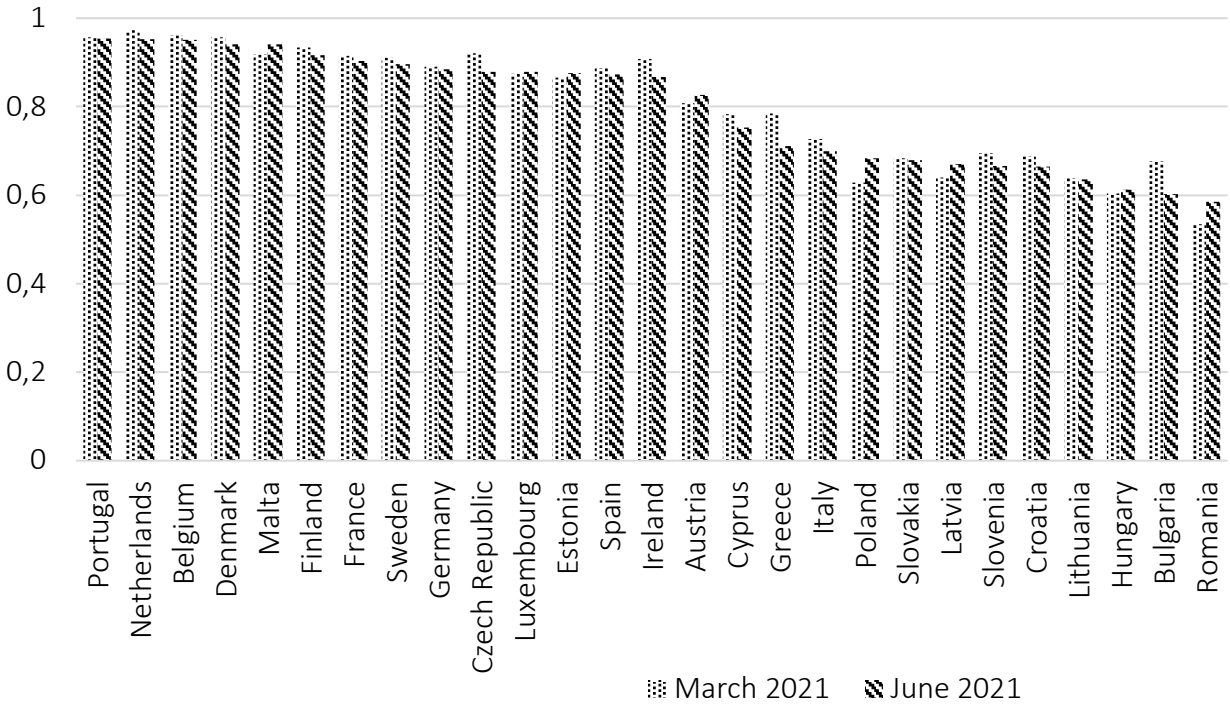


Image 5 Trust in health professionals, by country, in descending order from highest to lowest

Images 5 and 6 present the reader with the distribution of trust in health professionals and trust in government (respectively) between the two survey waves. These images help to understand the dynamics of trust and detect any potential outliers in the dataset. Minor differences in the level of trust in health authorities are seen (Image 5). In countries with a prominent level of trust, there is no change with time, but in countries with lower levels during the first wave of survey in some cases (Greece and Bulgaria), trust declines in the second wave; in Poland and Romania, trust in health professionals rose from February to June. Image 6 demonstrates the mean values for the variable trust in government. Similarly,

the distribution of trust in health professionals in government changes within two waves of the survey. This change is more prominent than changes in trust in health authorities. According to this distribution, in Sweden, the Netherlands, Germany, Estonia, and Portugal, trust decreased. In Italy, Austria, Cyprus, and the Chech Republic, trust in government increased between the two waves. An important conclusion of this section is that the two types of trust analyzed here have different distributions; hence, they could have different impacts on vaccination hesitancy at the country level.

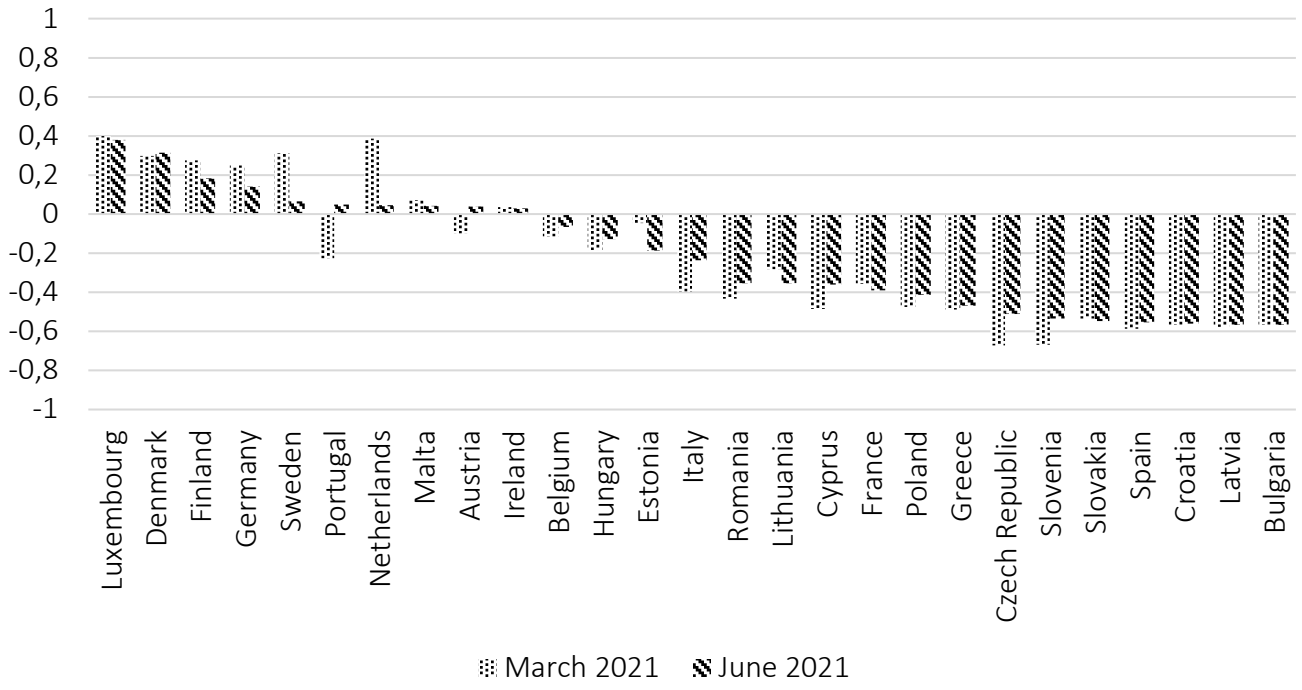


Image 6 Trust in national government by country and wave of the survey, descending order from highest to lowest

In the aggregated sample, about 12% of respondents express vaccination hesitancy, refusing to vaccinate, 15% will vaccinate "sometime later", other 15% will vaccinate in the year 2021, and finally, 58% express willingness to vaccinate as soon as possible (Image 7). Together with the hesitant population, the proportion of vaccine acceptors totals 88%. The same question is best examined by looking separately at survey waves, as this shows the changes in vaccine attitudes.

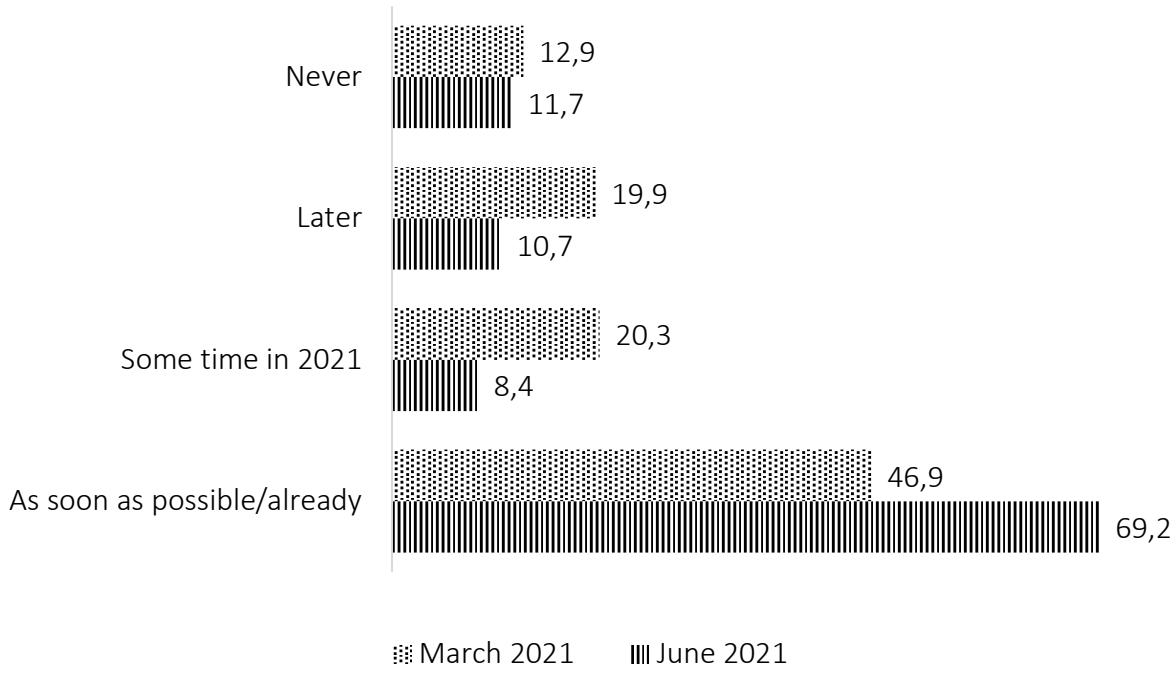


Image 7 Joint distribution for Wave 1 and Wave 2 of the vaccine hesitancy

From Image 7 the time effect is seen clearly, as responses shift from the hesitant categories to the total acceptance. This shift happens predominantly from the groups of hesitant respondents. The group of respondents who refuse vaccination is stable at 12-11%. This difference in attitudes to vaccination and its significance for future research in the field, as well as its importance for policy development, will be discussed later in this project. Below is presented the country's mean distribution of vaccine hesitancy (see Images 8 and 9).

The distribution of vaccine hesitancy between countries is vast, both between countries and between the waves. A survey of vaccine hesitancy performed in February–March of 2021, when vaccines first appeared in Europe, showed countries, mainly Eastern Europe, with the lowest vaccine acceptance (Bulgaria and Croatia) and highest in Western countries – Denmark, for example (Image 8). After a three-month break, a survey performed in June-July of 2021 registered changes in the level of vaccine hesitancy. Overall, the distribution preserves – Eastern countries are more hesitant, whereas Western countries are less hesitant (Image 9). Yet, overall, even hesitant countries become more accepting of the COVID-19 vaccine. This change is due to time – vaccines had become more available by summer 2021, and more people had the chance to be vaccinated.

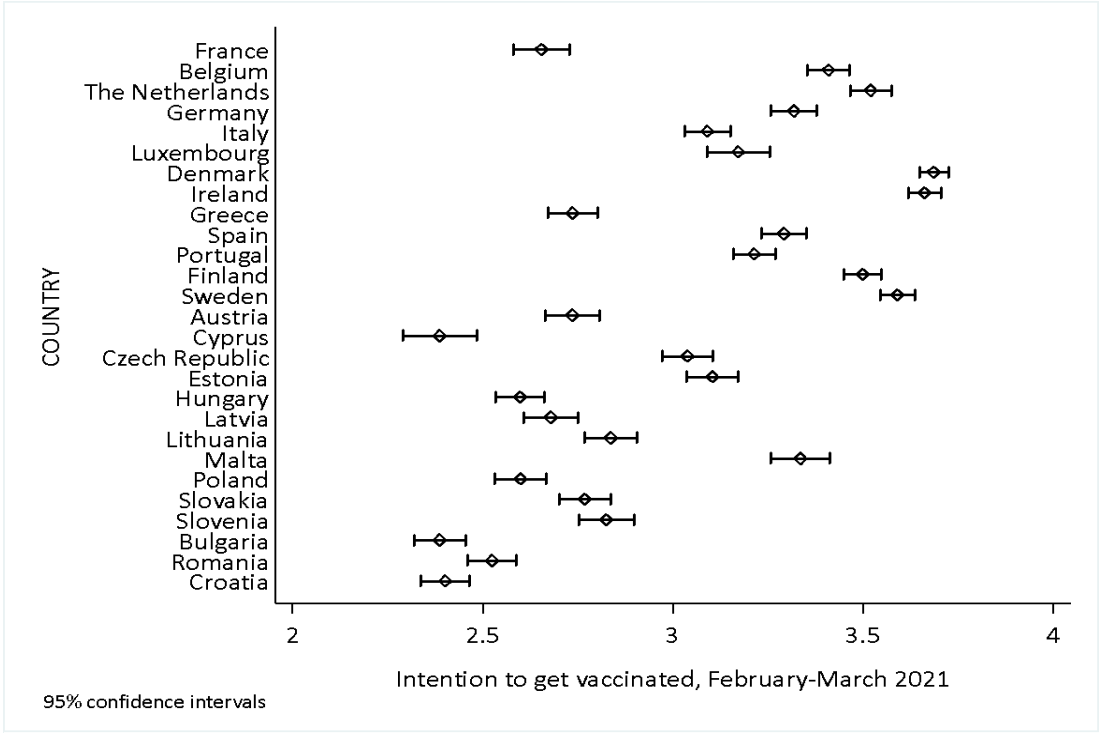


Image 8 By country distribution of the vaccine hesitancy in wave 1, February-March 2021, 95% confidence interval

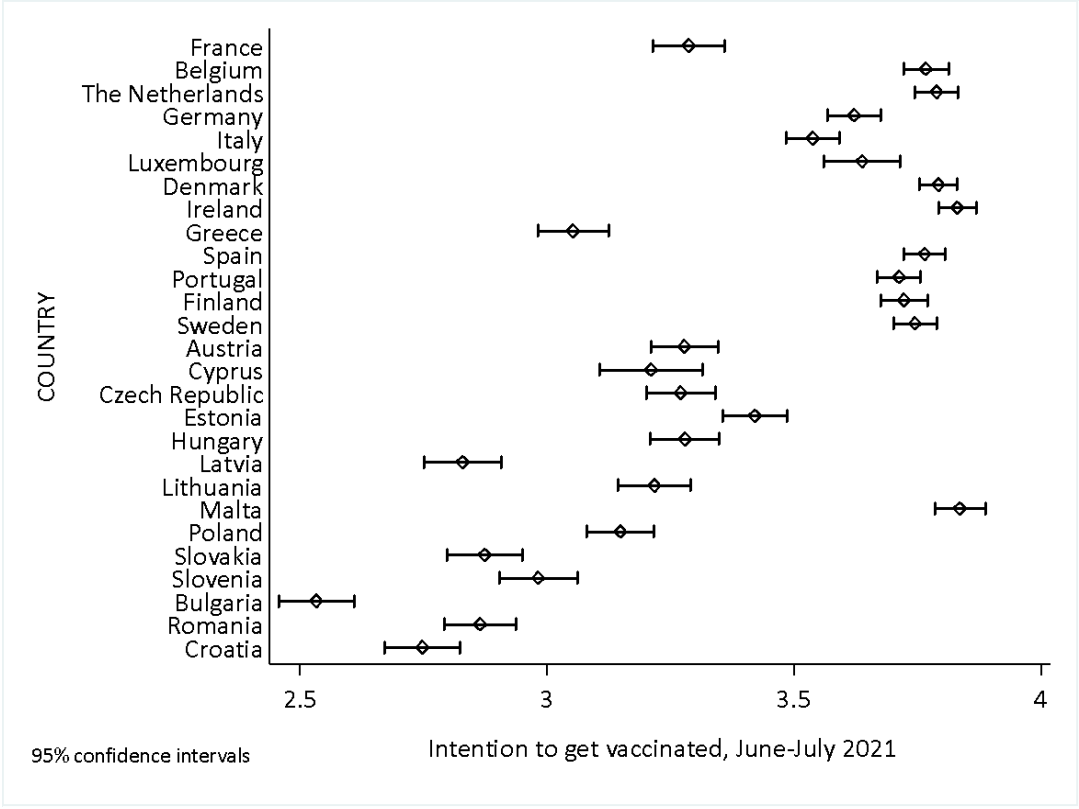


Image 9 By country distribution of the vaccine hesitancy in wave 2, June-July 2021, 95% confidence interval

5.2 Bivariate Correlations

An analysis of correlations between the individual-level variables shows that most of the variables statistically significantly correlate with each other. However, in most cases, the coefficients are too small to be treated as a potential problem for regression model estimates (see *Appendix III* for the respective correlation matrixes). Vaccination intention is positively associated with:

- gender (women are more hesitant);
- age (older people are less hesitant);
- education, the less educated population shows more hesitancy;
- social class positively correlates with vaccine acceptance;
- political placement correlates negatively with vaccine acceptance, i.e., the further on the right side of the scale, the more hesitant individuals are;
- trust in government has a significant positive correlation with vaccine acceptance;
- a similar positive significant relationship is registered with vaccine acceptance and trust in health authorities;
- approval of pandemic restrictions is also positively correlated with vaccine acceptance.

The correlation between second-level variables and vaccination intention is positive and significant *(Appendix III)*. There is a small negative but statistically significant correlation between gender and vaccine hesitancy ($r = -0.03$, p-value < 0.05), a positive statistically significant correlation between vaccine hesitancy and age, years of education, as predicted by a literature review($r = 0.2$, p-value < 0.05, $r = 0.08$, p-value < 0.05, respectively) - older people and people with more years of education are less hesitant towards vaccine. A small negative but statistically significant correlation between vaccine hesitancy and political placement ($r = -0.02$, p-value < 0.05), meaning that the right-leaning population is more vaccine-hesitant.

Trust in government and trust in health professionals positively and significantly correlate with vaccine hesitancy, meaning the less hesitant report higher trust in government or trust in health professionals ($r = 0.27$, p-value < 0.05, $r = 0.29$, p-value < 0.05, respectively). Another variable highly and positively correlated with vaccine hesitancy is approval of COVID-19 restrictions ($r = 0.38$, p-value < 0.05). Trust in government and trust in health professionals are correlated constructs but show a modest size of correlation – 0.29 (p-value < 0.05). Restriction approval and trust in government correlate at a level of 0.34 (p-value < 0.05), and with trust in health authorities at 0.27 (p-value < 0.05). Country-level GDP correlates with all three variables discussed above – trust in government ($r = 0.24$, p-value < 0.05), trust in health professionals ($r = 0.17$, p-value < 0.05), and restrictions approval ($r = 0.15$, p-value < 0.05),

meaning that population in more developed countries report higher levels of trust and approval of government.

There are changes in correlations between the two waves. In the second wave, the relationship between political placement and attitudes to vaccination disappears. Overall, with time, socio-economic variables lose in the effect size and significance, yet the correlation between trust variables and vaccination acceptance remains constant and positive. Described correlations are expected and similar to those shown in the reviewed literature. This fact provides additional support for this research.

5.3 Regression Results

As described in Subsection 4.4 *Model Building Strategy*, the analysis comprises four steps. First, the variables have been centred on allocating on the same scale and on easing the interpretation, centred variables are – trust in government, trust in health authorities, internet use index, and political placement. Second, the proportional odds assumption test was performed, which yielded negative results. Performed Wald test rejects the proportional odds assumption, which may result in underestimation of regression coefficients (Harrell 2020; Williams 2016). However, violation of the proportional odds assumption does not bias the direction of the effects; thus, it is still possible to yield unbiased general effects of the dependent variable on the independent and discuss general direction. Considering this and that, in general, tests for proportionality have been shown to lack statistical power and are anticonservative (O'Connell 2006) as well as not widely available, it was decided to do this research using the proportional odds model for 2-level data.

According to the procedure described in Subsection 4.4, models 1 and 2 are intermediates to test which model is the better fit for data. Model 1 only accounts for random intercept, and model 2 for random intercept and slope. Model 3 – is a model for random intercept, slope and cross-level effects.

The empty 2-level model was evaluated. Results show high variability at the second level. The ICC is equal to 0.215, which corresponds to 22% of the total variation of vaccination hesitancy explained at the country level. The estimated between-state variance is 0.9 (SE=0.18). In image 10, the estimates of the state effects or residuals $\hat{u_j}$ obtained from the null model presented.

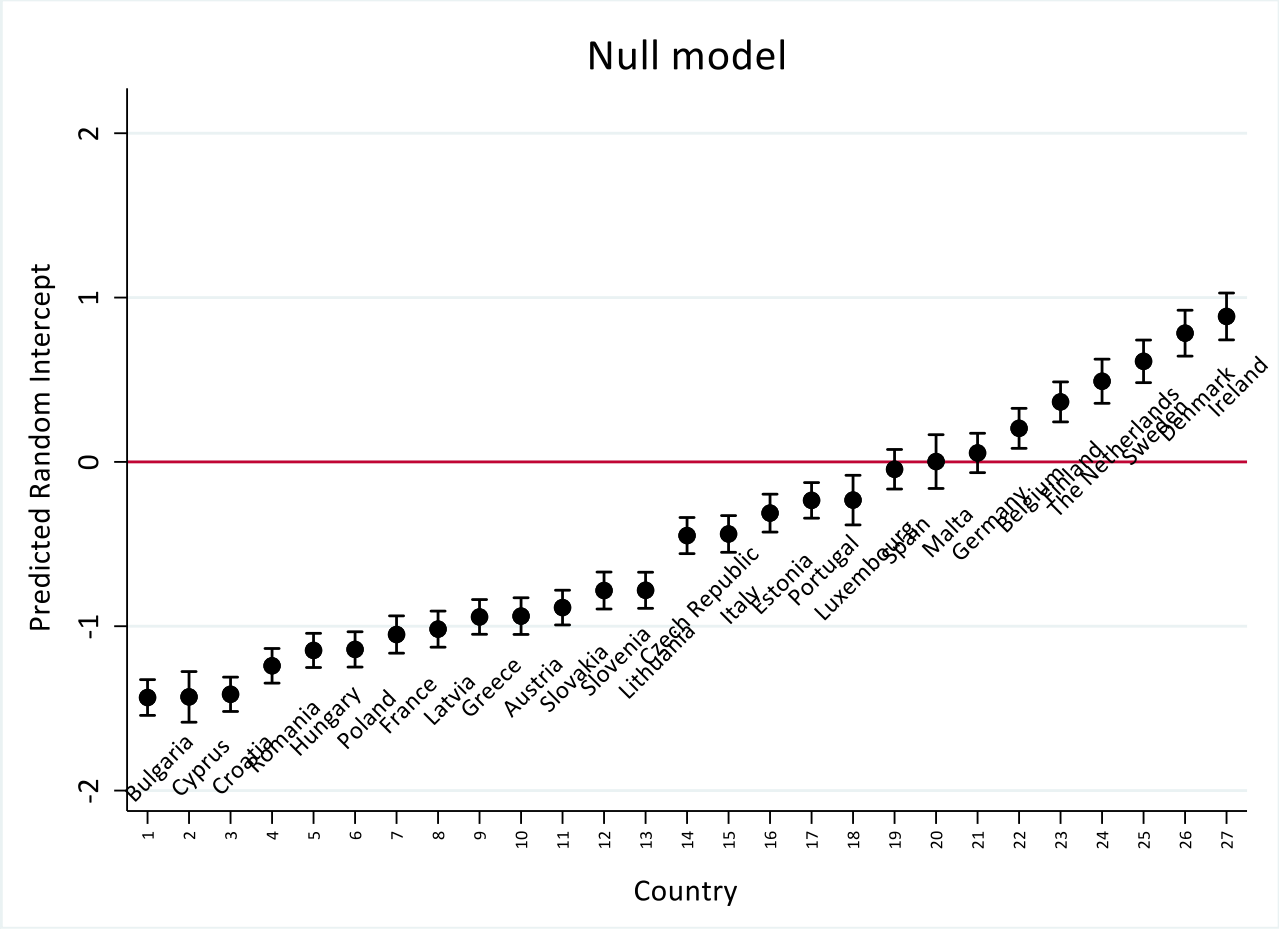


Image 10 The state effects are shown in rank order together

The plot in Image 10 shows the estimated residuals for the 27 EU states. For a substantial number of states, the 95% confidence interval does not overlap zero, indicating that vaccination hesitancy is significantly above average (above the zero line) or below average (below the zero line) at the 5% level for these states with 95% confidence intervals.

The next stage consisted of adding the individual- and 2-level variables into the model. Since trust in government and trust in health professionals had been estimated separately, this section reports obtained results separately. It starts with presenting estimations of trust in health professionals.

The addition of individual and 2-level variables into the model further decreases the ICC down to 8%, which is a sign that the proposed set of variables shows a good data fit. The statistical analysis shows that almost every variable used as a control has a statistically significant relationship with the dependent variable (resulting tables containing complete lists of independent variables are given in *Appendix VI*).

The variable of interest - trust in health professionals - is a statistically significant predictor of vaccination hesitancy (Table 4, odds ratios reported, standard errors in parentheses). Estimated odds

ratios suggest that for a one-unit increase in vaccination intention, the odds of high trust in health professionals versus the combined middle and low are 2.1 times greater, given the other variables are held constant in the model.

In the next step, individual-level trust in health authorities was added to the model at the country level to test whether some of the individual-level predictors have a different effect for each group or region, as in the case of this study. According to the results, trust in health professionals is a significant predictor of vaccination propensity at the country level, which confirms the hypothesis about the contextual effect of trust within countries.

Table 4 2-level ordinal logistic model, trust in health professionals and vaccination propensity

	Null	**Individual and 2-level variables**	**Random effect**	**Random effect, cross-level interaction**
Constant	2.466***	1.348***	1.160***	1.273***
	(0.432)	(0.081)	(0.033)	(0.082)
Intercept variance			1.293***	1.111***
			(0.062)	(0.033)
Controls individual level		Yes	Yes	Yes
Controls 2-level		Yes	Yes	Yes
Individual trust in health professionals		2.097***	2.478***	2.060***
		(0.054)	(0.154)	(0.287)
Trust in health professionals (country level)			1.293***	1.111***
			(0.062)	(0.033)
Country trust in health professionals *Netuse				1.081***
				(0.019)
Country trust in health professionals *Political placement				0.943*
				(0.031)
Observations	51496	44580	44580	44580
Number of groups	54	54	54	54
ICC	0.215	0.083	0.043	0.068
	(0.033)	(0.015)	(0.008)	(0.017)
LR chi2		22889.78	159.09	25.96
Prob > chi2		0.000	0.000	0.000

Odds ratios

Standard errors in parentheses, P-values *** p<0.01, ** p<0.05, * p<0.1

Finally, the model with cross-level effects was estimated. Results suggest an interaction effect between internet use and political placement. The ICC for this model is 7%, suggesting variance in the dependent variable is explained by country differences. The introduction of cross-level variables affected constant – it rose from 1.16 to 1.27 – and slightly decreased intercept variance from 1.29 to 1.11. Cross-level interactional effects between internet use and trust in health professionals, as well as trust and political placement, are significant. The Likelihood Ratio test concludes that the last model accounting for individual and 2-level variables, random effect and cross-level effect, is the best fit for the use of data.

Comparing two images of predicted random effects for an empty model and a model that accounts for all controls, a special dimension is added to the analysis. The empty model shows significant variability between countries. The model that accounts for controls shows less variability (see Image 11), and the intercepts are smaller and include zero, meaning they are not substantially different. Only some countries are below the average line – Romania, Croatia, Greece, Cyprus, and Luxemburg. Belgium is slightly above the average. Obtained results suggest that individual trust in health professionals has the potential to explain vaccination hesitancy at individual and country levels, i.e., is a contextual variable.

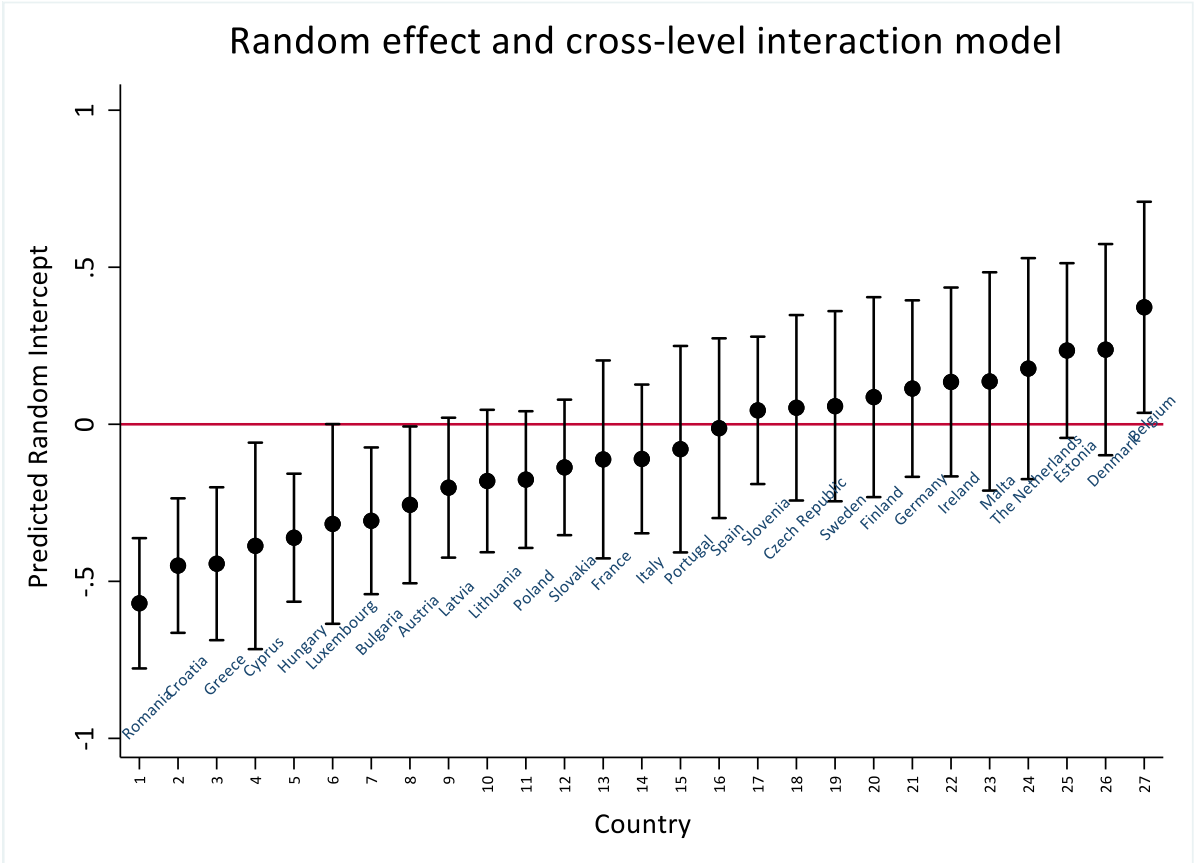


Image 11 The state effects are shown in rank order by country, random intercept, random slope and cross-level effects model

Table 5 summarizes the results obtained, reporting probability odds and standard errors (in parenthesis) for the variable of interest – trust in government. In the final model, the individual-level and country-level associations between trust and vaccination intention are assessed, including their interactions with the level of political placement and use of the internet.

The empty model estimations are the same as for the previous analysis. The addition of individual and 2-level variables into the model decreases the ICC to 9% from 22% in an empty model, again suggesting a good data fit. The statistical analysis shows that almost every variable used as a control has a statistically significant relationship with the dependent variable (the resulting table containing a complete list of independent variables is given in *Appendix VII*).

The variable of interest - trust in government - is a statistically significant predictor of vaccination hesitancy (Table 5, odds ratios reported, standard errors in parentheses). Estimated odds ratios suggest that for a one-unit increase in vaccination intention, the odds of high trust in health professionals versus the combined middle and low are 1.3 times greater, given that the other variables are held constant in the model. This is lower than the odds ratios of trust to health professionals.

Table 5 Multilevel regression model random intercept and random slope, trust in government cluster mean

	Null	**Individual and 2-level variables**	**Random effect**	**Random effect, cross-level interaction**
Constant	2.466***	1.405***	1.404***	1.401***
	(0.432)	(0.095)	(0.096)	(0.095)
Intercept variance			1.036***	1.037***
			(0.01)	(0.01)
Controls individual level		Yes	Yes	Yes
Controls 2-level		Yes	Yes	Yes
Individual trust in government		1.314***	1.329***	1.484***
		(0.017)	(0.039)	(0.111)
Trust in government (country level)			1.036***	1.037***
			(0.009)	(0.009)
Country trust*Netuse				0.980
				(0.021)

Country Trust*Political placement				0.974* (0.016)
Observations	51496	44447	44447	44447
Number of groups	54	54	54	54
ICC	0.215 (0.033)	0.094 (0.017)	0.094 (0.017)	0.093 (0.017)
LR chi2		22629.24	112.80	3.67
Prob > chi2		0.000	0.000	0.299

Odds ratios

Standard errors in parentheses, P-values *** p<0.01, ** p<0.05, * p<0.1

Next, the random effect – individual-level trust in government – was added to the model at the country level. It tests whether some of the individual-level predictors have a different effect for each group or region in the case of this study. Random effects of trust in government are also a significant predictor of vaccination propensity, meaning that countries with higher trust in health professionals have higher vaccination propensity. The Loglikelihood test suggests a good model fit, but the ICC is at the same level (0.94), meaning that the addition of new variables did not explain more variance.

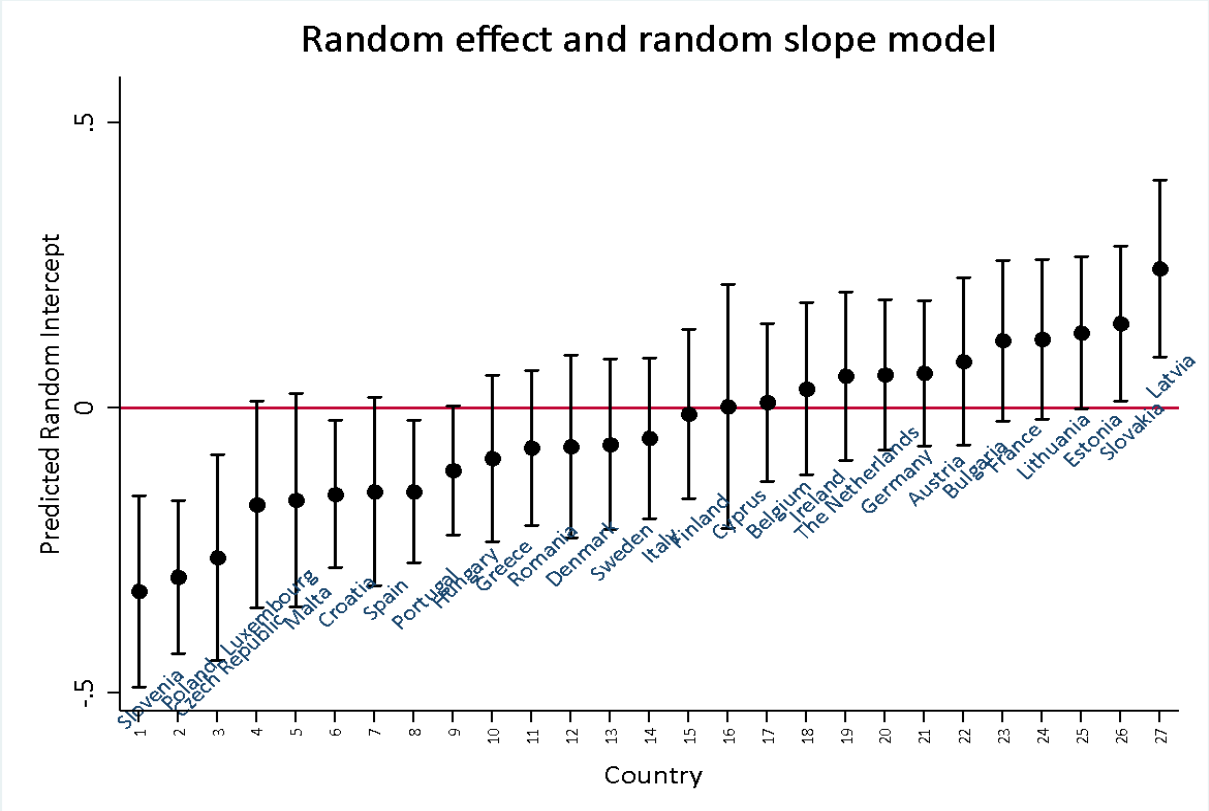


Image 12 The state effects are shown in rank order by country, random intercept, and random slope model

The last estimated model included cross-level effects. Contrary to previous results, there are no significant effects of cross-level interactions between trust in government and internet use and political placement. The ICC is at the same level, and the Loglikelihood test is insignificant, indicating poor model fit. A model with a random effect of individual trust in government added on a country level is the best fit.

Image 12 shows predicted random effects for random intercept and random slope model and trust in government. Comparing plotted predicted intercepts, this research concludes like previously reported results – trust in government acts as an individual and contextual determinant of vaccination hesitancy. Though its effects are smaller than trust in health professionals, it is a powerful tool to explain between-country variance in vaccination hesitance.

Whereas the empty model shows bigger variability between countries, the model that accounts for controls shows less variability. The intercepts are smaller and include zero – meaning they are not substantially different. Only some countries are below the average line – Slovenia, Poland, Czech Republic, Malta, Spain, Greece, Cyprus, and Luxemburg. Slovakia and Latvia are above the average. The primary goal of this research was to investigate the contextual effects of trust and vaccine hesitancy. In the course of this work, several hypotheses have been tested. We conclude that the central hypothesis is supported by the current analysis.

Finally, to ensure the reliability and validity of statistical models, a robustness check was performed by examining the impact of various mathematical functions for independent variables, ranging from linear to squared and logarithmical transformations. The goal was to assess whether the original model was correctly specified and whether its results could withstand alternative specifications. The findings reveal that, despite the variation in independent variable specifications, the obtained results consistently align with those of the basic model. These results provide confidence in the reliability and stability of the research model, reinforcing its suitability for understanding and explaining the underlying phenomenon.

Chapter 6. Discussion

Vaccines are regarded as the most successful public health intervention for preventing infectious diseases (Augsburger et al. 2023), nonetheless, they are sometimes questioned regarding their efficacy and safety (Dubé et al. 2018; Dubé and MacDonald 2016). In Europe, vaccine hesitancy has been growing steadily in the past two decades, raising concerns among policymakers and contributing to the resurgence of some infectious diseases. During the COVID-19 pandemic vaccine hesitancy highlighted a striking decline of trust in health professionals, science and government. In this work we aimed to test a set of research hypotheses of trust connection to vaccination hesitancy in EU countries, controlling for contextual factors. Following a literature review and theoretical predisposition presented earlier, eight different hypotheses had been tested:

- *People reporting high trust in government are less vaccine hesitant;*
- *People reporting high trust in health professionals are less vaccine hesitant;*
- *Citizens are more prone to having positive anti-COVID-19 vaccination intentions in countries with higher political trust;*
- *Citizens are more likely to have positive anti-COVID-19 vaccination intentions in countries with higher trust in health professionals;*
- *There is a cross-level effect between the political identification and trust in government on vaccination intention;*
- *There is a cross-level effect on vaccination intention between political identification and trust in health professionals;*
- *There is a cross-level effect between citizens' internet use and trust in the government on vaccination intention;*
- *There is a cross-level effect between citizens' internet use and trust in health professionals on vaccination intention.*

The first hypotheses were the basic ones and were the primary interest of the study. In contrast, the other four hypotheses were supplementary to this study and served to clarify the nature of the relationship between trust and hesitancy. Results indicate that citizens with higher trust in the government are more prone to accept the coronavirus vaccine, confirming trust's previously theorised positive role in making health decisions. The same result holds for the role of trust in health professionals, less hesitant people are more trusting to health workers. Overall, the results support empirical observations – "… *accepting*

vaccination, the public relies on the integrity, competence, and good faith of public health and government authorities to recommend vaccines appropriately, and of health providers to administer them safely (Larson et al. 2015:1)". The fact that higher vaccine hesitancy is associated with higher trust supports the observation made in previous studies that confidence in vaccination is connected to confidence in the broader context or system with which it is associated (Larson et al., 2015).

The tested model also supports the hypothesis about the country (or contextual) effect of trust on vaccine hesitancy. We conclude that citizens from more trusting countries are more certain about vaccines and vice versa. In other words, societal characteristics like the level of trust in a given country affect individual decisions and facilitate citizens' behaviour. This is correct for both trust in health professionals and the government. Unfortunately, the conceptual model of public trust presented in Section 2.3 does not explicitly account for contextual/group effects. Although it discusses the role of value attribution for trust formation it does not clearly describe values formation, whether are they individual or group, how the two may interact, and what process is at play, may it be an adaptation to a social norm? However, in this work, we can try to propose several solutions assuming at least two ways the contextual effects might act. First, we can propose that living in a trusting society will lead to a higher individual trust. For example, the baseline individual trust is higher in Sweden when compared to Hungary because Sweden is in general more trusting country. Another potential way is non-direct, an individual might have low levels of institutional trust, yet if she lives in a trusting environment she experiences less hesitancy because she is influenced by the context. Earlier we presented several theories explaining it – value attribution, bandwagon effect, wait-and-see strategy, or peer effects might be in place.

In addition to the central hypothesis, this work tested several complementary hypotheses. It finds 1) a cross-level effect between trust in health professionals and political placement, and 2) a cross-level effect between trust in health professionals and internet use. Obtained results that trust in health professionals is contextual to the political placement of respondents, i.e., people from different political camps vary in their level of trust. A similar interpretation is provided for the link between trust and the Internet use index – trust in health professionals is affected by Internet use – higher Internet access leads to higher trust in health professionals. Based on that result, I hypothesize that access to trustworthy information online about vaccines could be a part of an effective policy campaign against misinformation and low trust.

The cross-level effect between trust in government and the political placement of the respondent is insignificant, which means that political leaning did not affect its trust in the government. We can further consider that this type of trust is based on an assessment of government performance, but not individual preferences or attitudes. A similar hypothesis about cross-level interaction between political trust and

Internet use was insignificant. This particular result might be a subject of the Type II error and needs further exploration. The error could be caused by the distribution of the internet use variable – almost half of the sample had internet access every day, and only a minor fraction had no internet access – i.e., the variable might not differentiate very well participants potentially causing Type II error. Overall, trust in government in this study demonstrates more minor effects after controlling for socio-demographic and contextual variables that trust in health professionals. Trust in health professionals has more considerable effects, and approval of government actions has a more significant coefficient. It is unclear if such results are specific to the health crisis in general, or are specific to the dataset, or the combination used.

Current research is in line with the emerging field of pandemic studies looking at the societal determinants of vaccine hesitancy. Obtained results show that prominent levels of trust are a necessary condition for the implementation of restrictive policies and public compliance with them. Additionally, the study introduces new research subjects to the field of collective action research and part of institutional economics researching game equilibriums, dealing with various scenarios in which competing actors are set to produce an optimal decision. Vaccination decisions should be understood and theorized as one of such strategic situations where actors are set to achieve some optimum. Solutions to these situations should be well thought out and documented to provide policymakers with provisional scenarios and prognoses in case of health emergencies like the recent coronavirus pandemic. It has been demonstrated in numerous studies that collective action problems like tax evasion, and voting participation are mediated by social and political trust (Devine et al. 2021).

Vaccine hesitancy is a well-known phenomenon that emerging as a response to the development of vaccines and their overwhelming use. Studies of vaccine hesitancy reveal how and why people refuse to be vaccinated. Hesitancy embodies 1) individual concerns about the safety of vaccines, risks connected to immaculate and 2) the perception of the probability of contagion and severity of the disease, and 3) individual attitude to social participation. An individual vaccination has two positive external effects – a direct external effect of reducing the likelihood of infection; and a collective external effect – of reducing the general probability of contagion (Hierro et al. 2023). An individual is always free to act in her best interests, to act opportunistically, but is also free to act in the interests of others, to act altruistically. Motivation to protect vulnerable or motivation to strengthen cooperation between members of society are core to pro-vaccine attitudes (Cucciniello et al. 2022). Unlike other social dilemmas, vaccine hesitancy is subject to change. Research in the field suggests that emphasizing the benefits for the wider community instead of self-interest could lower vaccine hesitancy (Galasso et al. 2023; Hierro et al. 2023). In a recent study, Galasso et al. demonstrated particularly interesting results –

according to authors, hesitant individuals were more prone to vaccinate when received motivation about the importance of protecting others and population health in general, but not individualistic motivation to protect themselves (Galasso et al. 2023).

To conclude, our survey advances social knowledge about the determinants of vaccine hesitancy in different countries by demonstrating the role of public trust in solving collective action problem related to health emergencies. Considering differences between countries in their political and health systems and different anti-coronavirus strategies. It is impressive to observe the universal effects of trust at the country level. The presented results are significant because they demonstrate the connection of trust to a broader set of behavioural attitudes (van Kessel et al. 2023). Therefore, future research in trust should broaden their analysis and search for alternative theoretical prepositions of the role trust plays in our lives.

Chapter 7. Conclusions

The success of a vaccination campaign depends on two factors: a sufficient supply (including effective vaccine development, manufacturing, distribution, and accessibility for target populations) and high demand (vaccine attitudes, trust in vaccine producers, and trust in science). This work provides an extensive analysis of the literature on the demand side of the equation by examining the concept of vaccine hesitancy and highlighting its connection to public trust. During our work, we analysed existing literature and approaches to understand vaccine hesitancy and public trust. We aimed to provide a solid foundation for future researchers in this field.

Vaccination hesitancy is an individual attitude existing in a social context where people have the freedom to disagree. Vaccine attitudes are influenced by various factors and determinants, including individual and contextual factors, as well as regional differences. The literature review highlights several associations between vaccine hesitancy and sociological factors, such as trust in policy compliance (Franic 2022), trust in science (Carrieri et al. 2023), trust in health professionals (Allen and Butler 2020), and altruism (Cucciniello et al. 2022), vaccine attitudes can be influenced by peers and social norms. Vaccines can sometimes conflict with people's religious beliefs, political views, and ideas about body autonomy and freedom of choice, they are often discussed in moralizing discourses and can be the subject of coercive practices. Therefore, research on hesitancy and trust is as essential as it inevitably brings together individual, political and social at times of existential danger.

There are at least three different approaches to describing attitudes towards vaccines. While they discuss similar determinants and generally come to similar conclusions, it can be difficult to compare the hesitancy determinants included in these approaches. For instance, the black American population exhibits higher levels of vaccine hesitancy due to past mistreatment inflicted upon this group. However, it is important to note that structural racism remains a harsh reality in many parts of society. In the 3-C model, this factor would be analyzed as part of the confidence pillow. Joshi would consider it a socio-demographic factor, and McDonald would include the same factor in contextual determinants. It is important to have interconnected approaches to analyse social phenomena, especially to hypothesise possible mechanisms behind observed relationships.

Trust is a variable commonly identified as a key component of many social phenomena, such as cooperation (Fukuyama 1995; Stoneman 2008), political involvement and voting behaviour (Devine et al. 2021). This work provides an extensive overview of the current state of trust research. Additionally, we present Lalumera's (2018) conceptual model of public trust formation, which can aid in understanding the mechanisms behind trust in public health. In our analysis trust is understood as

individual expectations that political institutions will function according to the established norms (Mishler and Rose 2001; Warren 1999). It is generally accepted by scholars that individuals put some diligence in existing political institutions to act in individual interests. Previous research hinted at the connection of trust to actual political behaviour – voting for conservative political parties, tax evasion and participation in protest politics (Van De Walle and Six 2014) – this work demonstrates a new behavioural domain connected to political trust, which is vaccination acceptance. The broad goal of this work was to advance knowledge of the social mechanisms underlying vaccination hesitancy. The study, therefore, resonates in other academic fields as it applies to research on the issues of trust, social cohesion, and health policies. It rests on the corpus of studies identifying numerous factors underlying vaccination hesitancy in general and vaccination hesitancy to COVID-19 vaccination specifically. This research sheds light on novel sequels of societal effects of political trust and presents considerable results in the fields of political studies.

There are two takeaways from the obtained results. First, to ensure a prominent level of vaccination acceptance, political institutions must preserve a high level of trust in health professionals and the healthcare system in general. Indeed, in this research, we do not discuss predictors of trust. Nonetheless, we show that stable, trustworthy attitudes in government have positive consequences for solving collective active action problems. It ensures public support for policies and broad social participation. Secondly, the work demonstrates for the first time in public health research the contextual effects of trust on individual attitudes as it introduces a new dimension of trust – group-level trust. In other words, societal characteristics like the level of trust in each country affect individual decisions and facilitate citizens' behaviour.

Another draw from this work is that the number of vaccine-hesitant populations refusing the vaccine is relatively low and stable in time and space – their number is similar between countries (from 6 to 10%). Unfortunately, this research is unable to provide an explanation of complete vaccine refusers and answer what could change rejection attitudes or whether trust can be a determinant of vaccine rejection. It is also still unclear what makes this social group substantially different from others – hesitant or accepting vaccines. This is a topic for future research because even a small number of refusers can potentially undermine vaccination campaigns in specific circumstances (Larson et al. 2015). This thesis provides readers with existing data about the effectiveness of mandatory vaccination policies for different social groups. In brief, vaccination mandates have limited effect and, if implemented, help speed up vaccination intake in particular groups but are unlikely to lower hesitancy. At the same time, obligatory policies are harmful to precarious groups, for example, illegal immigrants or unregistered workers. Vaccination must stay a healthcare intervention and not an instrument for political control. Mandates may harm

Governments should concentrate their forces on building better trust between health professionals and trust in government through comprehensive interaction between various levels of policymakers and ordinary people.

The final advantage of the obtained results is that they demonstrate the importance of trustful information in forming trust in health professionals. According to Smith, around three-quarters of the US adult population use the Internet yearly to search for health information, and relatively few discuss these findings with healthcare professionals (Smith 2017). This illustrates the scale of the potential population potentially affected by online misinformation. Dissemination of truthful information about vaccines, diseases, health measures, medical advances, identification and denunciation of false information, identification of false information spreaders, and so on should be a matter of state security. This crisis was underlined as never the role of information in trust building and maintaining. It also demonstrated that with modern technologies, it is easier than ever to create and spread misinformation, manipulate public opinion, and mobilise supporters into militant groups.

The pandemic introduced massive unforeseen challenges to all aspects of our lives. Nobody could predict that coronavirus vaccines would be met with low trust, that it would polarise society and would lead to mass protests around the EU. It is tempting to give readers simple recommendations about restoring trust and keeping vaccination hesitancy low. But they do not exist. European governments tried different methods to boost vaccine acceptance and lower hesitancy, including the application of mandatory vaccine certificates and other monetary or non-monetary measures, but it did not solve the problem of vaccine hesitancy (Campos-Mercade et al. 2021; Mills and Rüttenauer 2022). Existing literature suggests mixed results; as discussed earlier, hesitancy is context-dependent, so there is no universal solution. Nonetheless, it is plausible to outline possible solutions in several directions.

Institutional trust. The first step to restoring public trust in science and healthcare is for our disciplines to get on board with what trust is, how it is nurtured and how it can be lost, and to develop specifically targeted strategies addressed to the public (Lalumera 2018). Several traditions of trust research understand trust from different perspectives and offer different definitions of trust. Furthermore, we lack the essential knowledge of the connection between trust and values, and the group/contextual effects of trust. Research about how these effects facilitate individual behaviour in collective action problems is needed.

The second suggestion that could be drawn from this research concerns better policymaking for building better and sustainable trust relationships with the public. What governments should do in the future is to foster trust in public institutions to make sure that these institutions are seen by citizens as acting in citizens' interests (to act in citizens' interests). Such initiatives should focus on value transparency,

carefully planned communication, and ethical education of citizens and policymakers. Ideally, all actors should understand their responsibility for restoring and maintaining high trust. It would not be an exaggeration to call trust an actual investment that governments should consider making to have better cooperation with citizens during social dilemmas such as this (Mannemar Sønderskov 2011; Rivetti and Cavatorta 2017).

In social setup vaccination is merely a personal choice, often it is a group commitment. At the same time, as public health authorities seek to achieve broad vaccine coverage, they tend to neglect individual liberties. To be able to keep a delicate balance between the welfare of society and individual autonomy, policymakers must ensure that citizens are provided with complete and correct information about vaccination, keeping people educated and informed and giving citizens a platform for raising their concerns before they crystalize into resentment (Giubilini 2019).

Erosion of trust in health care could lead people to seek health-related advice from alternative sources. Lalumera argues that this might be applied to the case of vaccine hesitancy – *"an alternative 'experts' (so-called independent researchers in immunology, but also proponents of natural remedies) are being consulted and followed by the public* (Lalumera 2018)*"* because public attributes them epistemic values that these expert are trustworthy and truly care for the public.

Tailored approach to different communities. Marginalised communities demonstrate a stronger deficit of intuitional trust and vaccine hesitancy as an outcome caused by a history of mistreatment and marginalisation (Krastev et al. 2023; Storer and Sarafian 2022). In these communities, the approach to restoring trust should recognise and better address pre-existing inequalities. In case of a pandemic, public health policies must identify and openly address the risks created by restrictions to mobility and labour participation, and facilitate access to health services such as testing and vaccination. Rather stigmatising hesitant population policies should seek to understand the priorities behind their decision-making. Finally, an attempt to engage marginalised groups and individuals could be made through existing trusted networks (Storer and Sarafian 2022).

Information distribution. The topic of misinformation in increasing vaccine hesitancy and decreasing trust is recurrent in the literature. Health misinformation is rooted in the cultural context surrounding healthcare, perceptions of risk, and trust in science. However, the connection between information access and hesitancy is not linear. We want to warn the public about hasty conclusions. A hesitant population might be perfectly educated and literate and still be suspicious of vaccines due to various contextual determinants (individual experience, historical experience, religious practices, and so on). Attempts to provide more scientific information on vaccination are not necessarily successful in convincing the hesitant population to vaccinate. What could help is finding common ground and working towards

shared values. Potential topics about vaccination should communicate vaccination uncertainties and health risks, vaccine safety and benefits of vaccination for individuals and society. Working in partnership with different communities and ensuring that messages come from trusted endorsers are the key successful strategies. According to Kata (2010), education is an ineffective approach to combat misinformation about vaccination yet is not enough (Kata 2010). According to Kata, some anti-vaccination groups embrace the postmodern paradigm, which inherently questions an authoritative, science-based approach, and demands to interpret the "*knowledge"* or scientific "*facts"* as just another *"opinion"* (Kata 2012). The author suggests that part of the anti-vaccination communication should aim at recognizing tactics and tropes behind disingenuous claims about vaccine safety, and critically evaluate these claims. In our opinion, part of the future information strategy should include education of children and adults about the ways to recognise the misinformation not only about vaccination but about broader health, political or social topics. With the power of contemporary generative AI tools, it's becoming easier to create convincing yet false content about almost anything, for example, Pope Francis wearing a stylish white puffy coat. It is fundamental now that we learn to critically evaluate the information and misinformation encountered online.

This research has number of shortcuts and limitations. First, the results could not be extrapolated to other populations of Asia, the Americas, and Africa as they only involve data about European Union countries. Direct comparison with surveys performed on samples from smaller communities or populations from other parts of the world is also problematic, as diverse surveys utilize different sample identification approaches, survey designs and or questionnaires.

On a theoretical level, this work highlights a need for more research into trust construct development. In our opinion, the concept of trust lacks clarity. As had been briefly outlined earlier, in contemporary political science three distinct concepts connected to trust are distinguished – trust, distrust, and mistrust. Empirically, most measures of the trust family aim to express the general orientations of citizens toward various political actors, institutions, or the system as a whole (Bunting, Gaskell, and Stoker 2021; Citrin and Stoker 2018). Typically, the three refer to a) political trust is a positive expectation toward political institutions; b) distrust is a negative expectation toward political institutions; c) mistrust reflects doubt or scepticism about the trustworthiness of the other (Bunting et al. 2021; Citrin and Stoker 2018). These contradictions between the understanding and operationalization of concepts indicate a need for more studies in the field.

The complexity of the vaccine hesitancy phenomenon itself brings the second limitation. This work demonstrated that it varies in time and is conditional to individual and contextual factors and their interaction with the vaccine itself. This outlines the importance of future research on the topic in various

contexts and the development of tuned policy measures for improving and sustaining prominent levels of vaccine acceptance, as not only old diseases may reoccur, but the appearance of new viruses is around the corner (Neumann and Kawaoka 2023).

This work warns from the stigmatization of hesitant individuals. Hesitancy is a complex phenomenon, people might refuse one vaccine but not the other, due to assorted reasons and at various points in their lives, such individual decisions should not serve as a basis for discrimination, humiliation or stigmatisation. According to Michel et al., *"stigmatisation can turn hesitancy into defence, and this will have detrimental effects* (Michel et al. 2021)*"* and possibly lead to bigger and faster deterioration of trust in health professionals. Considering that most hesitant people have no political agenda or hold anti-scientific attitudes, public health officials must stay in contact and provide reliable information about available vaccines, vaccine benefits and potential undesirable effects, discuss the risk/benefit ratio connected to vaccination, and update individuals on the vaccination schedules.

Three years after the World Health Organization officially announced the coronavirus pandemic, we still calculate the damage the pandemic has brought to our societies, our labour markets, health systems, and individual well-being, local and global economy. Preliminary funding demonstrates the disproportionate effect it has on the most vulnerable in all countries: mothers, precarious workers, children, migrants, the elderly, people with health conditions and many more. The EU had launched special financial aid to help countries recover economic sectors most affected by the pandemic. Our goal task as a society now is to understand what happened and why our system was so susceptible to the pandemic shock. As a science about societies, sociology should analyse societal changes caused by COVID-19 and the challenges it poses for social tissue, cooperation and connection. With the growing complexity of the world around us, trust has become an essential phenomenon for understanding the relationship between state and citizens, understanding how trust facilitates and hinders policy responses should become a mainstream question in trust research. We would like to conclude this work by saying that the success of vaccination campaigns is mainly influenced by people's access to the competence and reliability of the institutions that deliver vaccines and the principles that guide government decisions and actions (Rangelova et al. 2022).

References

1. Adhikari, Bipin, Phaik Yeong Cheah, and Lorenz von Seidlein. 2022. 'Trust Is the Common Denominator for COVID-19 Vaccine Acceptance: A Literature Review'. *Vaccine: X* 12:100213. doi: 10.1016/j.jvacx.2022.100213.
2. Allen, Arthur, and Robb Butler. 2020. 'The Challenge of Vaccination Hesitancy and Acceptance: An Overview'. *Meeting the Challenge of Vaccine Hesitancy* 48–86.
3. Alsuwaidi, Ahmed R., Hamza Abed Al-Karim Hammad, Iffat Elbarazi, and Mohamud Sheek-Hussein. 2003. 'Vaccine Hesitancy within the Muslim Community: Islamic Faith and Public Health Perspectives'. *Human Vaccines & Immunotherapeutics* 19(1). doi: 10.1080/21645515.2023.2190716.
4. Anderson, Elizabeth. 2004. 'Uses of Value Judgments in Science: A General Argument, with Lessons from a Case Study of Feminist Research on Divorce'. *Hypatia* 19(1):1–24.
5. Augsburger, Ian B., Grace K. Galanthay, Jacob H. Tarosky, Jan Rychtář, and Dewey Taylor. 2023. 'Imperfect Vaccine Can Yield Multiple Nash Equilibria in Vaccination Games'. *Mathematical Biosciences* 356:108967. doi: 10.1016/j.mbs.2023.108967.
6. Ayhan, Sule Goncu, Deniz Oluklu, Aysegul Atalay, Dilek Menekse Beser, Atakan Tanacan, Ozlem Moraloglu Tekin, and Dilek Sahin. 2021. 'COVID-19 Vaccine Acceptance in Pregnant Women'. *International Journal of Gynecology & Obstetrics* 154(2):291–96. doi: 10.1002/ijgo.13713.
7. Baker, Jeffrey P. 2003. 'The Pertussis Vaccine Controversy in Great Britain, 1974-1986'. *Vaccine* 21(25–26):4003–10. doi: 10.1016/s0264-410x(03)00302-5.
8. Barone, C., M. Lucchini, and S. Sarti. 2007. 'Class and Political Preferences in Europe: A Multilevel Analysis of Trends Over Time'. *European Sociological Review* 23(3):373–92. doi: 10.1093/esr/jcm009.
9. Bauch, Chris T., and David J. D. Earn. 2004. 'Vaccination and the Theory of Games'. *Proceedings of the National Academy of Sciences of the United States of America* 101(36):13391–94. doi: 10.1073/pnas.0403823101.
10. Bauer, Daniel J., and Sonya K. Sterba. 2011. 'Fitting Multilevel Models with Ordinal Outcomes: Performance of Alternative Specifications and Methods of Estimation'. *Psychological Methods* 16(4):373–90. doi: 10.1037/a0025813.

11. Baumgaertner, Bert, Juliet E. Carlisle, and Florian Justwan. 2018. 'The Influence of Political Ideology and Trust on Willingness to Vaccinate'. *PLOS ONE* 13(1):e0191728. doi: 10.1371/journal.pone.0191728.

12. Bazin, Hervé. 2001. 'The Ethics of Vaccine Usage in Society: Lessons from the Past'. *Endeavour* 25(3):104–8. doi: 10.1016/S0160-9327(00)01376-4.

13. Brandt, Allan M. 1978. 'Racism and Research: The Case of the Tuskegee Syphilis Study'. *The Hastings Center Report* 8(6):21–29. doi: 10.2307/3561468.

14. Brimnes, Niels. 2004. 'Variolation, Vaccination and Popular Resistance in Early Colonial South India'. *Medical History* 48(2):199–228.

15. Budhiraja, Salil, and Raghuram Akinapelli. 2010. 'Pharmacovigilance in Vaccines'. *Indian Journal of Pharmacology* 42(2):117. doi: 10.4103/0253-7613.64488.

16. Bunting, Hannah, Jennifer Gaskell, and Gerry Stoker. 2021. 'Trust, Mistrust and Distrust: A Gendered Perspective on Meanings and Measurements'. *Frontiers in Political Science* 3.

17. Cadeddu, Chiara, Martina Sapienza, Carolina Castagna, Luca Regazzi, Andrea Paladini, Walter Ricciardi, and Aldo Rosano. 2021. 'Vaccine Hesitancy and Trust in the Scientific Community in Italy: Comparative Analysis from Two Recent Surveys'. *Vaccines* 9(10):1206. doi: 10.3390/vaccines9101206.

18. Campos-Mercade, Pol, Armando N. Meier, Florian H. Schneider, Stephan Meier, Devin Pope, and Erik Wengström. 2021. 'Monetary Incentives Increase COVID-19 Vaccinations'. *Science* 374(6569):879–82. doi: 10.1126/science.abm0475.

19. Carrieri, Vincenzo, Sophie Guthmuller, and Ansgar Wübker. 2023. 'Trust and COVID-19 Vaccine Hesitancy'. *Scientific Reports* 13(1):9245. doi: 10.1038/s41598-023-35974-z.

20. Carrieri, Vincenzo, Leonardo Madio, and Francesco Principe. 2019. 'Vaccine Hesitancy and (Fake) News: Quasi-experimental Evidence from Italy'. *Health Economics* 28(11):1377–82. doi: 10.1002/hec.3937.

21. Chapman, Gretchen B., Meng Li, Jeffrey Vietri, Yoko Ibuka, David Thomas, Haewon Yoon, and Alison P. Galvani. 2012. 'Using Game Theory to Examine Incentives in Influenza Vaccination Behavior'. *Psychological Science* 23(9):1008–15.

22. Cherkaev, Xenia. 2022. 'The Golden Billion: Russia, COVID, Murderous Global Elites'. *Anthropology and Humanism* 10.1111/anhu.12386. doi: 10.1111/anhu.12386.

23. Chuang, Ying-Chih, Kun-Yang Chuang, and Tzu-Hsuan Yang. 2013. 'Social Cohesion Matters in Health'. *International Journal for Equity in Health* 12(1):87. doi: 10.1186/1475-9276-12-87.

24. Chung, Adrienne, and Rajiv N. Rimal. 2016. 'Social Norms: A Review'. *Review of Communication Research* 4:1–28.

25. Citrin, Jack, and Laura Stoker. 2018. 'Political Trust in a Cynical Age'. *Annual Review of Political Science* 21(1):49–70. doi: 10.1146/annurev-polisci-050316-092550.

26. Clemens, John D., G. Balakrish Nair, Tahmeed Ahmed, Firdausi Qadri, and Jan Holmgren. 2017. 'Cholera'. *Lancet (London, England)* 390(10101):1539–49. doi: 10.1016/S0140-6736(17)30559-7.

27. Corbie-Smith, Giselle. 1999. 'The Continuing Legacy of the Tuskegee Syphilis Study: Considerations for Clinical Investigation'. *The American Journal of the Medical Sciences* 317(1):5–8. doi: 10.1016/S0002-9629(15)40464-1.

28. Cowan, Sarah K., Nicholas Mark, and Jennifer A. Reich. 2021. 'COVID-19 Vaccine Hesitancy Is the New Terrain for Political Division among Americans'. *Socius* 7:23780231211023657. doi: 10.1177/23780231211023657.

29. Cowie, Leonard W. 1972. *The Black Death and the Peasants' Revolt*. London : Wayland.

30. Craig, Stephen C. 1980. 'The Mobilization of Political Discontent'. *Political Behavior* 2(2):189–209.

31. Cucciniello, Maria, Paolo Pin, Blanka Imre, Gregory A. Porumbescu, and Alessia Melegaro. 2022. 'Altruism and Vaccination Intentions: Evidence from Behavioral Experiments'. *Social Science & Medicine (1982)* 292:114195. doi: 10.1016/j.socscimed.2021.114195.

32. Dearmon, Jacob, and Kevin Grier. 2009. 'Trust and Development'. *Journal of Economic Behavior & Organization* 71(2):210–20. doi: 10.1016/j.jebo.2009.02.011.

33. Deb, Pragyan, Davide Furceri, Daniel Jiménez, Siddharth Kothari, Jonathan D. Ostry, and Nour Tawk. 2021. 'Determinants of COVID-19 Vaccine Rollouts and Their Effects on Health Outcomes'.

34. Denu, Mawulorm K. I., Alberto Montrond, Rachael Piltch-Loeb, Marco Bonetti, Veronica Toffolutti, Marcia A. Testa, and Elena Savoia. 2022. 'Freedom of Choice to Vaccinate and COVID-19 Vaccine Hesitancy in Italy'. *Vaccines* 10(11):1973. doi: 10.3390/vaccines10111973.

35. D'Errico, Stefano, Martina Zanon, Monica Concato, Michela Peruch, Matteo Scopetti, Paola Frati, and Vittorio Fineschi. 2021. '"First Do No Harm". No-Fault Compensation Program for COVID-

19 Vaccines as Feasibility and Wisdom of a Policy Instrument to Mitigate Vaccine Hesitancy'. *Vaccines* 9(10):1116. doi: 10.3390/vaccines9101116.

36. Devine, Daniel, Jennifer Gaskell, Will Jennings, and Gerry Stoker. 2021. 'Exploring Trust, Mistrust and Distrust'. *Political Studies Review* 19(2):274/285. doi: 10.1177/1478929920948684.

37. Dinesen, Peter Thisted, Kim Mannemar Sønderskov, Jacob Sohlberg, and Peter Esaiasson. 2022. 'Close (Causally Connected) Cousins?' *Public Opinion Quarterly* 86(3):708–21. doi: 10.1093/poq/nfac027.

38. Dror, Amiel A., Netanel Eisenbach, Shahar Taiber, Nicole G. Morozov, Matti Mizrachi, Asaf Zigron, Samer Srouji, and Eyal Sela. 2020. 'Vaccine Hesitancy: The next Challenge in the Fight against COVID-19'. *European Journal of Epidemiology* 35(8):775–79. doi: 10.1007/s10654-020-00671-y.

39. Druckman, James N. 2022. 'Threats to Science: Politicization, Misinformation, and Inequalities'. *The ANNALS of the American Academy of Political and Social Science* 700(1):8–24. doi: 10.1177/00027162221095431.

40. Dubé, Eve, Dominique Gagnon, Noni MacDonald, Aurélie Bocquier, Patrick Peretti-Watel, and Pierre Verger. 2018. 'Underlying Factors Impacting Vaccine Hesitancy in High Income Countries: A Review of Qualitative Studies'. *Expert Review of Vaccines* 17(11):989–1004. doi: 10.1080/14760584.2018.1541406.

41. Dubé, Ève, and Noni E. MacDonald. 2016. 'Managing the Risks of Vaccine Hesitancy and Refusals'. *The Lancet. Infectious Diseases* 16(5):518–19. doi: 10.1016/S1473-3099(16)00028-1.

42. Eisnecker, Philipp Simon, Martin Kroh, and Simon Kühne. 2022. 'The Role of Generalized Trust in COVID-19 Vaccine Acceptance'. *PLOS ONE* 17(12):e0278854. doi: 10.1371/journal.pone.0278854.

43. El-Krab, Renee, Natalie Brousseau, and Seth Kalichman. 2023. 'Medical Mistrust as a Barrier to HIV Prevention and Care'. *Journal of Behavioral Medicine* 46:1–15. doi: 10.1007/s10865-023-00417-7.

44. Ellner, P. D. 1998. 'Smallpox: Gone but Not Forgotten'. *Infection* 26(5):263–69. doi: 10.1007/BF02962244.

45. European Centre for Disease Prevention and Control. 2015. *Rapid Literature Review on Motivating Hesitant Population Groups in Europe to Vaccinate.* LU: Publications Office.

46. Feinberg, Matthew, Chloe Kovacheff, Rimma Teper, and Yoel Inbar. 2019. 'Understanding the Process of Moralization: How Eating Meat Becomes a Moral Issue'. *Journal of Personality and Social Psychology* 117(1):50–72. doi: 10.1037/pspa0000149.

47. Fiala, Mark. 2023. 'Discrimination, Medical Mistrust, and Delaying Cancer Screenings and Other Medical Care.' *JCO Oncology Practice* 19:159–159. doi: 10.1200/OP.2023.19.11_suppl.159.

48. Flaherty, Eoin, Tristan Sturm, and Elizabeth Farries. 2022. 'The Conspiracy of Covid-19 and 5G: Spatial Analysis Fallacies in the Age of Data Democratization'. *Social Science & Medicine (1982)* 293:114546. doi: 10.1016/j.socscimed.2021.114546.

49. Foucault, Michel, and Michel Senellart. 2008. *The Birth of Biopolitics: Lectures at the Collège de France, 1978-79*. Basingstoke [England] ; New York: Palgrave Macmillan.

50. Franic, Josip. 2022. 'What Lies Behind Substantial Differences in COVID-19 Vaccination Rates Between EU Member States?' *Frontiers in Public Health* 10.

51. Freeman, Daniel, Sinéad Lambe, Ly-Mee Yu, Jason Freeman, Andrew Chadwick, Cristian Vaccari, Felicity Waite, Laina Rosebrock, Ariane Petit, Samantha Vanderslott, Stephan Lewandowsky, Michael Larkin, Stefania Innocenti, Helen McShane, Andrew J. Pollard, and Bao Sheng Loe. 2023. 'Injection Fears and COVID-19 Vaccine Hesitancy'. *Psychological Medicine* 53(4):1185–95. doi: 10.1017/S0033291721002609.

52. Freeman, Daniel, Bao S. Loe, Andrew Chadwick, Cristian Vaccari, Felicity Waite, Laina Rosebrock, Lucy Jenner, Ariane Petit, Stephan Lewandowsky, Samantha Vanderslott, Stefania Innocenti, Michael Larkin, Alberto Giubilini, Ly-Mee Yu, Helen McShane, Andrew J. Pollard, and Sinéad Lambe. 2020. 'COVID-19 Vaccine Hesitancy in the UK: The Oxford Coronavirus Explanations, Attitudes, and Narratives Survey (Oceans) II'. *Psychological Medicine* 1–15. doi: 10.1017/S0033291720005188.

53. Freitag, Markus, and Richard Traunmüller. 2009. 'Spheres of Trust: An Empirical Analysis of the Foundations of Particularised and Generalised Trust'. *European Journal of Political Research* 48(6):782–803. doi: 10.1111/j.1475-6765.2009.00849.x.

54. Fridman, Ariel, Rachel Gershon, and Ayelet Gneezy. 2021. 'COVID-19 and Vaccine Hesitancy: A Longitudinal Study'. *PLOS ONE* 16(4). doi: 10.1371/journal.pone.0250123.

55. Fukuyama, Francis. 1995. *Trust: The Social Virtues and the Creation of Prosperity*. Free Press.

56. Galasso, Vincenzo, Vincent Pons, Paola Profeta, Martin McKee, David Stuckler, Michael Becher, Sylvain Brouard, and Martial Foucault. 2023. 'Addressing Vaccine Hesitancy: Experimental

Evidence from Nine High-Income Countries during the COVID-19 Pandemic'. *BMJ Global Health* 8(9):e012658. doi: 10.1136/bmjgh-2023-012658.

57. Gambetta, Diego, ed. 1988. *Trust: Making and Breaking Cooperative Relations*. Blackwell.

58. Gellin, Bruce, John F. Modlin, and Stanley A. Plotkin. 2001. 'CHAT Oral Polio Vaccine Was Not the Source of Human Immunodeficiency Virus Type 1 Group M for Humans'. *Clinical Infectious Diseases* 32(7):1068–84. doi: 10.1086/319612.

59. Giubilini, Alberto. 2019. *The Ethics of Vaccination*. Cham: Springer Verlag.

60. Goldman, Ran D., Tyler D. Yan, Michelle Seiler, Cristina Parra Cotanda, Julie C. Brown, Eileen J. Klein, Julia Hoeffe, Renana Gelernter, Jeanine E. Hall, Adrienne L. Davis, Mark A. Griffiths, Ahmed Mater, Sergio Manzano, Gianluca Gualco, Naoki Shimizu, Thomas L. Hurt, Sara Ahmed, Matt Hansen, David Sheridan, Samina Ali, Graham C. Thompson, Nathalie Gaucher, and Georg Staubli. 2020. 'Caregiver Willingness to Vaccinate Their Children against COVID-19: Cross Sectional Survey'. *Vaccine* 38(48):7668–73. doi: 10.1016/j.vaccine.2020.09.084.

61. Gostin, Lawrence O. 2005. 'Jacobson v Massachusetts at 100 Years: Police Power and Civil Liberties in Tension'. *American Journal of Public Health* 95(4):576–81. doi: 10.2105/AJPH.2004.055152.

62. Grabenstein, John D. 2003. 'Where Medicine and Religion Intersect'. *Annals of Pharmacotherapy* 37(9):1338–39. doi: 10.1345/aph.1D196.

63. Guidry, Jeanine P. D., Linnea I. Laestadius, Emily K. Vraga, Carrie A. Miller, Paul B. Perrin, Candace W. Burton, Mark Ryan, Bernard F. Fuemmeler, and Kellie E. Carlyle. 2021. 'Willingness to Get the COVID-19 Vaccine with and without Emergency Use Authorization'. *American Journal of Infection Control* 49(2):137–42. doi: 10.1016/j.ajic.2020.11.018.

64. Haase, Niels, Philipp Schmid, and Cornelia Betsch. 2020. 'Impact of Disease Risk on the Narrative Bias in Vaccination Risk Perceptions'. *Psychology & Health* 35(3):346–65. doi: 10.1080/08870446.2019.1630561.

65. Haire, Bridget, Paul Komesaroff, Rose Leontini, and C. Raina MacIntyre. 2018. 'Raising Rates of Childhood Vaccination: The Trade-off Between Coercion and Trust'. *Journal of Bioethical Inquiry* 15(2):199–209. doi: 10.1007/s11673-018-9841-1.

66. Hammond, Edward. 2007. 'Should the US and Russia Destroy Their Stocks of Smallpox Virus?' *BMJ* 334(7597):774–774. doi: 10.1136/bmj.39155.695255.94.

67. Hannah, Matthew G., Jan Simon Hutta, and Christoph Schemann. 2020. 'Thinking through Covid-19 Responses with Foucault : An Initial Overview'. *Antipode Online*. Retrieved 9 November 2023 (https://antipodeonline.org/2020/05/05/thinking-through-covid-19-responses-with-foucault/).

68. Harrell, Frank. 2020. 'Statistical Thinking - Violation of Proportional Odds Is Not Fatal'. Retrieved 4 July 2023 (https://www.fharrell.com/post/po/).

69. Hedeker, Donald. 2008. 'Multilevel Models for Ordinal and Nominal Variables'. Pp. 237–74 in *Handbook of Multilevel Analysis*, edited by J. de Leeuw and E. Meijer. New York, NY: Springer.

70. Heier Stamm, Jessica L., Nicoleta Serban, Julie Swann, and Pascale Wortley. 2017. 'Quantifying and Explaining Accessibility with Application to the 2009 H1N1 Vaccination Campaign'. *Health Care Management Science* 20(1):76–93. doi: 10.1007/s10729-015-9338-y.

71. Hetherington, Marc J. 1998. 'The Political Relevance of Political Trust'. *The American Political Science Review* 92(4):791–808. doi: 10.2307/2586304.

72. Hierro, Luis Á., David Patiño, Pedro Atienza, Antonio J. Garzón, and David Cantarero. 2023. 'The Effect of Altruism on COVID-19 Vaccination Rates'. *Health Economics Review* 13(1):2. doi: 10.1186/s13561-022-00415-6.

73. Hoffmann, Manuel, Marianna Baggio, and Michal Wiktor Krawczyk. 2023. *Vaccination Demand and Acceptance: A Literature Review of Key Behavioural Insights*. Publications Office of the European Union. doi: 10.2760/420996.

74. Højme, Philip. 2022. 'Biopolitics and the COVID-19 Pandemic: A Foucauldian Interpretation of the Danish Government's Response to the Pandemic'. *Philosophies* 7(2):34. doi: 10.3390/philosophies7020034.

75. Hooper, Edward. 1999. *The River : A Journey to the Source of HIV and AIDS*. 1st edition. Boston, MA: Little Brown & Co.

76. Jentsch, Peter C., Madhur Anand, and Chris T. Bauch. 2021. 'Prioritising COVID-19 Vaccination in Changing Social and Epidemiological Landscapes: A Mathematical Modelling Study'. *The Lancet Infectious Diseases* 21(8):1097–1106. doi: 10.1016/S1473-3099(21)00057-8.

77. Joshi, Ashish, Mahima Kaur, Ritika Kaur, Ashoo Grover, Denis Nash, and Ayman El-Mohandes. 2021. 'Predictors of COVID-19 Vaccine Acceptance, Intention, and Hesitancy: A Scoping Review'. *Frontiers in Public Health* 9:1152. doi: 10.3389/fpubh.2021.698111.

78. Kata, Anna. 2010. 'A Postmodern Pandora's Box: Anti-Vaccination Misinformation on the Internet'. *Vaccine* 28(7):1709–16. doi: 10.1016/j.vaccine.2009.12.022.

79. Kata, Anna. 2012. ‘Anti-Vaccine Activists, Web 2.0, and the Postmodern Paradigm – An Overview of Tactics and Tropes Used Online by the Anti-Vaccination Movement’. *Vaccine* 30(25):3778–89. doi: 10.1016/j.vaccine.2011.11.112.

80. Kaufman, Martin. 1967. ‘The American Anti-Vaccinationists and Their Arguments’. *Bulletin of the History of Medicine* 41(5):463–78.

81. van Kessel, Robin, Rebecca Forman, Ricarda Milstein, Alicja Mastylak, Katarzyna Czabanowska, Thomas Czypionka, Isabelle Durand-Zaleski, Anja Hirche, Magdalena Krysinska-Pisarek, Laia Maynou, Bjelle Roberts, Aleksandra Torbica, Karsten Vrangbæk, Yuxi Wang, Olivier J. Wouters, and Elias Mossialos. 2023. ‘Divergent COVID-19 Vaccine Policies: Policy Mapping of Ten European Countries’. *Vaccine* 41(17):2804–10. doi: 10.1016/j.vaccine.2023.03.036.

82. Kibongani Volet, Annie, Cristina Scavone, Daniel Catalán-Matamoros, and Annalisa Capuano. 2022. ‘Vaccine Hesitancy Among Religious Groups: Reasons Underlying This Phenomenon and Communication Strategies to Rebuild Trust’. *Frontiers in Public Health* 10.

83. Klepac, Petra, Itamar Megiddo, Bryan T. Grenfell, and Ramanan Laxminarayan. 2016. ‘Self-Enforcing Regional Vaccination Agreements’. *Journal of The Royal Society Interface* 13(114):20150907. doi: 10.1098/rsif.2015.0907.

84. Klymak, Margaryta, and Tim Vlandas. 2022. ‘Partisanship and Covid-19 Vaccination in the UK’. *Scientific Reports* 12(1):19785. doi: 10.1038/s41598-022-23035-w.

85. Kossowska, Małgorzata, Gabriela Czarnek, and Paulina Szwed. 2021. ‘Ideology Shapes Trust in Scientists and Attitudes towards Vaccines during the COVID-19 Pandemic’. *Group Processes & Intergroup Relations* 24(5). doi: 10.1177/13684302211001946.

86. Krastev, Sekoul, Oren Krajden, Zoua M. Vang, Fernanda Pérez-Gay Juárez, Elizaveta Solomonova, Maya J. Goldenberg, Daniel Weinstock, Maxwell J. Smith, Esme Dervis, Dan Pilat, and Ian Gold. 2023. ‘Institutional Trust Is a Distinct Construct Related to Vaccine Hesitancy and Refusal’. *BMC Public Health* 23(1):2481. doi: 10.1186/s12889-023-17345-5.

87. Kulenkampff, M., J. S. Schwartzman, and J. Wilson. 1974. ‘Neurological Complications of Pertussis Inoculation’. *Archives of Disease in Childhood* 49(1):46–49.

88. Laera, Donatello, Harm HogenEsch, and Derek T. O’Hagan. 2023. ‘Aluminum Adjuvants—“Back to the Future”’. *Pharmaceutics* 15(7):1884. doi: 10.3390/pharmaceutics15071884.

89. Lalumera, Elisabetta. 2018. ‘Trust in Health Care and Vaccine Hesitancy’. *Rivista Di Estetica* (68):105–22. doi: 10.4000/estetica.3553.

90. Lalumera, Elisabetta. 2023. ‘Moralisation of Medicines: The Case of Hydroxychloroquine’. *European Journal for Philosophy of Science* 13(3):39. doi: 10.1007/s13194-023-00542-9.

91. Larson, Heidi J., William S. Schulz, Joseph D. Tucker, and David M. D. Smith. 2015. ‘Measuring Vaccine Confidence: Introducing a Global Vaccine Confidence Index’. *PLoS Currents* 7. doi: 10.1371/currents.outbreaks.ce0f6177bc97332602a8e3fe7d7f7cc4.

92. Lenard, Patti Tamara. 2008. ‘Trust Your Compatriots, but Count Your Change: The Roles of Trust, Mistrust and Distrust in Democracy’. *Political Studies* 56(2):312–32. doi: 10.1111/j.1467-9248.2007.00693.x.

93. Lewicki, Roy J., and Chad T. Brinsfield. 2011.in *Framing trust: trust as a heuristic*. New York: Peter Lang Publishing.

94. Lim, Wooyoung, and Pengfei Zhang. 2020. ‘Herd Immunity and a Vaccination Game: An Experimental Study’. *PLOS ONE* 15(5):e0232652. doi: 10.1371/journal.pone.0232652.

95. Loomba, Sahil, Alexandre de Figueiredo, Simon J. Piatek, Kristen de Graaf, and Heidi J. Larson. 2021. ‘Measuring the Impact of COVID-19 Vaccine Misinformation on Vaccination Intent in the UK and USA’. *Nature Human Behaviour* 5(3):337–48. doi: 10.1038/s41562-021-01056-1.

96. Lorenzo, F. De, G. Manzillo, M. Soscia, and G. G. Balestrieri. 1974. ‘EPIDEMIC OF CHOLERA EL TOR IN NAPLES, 1973’. *The Lancet* 303(7859):669. doi: 10.1016/S0140-6736(74)93214-0.

97. Lundåsen, Susanne. 2010. ‘Methodological Problems with Surveying Trust’. Pp. 5806–15 in *2010 JSM proceedings : papers presented at the joint statistical meetings*. American Statistical Association.

98. MacDonald, Noni E. 2015. ‘Vaccine Hesitancy: Definition, Scope and Determinants’. *Vaccine* 33(34):4161–64. doi: 10.1016/j.vaccine.2015.04.036.

99. Mackintosh, Eliza. 2021. ‘Making Covid-19 Vaccines Mandatory Was Once Unthinkable. But European Countries Are Showing It Can Work’. *CNN*, November 30.

100. Mannemar Sønderskov, Kim. 2011. ‘Explaining Large-N Cooperation: Generalized Social Trust and the Social Exchange Heuristic’. *Rationality and Society* 23(1):51–74. doi: 10.1177/1043463110396058.

101. Mardian, Yan, Kathryn Shaw-Shaliba, Muhammad Karyana, and Chuen-Yen Lau. 2021. ‘Sharia (Islamic Law) Perspectives of COVID-19 Vaccines’. *Frontiers in Tropical Diseases* 2.

102. McNeill, William Hardy. 1997. ‘Naples in the Time of Cholera, 1884-1911 (Review)’. *Bulletin of the History of Medicine* 71(3):546–47. doi: 10.1353/bhm.1997.0132.

103. McNulty, Keith. 2021. *Handbook of Regression Modeling in People Analytics: With Examples in R and Python*.

104. Michel, Janet, Thomas C. Sauter, and Marcel Tanner. 2021. ‘Vaccine Hesitancy and Its Determinants – a Way Forward?’ *Journal of Global Health Economics and Policy* 1:e2021017. doi: 10.52872/001c.30018.

105. Miller, Arthur H. 1974. ‘Political Issues and Trust in Government: 1964–1970’. *American Political Science Review* 68(3):951–72. doi: 10.2307/1959140.

106. Mills, Melinda C., and Tobias Rüttenauer. 2022. ‘The Effect of Mandatory COVID-19 Certificates on Vaccine Uptake: Synthetic-Control Modelling of Six Countries’. *The Lancet Public Health* 7(1):e15–22. doi: 10.1016/S2468-2667(21)00273-5.

107. Mishler, William, and Richard Rose. 2001. ‘What Are the Origins of Political Trust?: Testing Institutional and Cultural Theories in Post-Communist Societies’. *Comparative Political Studies* 34(1):30–62. doi: 10.1177/0010414001034001002.

108. Möllering, Guido. 2006. *Trust: Reason, Routine, Reflexivity*. Emerald Group Publishing.

109. Neumann, Gabriele, and Yoshihiro Kawaoka. 2023. ‘Which Virus Will Cause the Next Pandemic?’ *Viruses* 15(1):199. doi: 10.3390/v15010199.

110. North, Douglass C. 1991. ‘Institutions’. *The Journal of Economic Perspectives* 5(1):97–112.

111. O’Connell, Ann A. 2006. *Logistic Regression Models for Ordinal Response Variables*. SAGE Publications, Inc.

112. OECD. 2019. *Government at a Glance 2019*. Paris: Organisation for Economic Co-operation and Development.

113. Offit, Paul A., and Rita K. Jew. 2003. ‘Addressing Parents’ Concerns: Do Vaccines Contain Harmful Preservatives, Adjuvants, Additives, or Residuals?’ *Pediatrics* 112(6 Pt 1):1394–97. doi: 10.1542/peds.112.6.1394.

114. Parmet, Wendy E., Richard A. Goodman, and Amy Farber. 2005. ‘Individual Rights versus the Public’s Health — 100 Years after Jacobson v. Massachusetts’. *New England Journal of Medicine* 352(7):652–54. doi: 10.1056/NEJMp048209.

115. Pavić, Željko, Emma Kovačević, Adrijana Šuljok, Juraj Jurlina, Maja Miškulin, Aida Mujkić, and Ivan Miškulin. 2023. 'The Deficit and Contextual Models of Vaccine Hesitancy: A Test of the Mediation Paths'. *SAGE Open* 13(4):21582440231218845. doi: 10.1177/21582440231218845.

116. Peng, Yilang. 2022. 'Politics of COVID-19 Vaccine Mandates: Left/Right-Wing Authoritarianism, Social Dominance Orientation, and Libertarianism'. *Personality and Individual Differences* 194:111661. doi: 10.1016/j.paid.2022.111661.

117. Qian, Mengcen, Shin-Yi Chou, and Ernest K. Lai. 2020. 'Confirmatory Bias in Health Decisions: Evidence from the MMR-Autism Controversy'. *Journal of Health Economics* 70:102284. doi: 10.1016/j.jhealeco.2019.102284.

118. Rangelova, Vanya, Ralitsa Raycheva, Sara Sariyan, and Ani Kevorkyan. 2022. 'Reporting Adverse Events of COVID-19 Vaccines: The Case of Bulgaria'. *PloS One* 17(6):e0269727. doi: 10.1371/journal.pone.0269727.

119. Reluga, Timothy C., Chris T. Bauch, and Alison P. Galvani. 2006. 'Evolving Public Perceptions and Stability in Vaccine Uptake'. *Mathematical Biosciences* 204(2):185–98. doi: 10.1016/j.mbs.2006.08.015.

120. Reynolds, Katherine J. 2019. 'Social Norms and How They Impact Behaviour'. *Nature Human Behaviour* 3(1):14–15. doi: 10.1038/s41562-018-0498-x.

121. Rivetti, Paola, and Francesco Cavatorta. 2017. 'Functions of Political Trust in Authoritarian Settings'. Pp. 53–68 in *Handbook on Political Trust*. Edward Elgar Publishing.

122. Roberts, Hannah. 2021. 'Coronavirus Brings Back Memories of Naples in the Time of Cholera'. *Politico*.

123. Rodrik, Dani. 1999. 'Where Did All the Growth Go? External Shocks, Social Conflict, and Growth Collapses'. *Journal of Economic Growth* 4(4):385–412. doi: 10.1023/A:1009863208706.

124. Rönnerstrand, B. 2014. 'Social Capital and Immunization against the 2009 A(H1N1) Pandemic in the American States'. *Public Health* 128(8):709–15. doi: 10.1016/j.puhe.2014.05.015.

125. Rothstein, Bo, and Dietlind Stolle. 2008. 'The State and Social Capital: An Institutional Theory of Generalized Trust'. *Comparative Politics* 40(4):441–59. doi: 10.5129/001041508X12911362383354.

126. Rothstein, Bo, and Eric M. Uslaner. 2005. 'All for All: Equality, Corruption, and Social Trust'. *World Politics* 58(1):41–72.

127. Rousseau, Denise M., Colin Camerer, Sim B. Sitkin, and Ronald S. Burt. 1998. 'Not So Different After All: A Cross-Discipline View Of Trust'. *Academy of Management Review* 23(3). doi: https://doi.org/10.5465/amr.1998.926617.

128. Rozin, Paul. 1999. 'The Process of Moralization'. *Psychological Science* 10(3):218–21. doi: 10.1111/1467-9280.00139.

129. Rozin, Paul, Maureen Markwith, and Caryn Stoess. 1997. 'Moralization and Becoming a Vegetarian: The Transformation of Preferences Into Values and the Recruitment of Disgust'. *Psychological Science* 8(2):67–73. doi: 10.1111/j.1467-9280.1997.tb00685.x.

130. Rudd, Gene. 2003. 'Is Vaccination Complicit with Abortion?' *Annals of Pharmacotherapy* 37(9):1340–41. doi: 10.1345/aph.1D157.

131. Saarinen, Arttu, Aki Koivula, and Teo Keipi. 2020. 'Political Trust, Political Party Preference and Trust in Knowledge-Based Institutions'. *International Journal of Sociology and Social Policy* 40(1/2):154–68. doi: 10.1108/IJSSP-06-2019-0113.

132. Saleska, Jessica Londeree, and Kristen R. Choi. 2021. 'A Behavioral Economics Perspective on the COVID-19 Vaccine amid Public Mistrust'. *Translational Behavioral Medicine* 11(3):821–25. doi: 10.1093/tbm/ibaa147.

133. Santirocchi, Alessandro, Pietro Spataro, Federica Alessi, Clelia Rossi-Arnaud, and Vincenzo Cestari. 2023. 'Trust in Science and Belief in Misinformation Mediate the Effects of Political Orientation on Vaccine Hesitancy and Intention to Be Vaccinated'. *Acta Psychologica* 237:103945. doi: 10.1016/j.actpsy.2023.103945.

134. Sapienza, Alessandro, and Rino Falcone. 2022. 'The Role of Trust in COVID-19 Vaccine Acceptance: Considerations from a Systematic Review'. *International Journal of Environmental Research and Public Health* 20(1):665. doi: 10.3390/ijerph20010665.

135. Sarasin, Philipp. 2020. 'Understanding the Coronavirus Pandemic with Foucault?' *GENEALOGY+CRITIQUE (G+C)*.

136. Sato, Ryoko, and Yoshito Takasaki. 2019. 'Peer Effects on Vaccination Behavior: Experimental Evidence from Rural Nigeria'. *Economic Development and Cultural Change* 68(1):93–129. doi: 10.1086/700570.

137. Savoia, Elena, Rachael Piltch-Loeb, Beth Goldberg, Cynthia Miller-Idriss, Brian Hughes, Alberto Montrond, Juliette Kayyem, and Marcia A. Testa. 2021. 'Predictors of COVID-19 Vaccine

Hesitancy: Socio-Demographics, Co-Morbidity, and Past Experience of Racial Discrimination'. *Vaccines* 9(7):767. doi: 10.3390/vaccines9070767.

138. Schmid, Philipp, Dorothee Rauber, Cornelia Betsch, Gianni Lidolt, and Marie-Luisa Denker. 2017. 'Barriers of Influenza Vaccination Intention and Behavior – A Systematic Review of Influenza Vaccine Hesitancy, 2005 – 2016'. *PLOS ONE* 12(1):e0170550. doi: 10.1371/journal.pone.0170550.

139. Scholz, John T., and Mark Lubell. 1998. 'Trust and Taxpaying: Testing the Heuristic Approach to Collective Action'. *American Journal of Political Science* 42(2):398–417. doi: 10.2307/2991764.

140. Schuster, Melanie, Juhani Eskola, and Philippe Duclos. 2015. 'Review of Vaccine Hesitancy: Rationale, Remit and Methods'. *Vaccine* 33(34):4157–60. doi: 10.1016/j.vaccine.2015.04.035.

141. Siegal, Gil, Neomi Siegal, and Richard J. Bonnie. 2009. 'An Account of Collective Actions in Public Health'. *American Journal of Public Health* 99(9):1583–87. doi: 10.2105/AJPH.2008.152629.

142. Sindoni, Alessandro, Valentina Baccolini, Giovanna Adamo, Azzurra Massimi, Giuseppe Migliara, Corrado De Vito, Carolina Marzuillo, and Paolo Villari. 2022. 'Effect of the Mandatory Vaccination Law on Measles and Rubella Incidence and Vaccination Coverage in Italy (2013-2019)'. *Human Vaccines & Immunotherapeutics* 18(1):1950505. doi: 10.1080/21645515.2021.1950505.

143. Skirbekk, Helge, Morten Magelssen, and Stein Conradsen. 2023. 'Trust in Healthcare before and during the COVID-19 Pandemic'. *BMC Public Health* 23(1):863. doi: 10.1186/s12889-023-15716-6.

144. Smith, Tara C. 2017. 'Vaccine Rejection and Hesitancy: A Review and Call to Action'. *Open Forum Infectious Diseases* 4(3):ofx146. doi: 10.1093/ofid/ofx146.

145. Solís Arce, Julio S., Shana S. Warren, Niccolò F. Meriggi, Alexandra Scacco, Nina McMurry, Maarten Voors, Georgiy Syunyaev, Amyn Abdul Malik, Samya Aboutajdine, Opeyemi Adeojo, Deborah Anigo, Alex Armand, Saher Asad, Martin Atyera, Britta Augsburg, Manisha Awasthi, Gloria Eden Ayesiga, Antonella Bancalari, Martina Björkman Nyqvist, Ekaterina Borisova, Constantin Manuel Bosancianu, Magarita Rosa Cabra García, Ali Cheema, Elliott Collins, Filippo Cuccaro, Ahsan Zia Farooqi, Tatheer Fatima, Mattia Fracchia, Mery Len Galindo Soria, Andrea Guariso, Ali Hasanain, Sofía Jaramillo, Sellu Kallon, Anthony Kamwesigye, Arjun Kharel, Sarah Kreps, Madison Levine, Rebecca Littman, Mohammad Malik, Gisele Manirabaruta, Jean Léodomir

Habarimana Mfura, Fatoma Momoh, Alberto Mucauque, Imamo Mussa, Jean Aime Nsabimana, Isaac Obara, María Juliana Otálora, Béchir Wendemi Ouédraogo, Touba Bakary Pare, Melina R. Platas, Laura Polanco, Javaeria Ashraf Qureshi, Mariam Raheem, Vasudha Ramakrishna, Ismail Rendrá, Taimur Shah, Sarene Eyla Shaked, Jacob N. Shapiro, Jakob Svensson, Ahsan Tariq, Achille Mignondo Tchibozo, Hamid Ali Tiwana, Bhartendu Trivedi, Corey Vernot, Pedro C. Vicente, Laurin B. Weissinger, Basit Zafar, Baobao Zhang, Dean Karlan, Michael Callen, Matthieu Teachout, Macartan Humphreys, Ahmed Mushfiq Mobarak, and Saad B. Omer. 2021. 'COVID-19 Vaccine Acceptance and Hesitancy in Low- and Middle-Income Countries'. *Nature Medicine* 27(8):1385–94. doi: 10.1038/s41591-021-01454-y.

146. Sommet, Nicolas, and Davide Morselli. 2017. 'Keep Calm and Learn Multilevel Logistic Modeling: A Simplified Three-Step Procedure Using Stata, R, Mplus, and SPSS'. *International Review of Social Psychology* 30(1):203–18. doi: 10.5334/irsp.90.

147. Stoneman, Paul. 2008. 'The Meaning of Trust'. Pp. 15–30 in *This Thing Called Trust: Civic Society in Britain*, edited by P. Stoneman. London: Palgrave Macmillan UK.

148. Storer, Elizabeth, and Iliana Sarafian. 2022. *Principles of Building Trust: Engaging Disenfranchised Communities Across the G7 in COVID-19 Vaccine Campaigns*. The British Academy. doi: 10.5871/c19-recoveryg7/ES.

149. Storer, Elizabeth, Iliana Sarafian, Costanza Torre, Sara Vallerani, and Eloisa Franchi. 2022. 'COVID-19 Vaccination Campaigns and the Production of Mistrust among Roma and Migrant Populations in Italy'. *BMJ Global Health* 7(9):e009537. doi: 10.1136/bmjgh-2022-009537.

150. Sturgis, Patrick, Ian Brunton-Smith, and Jonathan Jackson. 2021. 'Trust in Science, Social Consensus and Vaccine Confidence'. *Nature Human Behaviour*. doi: 10.1038/s41562-021-01115-7.

151. Thomas, S. Joshua. 2019. 'Reconsidering the Moralization of Health: Practices Versus Concepts, and What We Can Learn from Evidence-Based Research'. *Cambridge Quarterly of Healthcare Ethics* 28(2):215–24. doi: 10.1017/S0963180119000069.

152. Tomljenovic, L., and C. A. Shaw. 2011. 'Aluminum Vaccine Adjuvants: Are They Safe?' *Current Medicinal Chemistry* 18(17):2630–37. doi: 10.2174/092986711795933740.

153. Törnblom, Emma. 2022. 'Political Trust and COVID-19 Vaccine Hesitancy'. Master's Thesis in Political Science, Götheborg University.

154. Van De Walle, Steven, and Frédérique Six. 2014. 'Trust and Distrust as Distinct Concepts: Why Studying Distrust in Institutions Is Important'. *Journal of Comparative Policy Analysis: Research and Practice* 16(2):158–74. doi: 10.1080/13876988.2013.785146.

155. Vlecken, Danielle H. W., Ralf P. M. Pelgrim, Slawomir Ruminski, Wilfried A. M. Bakker, and Leo A. van der Pol. 2013. 'Comparison of Initial Feasibility of Host Cell Lines for Viral Vaccine Production'. *Journal of Virological Methods* 193(1):28–41. doi: 10.1016/j.jviromet.2013.04.020.

156. Wade, Lizzie. 2020. 'From Black Death to Fatal Flu, Past Pandemics Show Why People on the Margins Suffer Most'. *Science*, May 14.

157. Ward, Jeremy K., Caroline Alleaume, Patrick Peretti-Watel, Valérie Seror, Sébastien Cortaredona, Odile Launay, Jocelyn Raude, Pierre Verger, François Beck, Stéphane Legleye, Olivier L'Haridon, and Jeremy Ward. 2020. 'The French Public's Attitudes to a Future COVID-19 Vaccine: The Politicization of a Public Health Issue'. *Social Science & Medicine* 265:113414. doi: 10.1016/j.socscimed.2020.113414.

158. Warraich, Haider J. 2009. 'Religious Opposition to Polio Vaccination'. *Emerging Infectious Diseases* 15(6):978. doi: 10.3201/eid1506.090087.

159. Warren, Mark E. 1999. *Democracy and Trust*. Cambridge University Press.

160. Wiedermann, Ursula, Erika Garner-Spitzer, and Angelika Wagner. 2016. 'Primary Vaccine Failure to Routine Vaccines: Why and What to Do?' *Human Vaccines & Immunotherapeutics* 12(1):239–43. doi: 10.1080/21645515.2015.1093263.

161. Williams, Richard. 2016. 'Understanding and Interpreting Generalized Ordered Logit Models'. *The Journal of Mathematical Sociology* 40(1):7–20. doi: 10.1080/0022250X.2015.1112384.

162. Williamson, Laura. 2021. 'The Ethical Impact of Mandating Childhood Vaccination: The Importance of the Clinical Encounter'. *Clinical Ethics* 16. doi: 10.1177/1477750921101142.

163. Włodarska, Alicja, Mariusz Gujski, Jarosław Pinkas, and Filip Raciborski. 2021. 'The Influence of Socio-Demographic Characteristics on Attitudes towards Prophylactic Vaccination in Poland'. *International Journal of Occupational Medicine and Environmental Health* 34(1):121–32. doi: 10.13075/ijomeh.1896.01671.

164. Wolfe, Robert M., and Lisa K. Sharp. 2002. 'Anti-Vaccinationists Past and Present'. *BMJ : British Medical Journal* 325(7361):430–32.

165. Wu, Sheng, Catherine M. Crespi, and Weng Kee Wong. 2012. 'Comparison of Methods for Estimating the Intraclass Correlation Coefficient for Binary Responses in Cancer Prevention Cluster Randomized Trials'. *Contemporary Clinical Trials* 33(5):869–80. doi: 10.1016/j.cct.2012.05.004.

166. Wynen, Jan, Sophie Op de Beeck, Koen Verhoest, Monika Glavina, Frédérique Six, Pierre Van Damme, Phillipe Beutels, Greet Hendrickx, and Koen Pepermans. 2022. 'Taking a COVID-19 Vaccine or Not? Do Trust in Government and Trust in Experts Help Us to Understand Vaccination Intention?' *Administration & Society* 54(10):1875–1901. doi: 10.1177/00953997211073459.

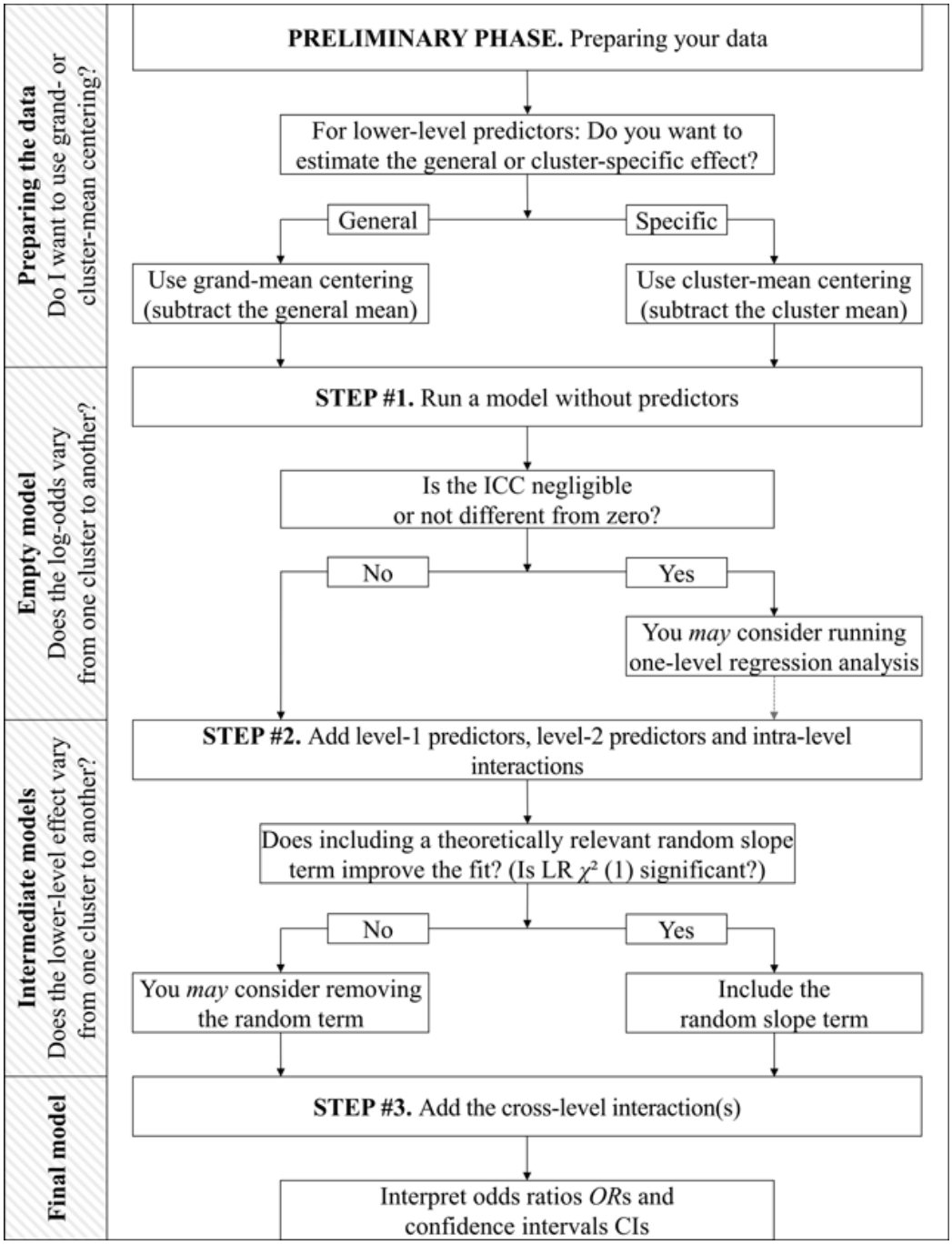
167. Younsi, Moheddine, and Mohamed Chakroun. 2016. 'Does Social Capital Determine Health? Empirical Evidence from MENA Countries'. *The Social Science Journal* 53(3):371–79. doi: 10.1016/j.soscij.2014.08.008.

168. Zhang, Yuyao, Leiyu Shi, Haiqian Chen, Xiaohan Wang, and Gang Sun. 2021. 'Policy Disparities in Response to the First Wave of COVID-19 between China and Germany'. *International Journal for Equity in Health* 20(1):86. doi: 10.1186/s12939-021-01424-3.

169. Zimmerman, Richard K. 2021. 'Helping Patients with Ethical Concerns about COVID-19 Vaccines in Light of Fetal Cell Lines Used in Some COVID-19 Vaccines'. *Vaccine* 39(31):4242–44. doi: 10.1016/j.vaccine.2021.06.027.

Appendix I. A Procedure for Multilevel Model Building

Summary of the three-step simplified procedure for multilevel logistic regression, from Sommet and Morselli, 2017, *Keep Calm and Learn Multilevel Logistic Modeling: A Simplified Three-Step Procedure Using Stata, R, Mplus, and SPSS*., p. 210 e.



Appendix II. List of Explanatory Variables Used in the Research

Table 1. An overview of the explanatory variables

	Variable name	Type	Coding details	Studies finding a significant effect of this or a related covariate
Individual-level variables	Gender	Binary	0: Male 1: Female	(Beleche et al. 2021; Luo et al. 2021; Malik et al. 2020; Navarre et al. 2021; de Sousa et al. 2021)
	Age	Categorical	Values representing the age group 1: 18-24 years old; 2: 25-34 years old; 3: 35-44 years old; 4: 45-54 years old; 5: 55-64 years old; 6: 65+ older.	(Aemro et al. 2021; Beleche et al. 2021; de Figueiredo and Larson 2021; Malik et al. 2020; de Sousa et al. 2021)
	Age when finalizing education	Categorical	1: Less than 15 2: 16-19 3: 20+ 4: Still studying 5: Never had formal education	(Allen et al. 2021; Banik et al. 2021; Beleche et al. 2021; McElfish et al. 2021; Soares et al. 2021; de Sousa et al. 2021)
	Place of residence	Categorical	1: Rural area 2: Small or mid-sized town 3: Large town/city	(Orangi et al. 2021, Allen and Butler 2020)
	Satisfaction with the government	Binary	Reported approval of government restrictions to curb the pandemic. 0: No 1: Yes	(Schmid et al. 2017, Joshi et al. 2021)

	Internet use	Categorical	1: No Internet; 2: Weekly; 3: Every day.	(Loomba et al. 2021, Lan, Wu, and Lin 2022)
	Political orientation	Binary	Political orientation is reported on a scale from 1 to 3. 1: lining to political left; 2: lining to the political centre; 3: lining to political right.	(Fridman et al. 2021; Ward et al. 2020; Włodarska et al. 2021)
	Trust in health professionals	Binary	0: Tend not to trust 1: Tend to trust	(Joshi et al. 2021; Solís Arce et al. 2021, Larson et al. 2014)
	Trust to government	Categorical	Individual trust in government, the index calculated as the mean average of two questions: "*How much trust do you have in the (NATIONALITY) Government?*" and "H*ow much trust do you have in the (NATIONALITY PARLIAMENT)?* Takes values: 1: tend not to trust 1.5: median 2: tend to trust	(Joshi et al. 2021; Solís Arce et al. 2021, Larson et al. 2014)
Country-level variables	GDP growth rate for 2020	Interval	Gross domestic product at market prices, annual growth rates	(Dror et al. 2020; Dubé et al. 2018)

Appendix III. Correlation Matrix for Individual-level Variables

Table 1. Correlation matrix for individual-level variables, total sample

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
(1)Vaccination intention	1.000										
(2) Gender	-0.033**	1.000									
(3) Age groups	0.197**	-0.009*	1.000								
(4) Years when finished education	0.077**	-0.024**	0.168**	1.000							
(5) Internet use index	0.002	-0.009**	-0.336**	0.235**	1.000						
(6) Political placement	-0.017**	-0.056**	0.009*	0.026**	0.007	1.000					
(7) Type of a settlement	0.022**	-0.010**	-0.071**	0.057**	0.097**	-0.018**	1.000				
(8) Trust in government	0.268**	0.000	0.066**	0.060**	0.026**	-0.008	0.010*	1.000			
(9) Trust in health professionals	0.291**	-0.019**	0.048**	0.047**	0.033**	-0.001	-0.009*	0.287**	1.000		
(10) Restrictions approval	0.377**	0.019**	0.095**	0.046**	0.000	-0.013**	0.017**	0.340**	0.267**	1.000	
(11) GDP in 2020	0.222**	-0.030**	0.056**	0.116**	0.151**	-0.084**	-0.050**	0.241**	0.171**	0.154**	1.000

** $p < 0.05$, * $p < 0.1$

Table 2. Correlation matrix for individual-level variables wave 1, February-March 2021

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
(1) Vaccination intention	1.000										
(2) Gender	-0.060**	1.000									
(3) Age groups	0.190**	-0.019**	1.000								
(4) Years when finished education	0.103**	-0.024**	0.211**	1.000							
(5) Internet use index	0.024**	-0.005	-0.313**	0.214**	1.000						
(6) Political placement	-0.026**	-0.054**	0.001	0.033**	0.012	1.000					
(7) Type of a settlement	0.045**	-0.007	-0.066**	0.052**	0.091**	-0.024*	1.000				
(8) Trust in government	0.294**	0.008	0.066**	0.071**	0.044**	-0.005	0.007	1.000			
(9) Trust in health professionals	0.300**	-0.018**	0.050**	0.055**	0.040**	0.006	-0.005	0.287**	1.000		
(10) Restrictions approval	0.376**	0.020**	0.095**	0.052**	0.000	-0.013*	0.013*	0.351**	0.265**	1.000	
(11) GDP in 2020	0.229**	-0.033**	0.067**	0.110**	0.146**	-0.082**	-0.047**	0.259**	0.172**	0.156**	1.000

** p<0.05, * p<0.1

Table 3. Correlation matrix for individual-level variables wave 1, June-July 2021

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
(1) Vaccination intention	1.000										
(2) Gender	-0.006	1.000									
(3) Age groups	0.203**	0.001	1.000								
(4) Years when finished education	0.062**	-0.023**	0.123**	1.000							
(5) Internet use index	-0.005	-0.013*	-0.357**	0.254**	1.000						
(6) Political placement	-0.009	-0.058**	0.018**	0.018**	0.003	1.000					
(7) Type of a settlement	0.004	-0.012*	-0.076**	0.063**	0.101**	-0.011	1.000				
(8) Trust in government	0.246**	-0.008	0.065**	0.048**	0.010	-0.012*	0.014**	1.000			
(9) Trust in health professionals	0.292**	-0.019**	0.047**	0.037**	0.026**	-0.009	-0.014**	0.287**	1.000		
(10) Restrictions approval	0.383**	0.017**	0.095**	0.041**	0.001	-0.014*	0.021*	0.328*	0.269**	1.000	
(11) GDP in 2020	0.222**	-0.026**	0.044**	0.121**	0.157**	-0.085**	-0.052**	0.223**	0.169**	0.152**	1.000

** p<0.05, * p<0.1

Appendix IV. Main Descriptive Statistics

Table 1. Descriptive statistic of the Eurobarometer 943, February-March 2021

Variable	N. Obs.	Mean	Std. dev.	Min	Max
Intention to get vaccinated	26233	3.012	1.087	1	4
Sex					
Male	26517	0.471	0.499	0	1
Female	26517	0.529	0.499	0	1
Age group					
18-24	26517	0.075	0.264	0	1
25-34	26517	0.137	0.344	0	1
35-44	26517	0.167	0.373	0	1
45-54	26517	0.190	0.393	0	1
55-64	26517	0.192	0.394	0	1
65+	26517	0.238	0.426	0	1
Years spent obtaining current educational level					
No/still studying.	24838	0.076	0.265	0	1
Up to 15	24838	0.079	0.271	0	1
16-19 years	24838	0.374	0.484	0	1
20+ years	24838	0.469	0.499	0	1
Political placement					
Left	24917	0.306	0.461	0	1
Center	24917	0.408	0.491	0	1
Right	24917	0.286	0.452	0	1
Type of community					
Rural	26512	0.306	0.461	0	1
Small town	26512	0.371	0.483	0	1
Big town	26512	0.323	0.468	0	1
Internet use index	26517	2.822	0.561	1	3
Restrictions approval	26377	0.722	0.448	0	1
Trust in health professionals	26122	180549	0.395	1	2
Trust in government	26048	1390587	0.451	1	2
GDP in the year 2020	27	46148.08	18146.21	25293.69	118961.5

Table 2. Descriptive statistic of the Eurobarometer 953, June-July 2021

Variable	Observations	Mean	Std. dev.	Min	Max
Intention to get vaccinated	25263	3.351.344	1.069.649	1	4
Sex					
Male	25513	0.467	0.499	0	1
Female	25513	0.533	0.499	0	1
Age group					
18-24	25555	0.071	0.257	0	1
25-34	25555	0.129	0.336	0	1
35-44	25555	0.167	0.373	0	1
45-54	25555	0.188	0.391	0	1
55-64	25555	0.189	0.391	0	1
65+	25555	0.256	0.436	0	1
Years spent obtaining current educational level					
No/still studying	24390	0.062	0.241	0	1
Up to 15	24390	0.112	0.315	0	1
16-19 years	24390	0.404	0.491	0	1
20+ years	24390	0.422	0.494	0	1
Political placement					
Left	23541	0.299	0.458	0	1
Center	23541	0.411	0.492	0	1
Right	23541	0.289	0.453	0	1
Type of community					
Rural	25556	0.323	0.468	0	1
Small town	25556	0.363	0.481	0	1
Big town	25556	0.314	0.464	0	1
Internet use index	25,557	2.77	0.627	1	3
Restrictions approval	25347	0.734	0.441	0	1
Trust in health professionals	25107	1794002	0.404	1	2
Trust in government	24980	1391673	0.450	1	2
GDP in the year 2020	27	4588736	17719.15	25293.69	118961.5

Appendix V. Summary Statistics of Trust in Government and Trust in Health Professionals

Table 1. Summary statistics of variable trust in government, alphabetical order, wave 1 (February-March 2021)

	N. Obs.	Mean	SD	Min	Max
Austria	979	-0.10	0.90	-1	1
Belgium	1044	-0.11	0.92	-1	1
Bulgaria	940	-0.57	0.76	-1	1
Croatia	991	-0.57	0.78	-1	1
Cyprus	478	-0.49	0.77	-1	1
Czech Republic	1096	-0.67	0.57	-1	1
Denmark	1004	0.30	0.84	-1	1
Estonia	1046	-0.04	0.90	-1	1
Finland	1097	0.28	0.86	-1	1
France	944	-0.36	0.88	-1	1
Germany	1033	0.25	0.92	-1	1
Greece	1037	-0.49	0.77	-1	1
Hungary	1000	-0.18	0.94	-1	1
Ireland	1084	0.04	0.94	-1	1
Italy	943	-0.40	0.84	-1	1
Latvia	1034	-0.58	0.75	-1	1
Lithuania	1033	-0.28	0.85	-1	1
Luxembourg	594	0.40	0.85	-1	1
Malta	465	0.07	0.96	-1	1
Poland	991	-0.48	0.82	-1	1
Portugal	1089	-0.23	0.90	-1	1
Romania	965	-0.43	0.79	-1	1
Slovakia	1101	-0.53	0.80	-1	1
Slovenia	1025	-0.67	0.68	-1	1
Spain	956	-0.59	0.76	-1	1
Sweden	1095	0.31	0.85	-1	1
The Netherlands	984	0.39	0.85	-1	1
Total	26048	-0.10	0.90	-1	1

Table 2. Summary statistics of variable trust in government, alphabetical order, wave 2 (June-July 2021)

	N. Obs.	Mean	SD	Min	Max
Austria	949	0.04	0.87	-1	1
Belgium	998	-0.07	0.94	-1	1
Bulgaria	912	-0.57	0.77	-1	1
Croatia	987	-0.56	0.78	-1	1
Cyprus	484	-0.36	0.86	-1	1
Czech Republic	1069	-0.51	0.74	-1	1
Denmark	986	0.32	0.86	-1	1
Estonia	1012	-0.19	0.85	-1	1
Finland	997	0.18	0.88	-1	1
France	922	-0.39	0.86	-1	1
Germany	964	0.14	0.94	-1	1
Greece	983	-0.47	0.81	-1	1
Hungary	986	-0.13	0.94	-1	1
Ireland	1015	0.03	0.94	-1	1
Italy	974	-0.24	0.90	-1	1
Latvia	1018	-0.57	0.78	-1	1
Lithuania	990	-0.35	0.81	-1	1
Luxembourg	496	0.38	0.88	-1	1
Malta	424	0.04	0.98	-1	1
Poland	958	-0.41	0.86	-1	1
Portugal	956	0.05	0.91	-1	1
Romania	984	-0.35	0.81	-1	1
Slovakia	964	-0.55	0.80	-1	1
Slovenia	980	-0.53	0.78	-1	1
Spain	944	-0.55	0.77	-1	1
Sweden	1005	0.06	0.88	-1	1
The Netherlands	1023	0.05	0.91	-1	1

Table 3. Summary statistics of variable trust in government, alphabetical order, total sample.

	N. Obs.	Mean	SD	Min	Max
Austria	1928	-0.03	0.89	-1	1
Belgium	2042	-0.09	0.93	-1	1
Bulgaria	1852	-0.57	0.76	-1	1
Croatia	1978	-0.56	0.78	-1	1
Cyprus	962	-0.42	0.82	-1	1
Czech Republic	2165	-0.59	0.66	-1	1
Denmark	1990	0.31	0.85	-1	1
Estonia	2058	-0.11	0.88	-1	1
Finland	2094	0.23	0.87	-1	1
France	1866	-0.37	0.87	-1	1
Germany	1997	0.20	0.93	-1	1
Greece	2020	-0.48	0.79	-1	1
Hungary	1986	-0.16	0.94	-1	1
Ireland	2099	0.03	0.94	-1	1
Italy	1917	-0.32	0.87	-1	1
Latvia	2052	-0.57	0.76	-1	1
Lithuania	2023	-0.32	0.83	-1	1
Luxembourg	1090	0.39	0.86	-1	1
Malta	889	0.06	0.97	-1	1
Poland	1949	-0.44	0.84	-1	1
Portugal	2045	-0.10	0.92	-1	1
Romania	1949	-0.39	0.81	-1	1
Slovakia	2065	-0.54	0.80	-1	1
Slovenia	2005	-0.60	0.73	-1	1
Spain	1900	-0.57	0.76	-1	1
Sweden	2100	0.19	0.88	-1	1
The Netherlands	2007	0.21	0.89	-1	1

Table 4. Summary statistics of variable trust in health authorities, alphabetical order, wave 1 (February-March 2021)

	N. Obs.	Mean	Std. dev.	Min	Max
Austria	984	0.81	0.39	0	1
Belgium	1046	0.96	0.19	0	1
Bulgaria	899	0.68	0.47	0	1
Croatia	1004	0.69	0.46	0	1
Cyprus	481	0.78	0.41	0	1
Czech Republic	1097	0.92	0.27	0	1
Denmark	1005	0.96	0.20	0	1
Estonia	1048	0.87	0.34	0	1
Finland	1097	0.93	0.25	0	1
France	965	0.92	0.28	0	1
Germany	1052	0.89	0.31	0	1
Greece	1034	0.78	0.41	0	1
Hungary	1010	0.60	0.49	0	1
Ireland	1083	0.91	0.29	0	1
Italy	963	0.73	0.45	0	1
Latvia	1034	0.64	0.48	0	1
Lithuania	1034	0.64	0.48	0	1
Luxembourg	596	0.87	0.33	0	1
Malta	477	0.92	0.27	0	1
Poland	978	0.63	0.48	0	1
Portugal	1089	0.96	0.20	0	1
Romania	970	0.54	0.50	0	1
Slovakia	1102	0.68	0.47	0	1
Slovenia	1025	0.70	0.46	0	1
Spain	968	0.89	0.32	0	1
Sweden	1096	0.91	0.29	0	1
The Netherlands	985	0.97	0.16	0	1

Table 5. Summary statistics of variable trust in health authorities alphabetical order wave 2 (June-July 2021)

	N. Obs.	Mean	Std. dev.	Min	Max
Austria	1937	0.82	0.39	0	1
Belgium	2044	0.96	0.21	0	1
Bulgaria	1798	0.64	0.48	0	1
Croatia	1988	0.68	0.47	0	1
Cyprus	972	0.77	0.42	0	1
Czech Republic	2167	0.90	0.30	0	1
Denmark	1995	0.95	0.22	0	1
Estonia	2061	0.87	0.34	0	1
Finland	2094	0.93	0.26	0	1
France	1928	0.91	0.29	0	1
Germany	2034	0.89	0.32	0	1
Greece	2012	0.75	0.43	0	1
Hungary	2009	0.61	0.49	0	1
Ireland	2098	0.89	0.31	0	1
Italy	1924	0.71	0.45	0	1
Latvia	2061	0.66	0.48	0	1
Lithuania	2024	0.64	0.48	0	1
Luxembourg	1098	0.88	0.33	0	1
Malta	920	0.93	0.26	0	1
Poland	1933	0.66	0.48	0	1
Portugal	2061	0.96	0.21	0	1
Romania	1960	0.56	0.50	0	1
Slovakia	2066	0.68	0.47	0	1
Slovenia	2006	0.68	0.47	0	1
Spain	1926	0.88	0.32	0	1
Sweden	2101	0.90	0.30	0	1
The Netherlands	2012	0.96	0.19	0	1

Table 6. Summary statistics of variable trust in health authorities, alphabetical order, total sample

	N. Obs.	Mean	Std. dev.	Min	Max
Austria	1937	0.82	0.39	0	1
Belgium	2044	0.96	0.21	0	1
Bulgaria	1798	0.64	0.48	0	1
Croatia	1988	0.68	0.47	0	1
Cyprus	972	0.77	0.42	0	1
Czech Republic	2167	0.90	0.30	0	1
Denmark	1995	0.95	0.22	0	1
Estonia	2061	0.87	0.34	0	1
Finland	2094	0.93	0.26	0	1
France	1928	0.91	0.29	0	1
Germany	2034	0.89	0.32	0	1
Greece	2012	0.75	0.43	0	1
Hungary	2009	0.61	0.49	0	1
Ireland	2098	0.89	0.31	0	1
Italy	1924	0.71	0.45	0	1
Latvia	2061	0.66	0.48	0	1
Lithuania	2024	0.64	0.48	0	1
Luxembourg	1098	0.88	0.33	0	1
Malta	920	0.93	0.26	0	1
Poland	1933	0.66	0.48	0	1
Portugal	2061	0.96	0.21	0	1
Romania	1960	0.56	0.50	0	1
Slovakia	2066	0.68	0.47	0	1
Slovenia	2006	0.68	0.47	0	1
Spain	1926	0.88	0.32	0	1
Sweden	2101	0.90	0.30	0	1
The Netherlands	2012	0.96	0.19	0	1

Appendix VI. Multilevel Regression Results, Trust in Health Professionals

Variables	(1) odds ratio	(2) odds ratio	(3) odds ratio	(4) odds ratio
Sex, RG - female		0.889***	0.891***	0.891***
		(0.0181)	(0.0182)	(0.0181)
Age, RG - 18-24 years old				
25-34		0.998	1.018	1.013
		(0.0505)	(0.0515)	(0.0513)
35-44		1.242***	1.268***	1.264***
		(0.0639)	(0.0652)	(0.0651)
45-54		1.615***	1.646***	1.641***
		(0.0832)	(0.0848)	(0.0847)
55-64		2.108***	2.153***	2.143***
		(0.110)	(0.113)	(0.112)
65+		3.633***	3.719***	3.698***
		(0.198)	(0.203)	(0.202)
Years spent obtaining current educational level, RG - No/still studying.				
Up to 15		0.671***	0.671***	0.678***
		(0.0435)	(0.0435)	(0.0440)
16-19 years		0.674***	0.662***	0.670***
		(0.0351)	(0.0344)	(0.0349)
20+ years		0.930	0.922	0.925
		(0.0479)	(0.0475)	(0.0477)
Internet use index, RG - no internet				
Weekly		1.039	1.050	0.974
		(0.110)	(0.112)	(0.107)
Every day		1.164***	1.173***	1.018
		(0.0513)	(0.0517)	(0.0748)
Political placement, RG - Left				
Center		0.856***	0.860***	0.900***
		(0.0211)	(0.0213)	(0.0315)
Right		1.031	1.039	1.137**
		(0.0280)	(0.0282)	(0.0646)
Type of community, RG - Rural				
Small town		1.061**	1.066**	1.062**
		(0.0267)	(0.0268)	(0.0267)
Big town		1.235***	1.238***	1.238***
		(0.0324)	(0.0325)	(0.0325)
Survey wave, RG - 1st wave		2.841***	2.053***	1.967***
		(0.428)	(0.0900)	(0.104)
Restrictions approval		3.453***	3.445***	3.437***
		(0.0804)	(0.0803)	(0.0800)
The GDP year 2020		1.000***	1.000***	1.000***
		(3.83e-06)	(1.34e-06)	(1.76e-06)

Trust in health authorities		2.097***	2.478***	2.060***
		(0.0538)	(0.154)	(0.287)
Trust in health authorities*Internet use				1.097**
				(0.0453)
Trust in health authorities*Political placement				0.943*
				(0.0305)
Cut1	0.101***	2.037***	1.988***	1.622***
	(0.0132)	(0.446)	(0.200)	(0.206)
Cut2	0.305***	7.259***	7.078***	5.779***
	(0.0396)	(1.590)	(0.714)	(0.735)
Cut3	0.651***	17.76***	17.34***	14.16***
	(0.0845)	(3.894)	(1.756)	(1.807)
Random slope			1.293***	1.111***
			(0.0616)	(0.0332)
Constant	2.466***	1.348***	1.160***	1.273***
	(0.432)	(0.0807)	(0.0327)	(0.0817)
Covariance				1.081***
				(0.0186)
Observations	51,496	44,580	44,580	44,580
Number of groups	54	54	54	54

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix VII. Multilevel Regression Results, Trust in Government

Variables	(1) odds ratio	(2) odds ratio	(3) odds ratio	(4) odds ratio
Sex, RG - female		0.875***	0.876***	0.876***
		(0.0178)	(0.0179)	(0.0179)
Age, RG - 18-24 years old				
25-34		0.996	0.995	0.996
		(0.0502)	(0.0503)	(0.0504)
35-44		1.240***	1.240***	1.241***
		(0.0635)	(0.0637)	(0.0637)
45-54		1.595***	1.602***	1.604***
		(0.0818)	(0.0824)	(0.0825)
55-64		2.078***	2.088***	2.092***
		(0.108)	(0.109)	(0.109)
65+		3.573***	3.581***	3.586***
		(0.194)	(0.195)	(0.195)
Years spent obtaining current educational level, RG - No/still studying.				
Up to 15		0.678***	0.685***	0.684***
		(0.0439)	(0.0444)	(0.0444)
16-19 years		0.671***	0.681***	0.681***
		(0.0349)	(0.0355)	(0.0355)
20+ years		0.930	0.935	0.936
		(0.0479)	(0.0482)	(0.0482)
Internet use index, RG - no internet				
Weekly		0.996	0.997	0.988
		(0.106)	(0.107)	(0.106)
Every day		1.159***	1.147***	1.129**
		(0.0509)	(0.0505)	(0.0531)
Political placement, RG - Left				
Political placement, RG - Left		0.867***	0.870***	0.862***
Center		(0.0214)	(0.0216)	(0.0220)
		1.025	1.032	1.014
Right		(0.0279)	(0.0287)	(0.0301)
Type of community, RG - Rural				
Small town		1.057**	1.055**	1.054**
		(0.0266)	(0.0266)	(0.0266)
Big town		1.228***	1.229***	1.228***
		(0.0322)	(0.0323)	(0.0323)
Survey wave, RG - 1st wave		2.797***	2.879***	2.870***
		(0.449)	(0.463)	(0.474)
Restrictions approval		3.383***	3.384***	3.382***
		(0.0800)	(0.0805)	(0.0805)
The GDP year 2020		1.000***	1.000***	1.000***
		(4.08e-06)	(4.08e-06)	(4.14e-06)

Trust in government		1.314***	1.329***	1.484***
		(0.0167)	(0.0388)	(0.111)
Trust in government*Internet use				0.980
				(0.0212)
Trust in government*Political placement				0.974*
				(0.0156)
Cut1	0.101***	1.011	1.052	1.019
	(0.0132)	(0.234)	(0.244)	(0.244)
Cut2	0.305***	3.540***	3.693***	3.579***
	(0.0396)	(0.820)	(0.856)	(0.855)
Cut3	0.651***	8.613***	9.011***	8.732***
	(0.0845)	(1.996)	(2.091)	(2.088)
Slope			1.036***	1.037***
			(0.00947)	(0.00959)
Constant	2.466***	1.405***	1.404***	1.401***
	(0.432)	(0.0953)	(0.0956)	(0.0946)
Covariance				1.001
				(0.0190)
Observations	51,496	44,447	44,447	44,447
Number of groups	54	54	54	54

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1