CROSS-NATIONAL VARIATION IN VACCINATION DURING THE PANDEMIC: ECONOMIC AND SOCIAL ROOTS OF SUCCESSFUL VACCINATIONS

by

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Abstract

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The COVID-19 pandemic has affected lives of many regular citizens as well as the performance of many governments around the world. Despite a significant demand for health safety measures and vaccination policies implemented in all countries, even after a 1.5 years after the introduction of vaccines against COVID-19 still only 68.2% of the world population has received at least one dose.

This thesis aims to investigate what social, economic, institutional or demographic factors have an impact on vaccination rates. I employ a vast amount of datasets collected from World Bank, Our World in Data, to analyze a statistical relation between these factors and vaccination rates cross-nationally. I also explore a unique survey conducted in Ukraine to address specific attitudinal variables why respondents hesitated to vaccinate. The estimation result showed that countries with crisis experience in the past, on average, have higher vaccination rates. Moreover, countries with a strict rule of law tend to have a higher number of administrated doses. On the individualistic level, applying law restrictions for the vaccination hesitation increases the chances to obtain a higher vaccination rate in the country.

TABLE OF CONTENTS

LIST OF FIGURES

Number *Page*

LIST OF TABLES

Number *Page*

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I would like to express deep gratitude to professor Tymofii Brik, for his kind support and meaningful advicece during the work on this study. Besides, I want to thank all professors who participated in this thesis by providing feedback and comments during Research Workshops.

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Last but not least, I wish to emphasize my gratitude to all my groupmates and especially to my friends Nina and Liza, for their constant support in the hard times of studying. Besides, from the bottom of my heart, I would like to thank my mother Iuliia, grandfather Ivan and grandmother Yevgenia for all they have done to support me, for their belief in me and for surrounding me with warmth and love.

LIST OF ABBREVIATIONS

COVID-19. COronaVIrus Disease 2019.

WHO. World Health Organization.

GDP. Gross Domestic Product.

BCG. Bacillus Calmette–Guérin

OECD. Organization for Economic Co-operation and Development

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Chapter 1

INTRODUCTION

COVID-19 pandemic has affected usual way of life. It has impacted both regular citizens and government, which caused abrupt adjustment to the new rules. The states have adopted many policies to stop people's deaths and coronavirus world-wide spread: sheltering, distancing, vaccination, sanitation, etc., however, the most effective way is vaccination. Thus, with money support from multilateral organizations, government institutions and private firms, the sciences from all over the world developed vaccines against COVID-19. Despite anticipations about delayed development of the vaccine, un fact it took only the year to invent it. Thus, the first vaccine was given in the year after the start of the pandemic in December of 2020 in the United Kingdom and was followed by other countries. However, the process of vaccination is not as fast as it was expected to be.

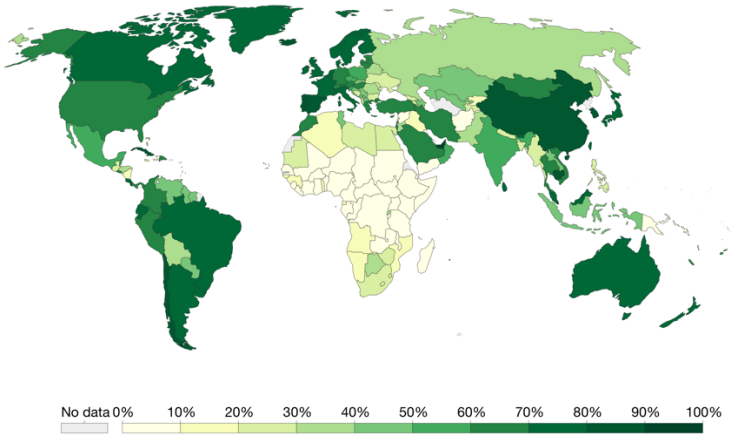

Figure 1.COVID-19 vaccine doses administrated per 100 people by November 8, 2021

Source: Our World in Data

According to Figure 1, the vaccination rates varies across countries very significantly. Due to different circumstances, after the start of the vaccination process, only 44% of the world population obtained the first dose, with 0.1% the lowest number observed in The Republic of Congo and 95% as the highest number in the United Arabian Emirates. At the same time, 112 countries reported vaccination rates, that are lower than an average in the world.[1] Such a low vaccination rates may transform into a possible barrier in the process of fighting with a new virus.

Obviously, the world's population vaccination process faces enormous challenges, including public hesitancy and skepticism (Rasai et al. 2021), limited amount of vaccines (Ighobor 2021) and many others. Moreover, in 2019, even before the COVID-19 pandemic and invention of vaccine against it, WHO announced that public vaccine hesitation is included in the top 10 threats to global health. Despite anecdotical evidence, various reports and ad-hoc studies, there is still no systematic investigation of these reasons in a comparative prospective controlling for socio-economic parameters of countries as well as their culture and political development. Hence, I see an importance of finding what main concerns become a reason for such observation. In this study I examine the impact of social concerns in a country, as people have different beliefs which can potentially cause a rise or decline in administration of vaccine doses. Along with it, I am going to check whether the economic appearance or government activity of countries may evoke various levels of vaccinated people.

This thesis aimed to contribute to the academic literature related to the analysis of variables which might explain a staggering variation of vaccination rates in different countries. In this research the effect of social, economic and institutional factors on vaccination rates will be analyzed. By this thesis I try to answer the question: "Why do some countries have higher vaccination rates against COVID-19 than

[1] Our World in Data, by 29.09.2021

others?" and I will focus on social, economic and institutional factors to address this question. Besides, to make one step further, I will explore a survey in Ukraine to test the causal relations between social variables and willingness to vaccinate.

The further research is structured in such a way, that Chapter 2 delivers literature review, concentrated on social concerns and economic and institutional factors, which cause an impact on vaccination rates; Chapter 3 supplies data description; Chapter 4 is focused on methodology of the study and model specification; Chapter 5 provides the main estimated results on what factors has effect on vaccination rate and cause difference in it among countries, along with estimated results of an analysis of survey in Ukraine; Chapter 6 offers conclusions and assumptions of possible following research.

Chapter 2

LITERATURE REVIEW

After the COVID-19 pandemic has started and vaccines against coronavirus were invented, many studies analyzing the impact of different factors on vaccination rates have been developed. Some researchers examine why people express vaccine hesitancy or acceptance, others investigate differences in vaccination rate across specific countries or regions. This chapter reviews all these papers to build up the framework for a new study. For future study, due to the variety of potential causes of difference in immunization rates, I decided to divide possible explanations of vaccination rates into economic or institutional factors and social reasons.

2.1. Social trust

Drawing on surveys of eight countries' representatives, Lindholt et al. (2021) investigated that people's trust in health institutions has a significant impact on decisions about vaccination. Furthermore, Sturgis, et al. (2020) with the use of surveys in 126 countries determined that people have more willingness to vaccinate in countries with high trust in science. However, most research was based on data, which were collected in 2018 or didn't include Ukraine and other EU countries. In my thesis, I will fill this gap and use the newest data in order to obtain actual results and analyze whether trust in science still is one of the reasons to vaccinate.

Furthermore, Lee et al. (2003) conducted a survey in the USA focusing on examining parent's attitude to vaccines against measles and pertussis, estimated that trust in government and health institutions are positively related to belief in the reliability of vaccines. Hence, citizen's confidence in government actions is supposed to influence the vaccination rates inside the country. Similar findings are presented by M. Trent et al. (2021), as based on the survey in several countries they obtained

evidence of high willingness of getting vaccine doses against COVID-19 by participants, who express confidence in their current government. Researchers highlight the relationship between people's trust in government and vaccine acceptance, but there is a lack of studies on whether confidence in county representatives become a cause of difference in vaccination rates. Moreover, previous studies estimate discussed relationships based on a small sample of countries, while in my thesis I would try to explore all countries in the world.

Therefore, there is a growing consensus that social trust to governments and trust to the science is the key variable to explain the vaccination. Nevertheless, the evidence is inconclusive since most studies were based on the data collected in 2018 or did not include Ukraine and other EU countries. In my thesis I will fill this gap and use the newest data in order to obtain actual results and analyze whether trust in science still is one of the reasons to vaccinate.

2.2 Economic factors

Countries' performance on the micro and macro level may have a significant impact on the nation's willingness to be vaccinated against the COVID-19 pandemic. High-income countries have better access to healthcare and education and citizens develop better understanding of how public health works. In terms of the context, rich countries may afford better health systems. One of the researchers that analyzed such hypotheses were Goel and Nelson (2021). Based on the 50 states USA data, obtained evidence of the impact of a country's GDP on citizens' desire to vaccinate and results claimed "that state economic prosperity and rural population aid vaccine administration and delivery efficiency". Thus, it was estimated that in case per capita state GDP rises by 10 percent, then vaccinations per capita will be observed to grow by approximately 9 percent. Nevertheless, Ukraine and many other EU members were not observed in research of the country's income on vaccination rate in academic papers.

2.3 Government activity

Government is the key decision maker related to the quality of life of the whole population. Thus, all government actions and implied measures on preventing the COVID-19 spread may have a direct impact on the vaccination rate. Israel as the fastest vaccination country, became an interesting case of fighting COVID-19 and became a basis for research of vaccination rates. Therefore, based on Israel vaccination experience, Gründler et al. (2021) estimated the relationship between countries' crisis experience and the amount of administered vaccine doses. As a result, they concluded, "that a one-standard-deviation increase in the crisis experience index gives rise to around 10 additional administered vaccine doses per 100 citizens". Moreover, their study estimated the positive relationship between health expenditures and vaccination rates. However, among observed countries in this paper, Ukraine, as a country with economic crisis caused by the war was not discovered which implied a gap in academic studies.

Some countries were not ready for the coronavirus pandemic and experienced not only a collapse in the health industry but also a large number of deaths. Therefore, some researchers examine the possible impact of the number of deaths in the country of living on people's desire to vaccinate. Gründler et al. (2021) concluded in their work, based on the USA data that "states with a greater number of deaths had greater vaccination efficiency", but it is still not fully investigated at different countries' level, whether such a relationship occurred.

During the growth of COVID-19 cases governments impose various quarantine restrictions for unvaccinated people, such as attending restaurants, cinemas, transport, travelling and visiting other public zones. However, such measures are supposed to be not only a containment measure of COVID-19 spread, but also a stimulation for citizens to become vaccinated and have an opportunity to avoid restrictions. To measure the government response to the COVID-19 spread, the

University of Oxford started the project, which collects the information about closing schools, workplace restrictions, vaccination policy and travel bans and converts it into the Stringency Index. Zebin et al. (2021) based on Asian countries discovered a positive impact of increase in stringency index on the decrease in cases of coronavirus illnesses. Also, the authors supposed that " when the vaccine intervention is implemented at a small scale, the stringency index can be increased to effectively control the spread of COVID-19". At the same time, Kaiser et al. (2020) studied that non-pharmaceutical interventions in Europe lead to diminish in COVID-19 cases. However, there are no studies about how imposed quarantine measures may motivate people to vaccinate and avoid restrictions. Thus, due to the lack of research I would like to fill this gap and examine the hypothesis of positive impact of stringency index on the vaccination rates.

2.4 Demographic factors

As elderly people are considered to be the weakest against coronavirus and being ill for them more often concludes to the death, governments emphasize their protection as a priority. Therefore, some researchers investigate the impact of country's structure of age, mainly the percentage of elderly citizens, on the vaccination rate. Thus, Goel, and Nelson (2021) found that "states with a larger share of elderly population were no different with others with regard to vaccinations". As such conclusions are based on country-level data, I would like to test such hypotheses among different countries, as there is a possibility of obtaining the opposite effect.

2.6 A survey in Ukraine

The impact of social factors on vaccination rates is more effective to examine on the individualistic level, based on the survey which shows the actual attitude of people towards certain questions. Some researchers have investigated that social

media news has a high impact on vaccine hesitancy. Thus, Wilson and Wiysonge (2020) found that "a 1-point shift upwards in the 5-point disinformation scale in the social media is associated with a 2-percentage point drop in mean vaccination coverage year over year". Such conclusions are based on the cross-country survey, however, it does not observe the individual-level data. As regression shows the mean impact across countries, it is interesting to analyze more people-based data and the impact of their attitude to social media news on the decision-making related to vaccinations. Besides, it was found by Uddin et al. (2010) that there is a positive impact of high education of parents on willingness to vaccinate against influenza. However, the research was based in the USA and is very old, that's why I want to fill this gap and analyze the impact of education on the Ukraine-based data in the case of Covid vaccine. Moreover, Endrich et al. (2009), found that the age of a person shows a positive correlation with a willingness to vaccinate. But the research was made in the 11 countries in Europe while there was no research conducted in Ukraine. That's why in my thesis I will try to investigate such a relationship on the individualistic level in Ukraine. At the same time, Morozova-Larina et al. (2022), had made an analysis on the basis of research in Ukraine and found that trust in the government may be the main factor in citizens' decision-making in vaccination acceptance. However, the study didn't prove it, just discussed and observe it as a point for further investigation. My thesis will try to continue to examine the factor of people's trust in government as a predictor of willingness to vaccinate.

To sum up, the literature findings suggest that differences in vaccination rates among countries are caused by enormous factors related to social, economic, government and demographic factors. In this thesis, I will use a newer and richer dataset, which accounts for factors from all countries to explore and estimate the reasons for significant variation in vaccination rates in the world. Moreover, I will try to support research by exploring social factors on the individualistic data with an example of Ukraine.

Chapter 3

DATA DESCRIPTION

The following research is focused on exploring the impact of economic, government, demographic and social factors on the vaccination rates in various countries. For the empirical analysis I use the merged dataset, which represents the cross-sectional macro-level data. Moreover, for the individual-level analysis, I would use a survey conducted in Ukraine by Gradus in 2020 before the start of vaccination process. The survey has social questions, and 938 respondents. This chapter is purposed to describe the variables included in both datasets and main patterns of explanatory factors.

3.1 Data overview of the macro-level data

All necessary data was taken from various international sources and is based on microeconomic indicators and survey results. The main sources for the data are World Bank, Our World in Data, Gallup World Poll, WHO and Center for systematic peace (Table 1).

However, the row dataset is far from the ideal one, because of big amount of missing values. According to the lack of survey result from some countries, the main problem of missing data is observed in such social variables, as Government efficiency and Rule of low.

The dependent variable - COVID-19 vaccine doses administrated per 100 people in this study is fixed and is taken by the end of October, according to the start of the research.

Table 1. Description of variables of the macro-level data

Variable	Description	Source
Vaccination rate	COVID-19 vaccines administrated doses per 100 people on November 8, 2021 (latest reported value)	Our World in Data
GDP	GDP per capita in current USD, average values in the period of 2000-2020	World Bank
Confirmed COVID-19 deaths	Total amount of deaths caused by COVID-19 virus per million citizens on November 8, 2021	Our World in Data
Elderly population	The number of people over the age of 65 as a share of the population	World Bank
Stringency index	A composite measure, which collects government reaction to the spread of COVID-19 disease and based on such indicators as travel restrictions, workplace and schools closures (value of index is in the range from 0 to 100, where 100 - strictest)	Our World in Data
Health expenditures	Health expenditures per capita in current USD, average values in the period of 2000-2018	World Bank
Expenditures on education	Expenditures on education as a % of GDP, 2020	World Bank
Military expenditures	Military expenditures as share of GDP, average values in the period of 2000-2020	World Bank
Conflict deaths	Deaths related to battles, which was divided by population, average values in the period of 2000-2020	World Bank
Disaster deaths	Deaths caused by natural or technical disasters which was divided by population, average values in the period of 2000-2020	World Bank
Crisis experience index	Measure of experienced crisis in the country in the scale from 0 to 1. Created with military expenditures, conflict deaths and disaster deaths using PSA method.	Author's estimation
Rule of law	Share of respondents who expressed confidence in the police force and in judicial system of their country.	Gallup World Poll
Government efficiency	Share of respondents who expressed satisfaction with public transportation system, with road and highways and with education system.	Gallup World Poll
Immunization of BCG	Share of population, which is fully vaccinated against tuberculosis, 2020.	WHO
Democracy index	Indicator of political regime in the country taken from Polity IV project, which is from 0 to 10, where 0 – closed anocracy and 10 – full democracy.	Systemic Peace
Gini index	Indicator which measures income inequality in country, where 0 – low inequality, 100 – high inequality.	World Bank

One of the explanatory variables is crisis experience, which might have a positive effect on vaccination rates. It may be explained by the fact that countries, which observed significant losses due to various crisis in the past, may put a lot of efforts into preventing future lockdowns and corona crisis and obtain high vaccination rate. In this study crisis experience will be measured in the form of a composite index, as different types of crisis may be presented as a crisis experience and influence on the vaccination rates. Measuring crisis experience index is based on the data of military expenditures, conflict deaths and disaster deaths with the use of principal component analysis, which will be discussed in detail in Chapter 4.

The other block of explanatory variables is focused on how health related factors influence on vaccination rate. Health expenditures is an indicator, which provides a measurement of how health care system of countries is developed. Thus, countries with high level of health spending may express more care and attention to the vaccination process, as well as, may provide more vaccines. Also, immunization against BCG is an explanatory variable, which expresses overall willingness of citizens to vaccinate against usual diseases. Countries with high percentage of immunized people against BCG infection might have higher vaccination rate because of positive attitude of citizens to vaccination. Also, the data of share of confirmed deaths from COVID-19 deliver an information how much country was affected by the pandemic. Experiencing such losses, I expect, that countries with high number of COVID-19 related death might have higher vaccination rate.

The third block of explanatory variables is aimed to analyze government activity and its impact on vaccination rate. Government spending on education as a share of GDP is an indicator of how well educated citizens are to realize the importance of vaccination during the new pandemic. Thus, countries with high share of expenditures on education might have more vaccinations. Also, the political regime which is in the power of government might express attitude and applied steps in terms of fighting COVID 19 spread from politicians. Therefore, because of solid

evolves of such countries to development, I expect countries with high level of democratization to have higher vaccination rate. Besides, stringency index delivers an aggregated measurement of how strict are the government policies in response to the COVID 19. Thus, countries which implement strict rules and provide active attempts in pandemic spread, are supposed to observe higher vaccination rate.

The other block of independent variables is demographic and economic factors, which might be the cause of different vaccination rates. GDP per capita is a macroeconomic indicator, which provides a measurement of economic development of the country. Thus, countries with high GDP might have more vaccinated citizens. Another factor - Gini index – provides a measurement of income inequality across citizens inside the country. I expect that countries which high distribution of income might have low vaccination rate. Also, higher share of elderly people (citizens older than 65 age) in the country might be a reason of many vaccinations. As such people have a harder form of the disease course and government supposed to protect them with faster vaccination process.

The last block of independent variables focuses on social attitude. People's attitude to government efficiency and rule of law in the country is taken as a proxy of citizens trust to government. Thus, countries, where people trust in government actions are expected to believe in appeals to vaccinate which lead to higher vaccination rates.

Explanatory variables discussed above might have a substantial impact on the vaccination rate in countries and provide explanations of significant differences in vaccination rates among various countries.

Also, the research uses the following control variables: the belonging to the geographical region and affiliation with OECD countries. As there might be other causes of difference in vaccination rates and omitted explanatory variables, it is important to control for the regional differences. Besides, to examine the impact

of crisis experience on vaccination rate based on Gründler et al. (2021), the study uses the control on belonging to OECD countries.

3.2 Macro-level data description

Since not all data is available for all countries, the number of observations in the final dataset decreased from 187 to 94. The mean vaccination rate among observed countries is 77.29 per 100 people. While the minimum of COVID-19 administrated doses are 1.20 and is observed in Haiti and maximum is 199.20 and is in Chile. The descriptive statistics of the dataset, which is used in this thesis is presented in the Table 2.

Table 2. Descriptive statistics of variables

Variable	Mean	St.dev.	Median	Min	Max
Vaccination rate	77.29	57.23	73.77	1.20	199.20
GDP per capita	8974.88	12750.60	39991.77	340.21	53357.33
Confirmed COVID-19 deaths	927.32	1070.82	434.64	3.21	60009.3
Elderly population	9.43	7.0	6.74	1.99	28.40
Stringency index	44.40	16.55	43.98	2.78	79.17
Health expenditures	892.78	1079.34	459.42	46.01	4280.94
Military expenditures	1.82	1.33	1.55	0.0	9.13
Conflict deaths	0.0	0.0	0.0	0.0	0.01
Disaster deaths	2..76	9.22	0.30	0.0	78.98
Rule of law	0.68	0.13	0.66	0.38	0.94
Government efficiency	0.56	0.14	0.56	0.27	0.93
Government expenditures on education	4.28	1.47	4.05	1.33	9.63
Immunization of BCG	75.15	32.84	87.50	0.00	99.00
Democracy index	6.21	3.66	8.00	0.00	10.00
Gini index	36.44	10.71	35.75	0.00	63.00

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in Haiti and maximum is 199.20 and is in Chile. The descriptive statistics of the dataset, which is used in this thesis is presented in Table 2.

Since in the study only 94 countries will be examined, it is important to observe the representation of the countries on Figure 2.

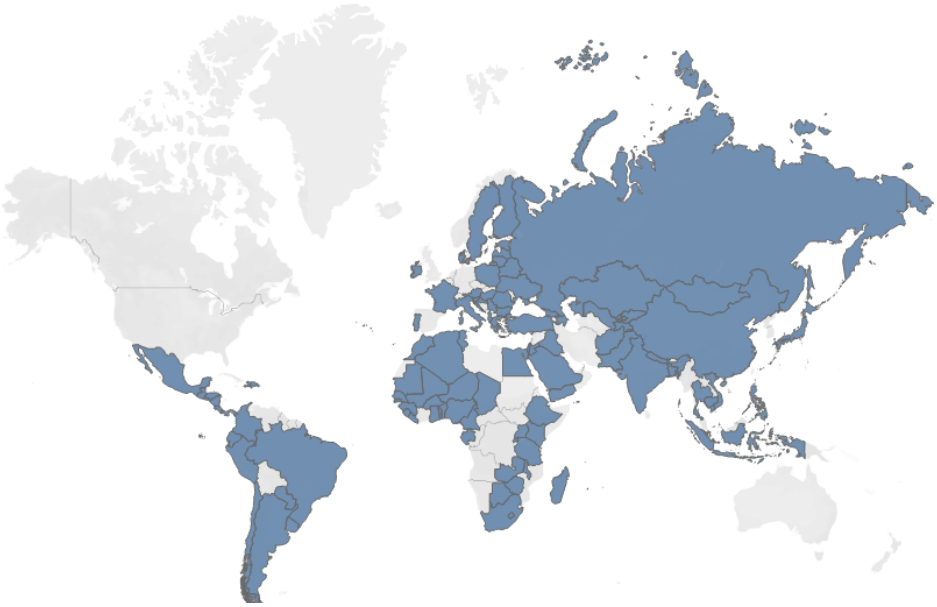

Figure 2. Countries covered in the study

Comparing variables across regions, it is important to mention some interesting observations. The highest average vaccination rate, amount of deaths from pandemic and stringency index are observed in North America. Despite of small amount of deaths from COVID-19 in the East Asia and Pacific, as well as in south Asia, the countries from these regions have imposed strict policies to prevent disease spread and have a high average vaccination rate. Sub-Saharan Africa has a high average of stringency index, while vaccination rate is the lowest among regions. It

can be caused by unavailability of vaccines. On Figure 3, the difference in vaccination rate, confirmed deaths from COVID-19 and stringency index across regions may be observed.

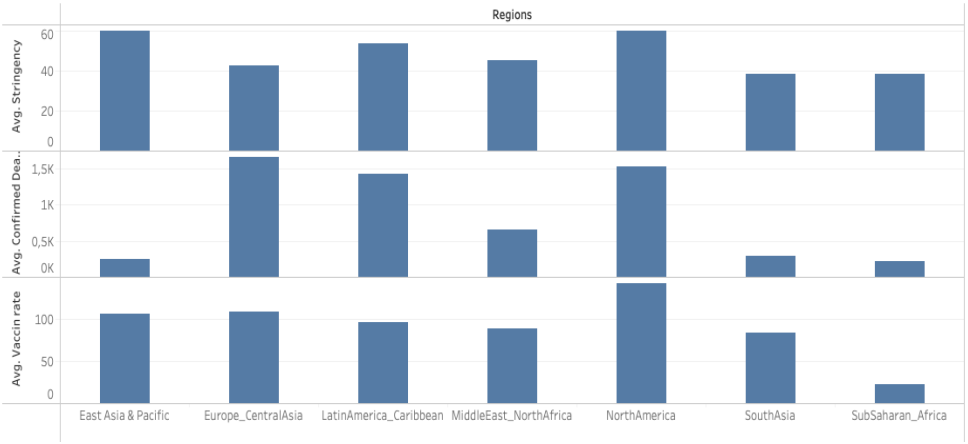

Figure 3. Distribution of vaccination rate, confirmed deaths from COVID-19 and stringency index across regions

To sum up, the final dataset consists of 98 countries and 17 explanatory variables, which will be analyzed on having an impact on the vaccination rates. The dataset is considered to be reliable for further regression analysis, as all possible factors, which may impact on vaccination rate is included.

3.3 Data overview of the individual-level data of the survey in Ukraine

The data was gathered by surveying citizens of Ukraine by Gradus in 2020, before the start of the vaccination process. The survey was conducted by sending a questionnaire via mobile phones to the respondents included in the base of Gradus. Questions in the survey are related to the behavior of the respondent and his attitude to different situations and organizations.

As there was no straightforward question about people's attitude or willingness to have a vaccine against COVID-19, it was decided to take questions related to other

preventing measures of COVID-19 spread as a dependent variable. Due to research by Lam et al. (2022), which was conducted on the survey data in the Los Angeles, it was found that "mask-wearing is associated with willingness to receive COVID-19 vaccine". It may be explained by people's willingness to continue applying protective measures and to enhance them.

That's why for further investigation of impact social factors on the vaccination acceptance in the survey in Ukraine I will use two proxies and observe two dependent variables based on the answers on such question as:

1. "To what extent do you agree with the following statement: In general, wearing masks in public places is effective in protecting you from COVID-19 (coronavirus)?"

This question has 5 possible answers: "Hard to say", "Rather DON'T trust", "DON'T trust at all ", "Rather trust", "Trust completely".

2. "How likely are you to wear a mask in public during the official quarantine?"

This question is a probability question, and has an answer from 0 to 100, expressing the percentage of probability that person will wear the mask.

The survey has a lot of questions aimed to analyze respondents' attitude and social behavior. However, to explain most of variation, only 10 questions are taken to observe as explanatory variables in further investigation. Questions may be distinguished in the following 4 blocks:

1. Questions about trust in news

Participants of the survey were asked to evaluate level of their trust in the news which are translated via television and social media by using one of the following answers: "Hard to say", "Rather DON'T trust", "DON'T trust at all ", "Rather trust", "Trust completely".

2. Questions about trust in government.

Respondents were asked about the level of their trust in the one of the representatives of the government - Ministry of Health of Ukraine. Possible answers are the same as in the previous block.

3. Questions about trust in the international health organizations.

Participants were asked about the level of their trust in World Health Organization. Possible answers are the same as in the previous block.

4. Question about attitude to the application of the rule of law from the police. Respondents were asked to what extend person agree that police should fine people who violate quarantine rules. Such options for answering may be used: "Hard to say", "Rather DON'T support", "DON'T support at all ", "Rather support", "Support completely".

5. Common questions about respondent's description.

Respondents were asked about their age, gender, education, size of the city and financial status.

All answers on this questions are collected into the dataset with categorical variables. As a result, dataset represents person's description and social attitude to various factors, related to the COVD-19 and preventing measures.

3.4 Description of the individual-level data of the survey in Ukraine

As the survey was conducted in different cities and with various groups of respondents, the dataset provides a representative sample and is fully reliable for further research.

In the survey have participated both female and male, however it should be noted that amount of respondents-women twice higher than men. Most of the respondents (48%) are from the big cities, which have a population of more than 1 million

people, while 42% are living in the average-sized cities and only 10% of respondents are from small towns. Such a diversity in the sample ensures more accurate outcomes of the analysis, which may be applicable to the whole country. On Figure 4, the distribution of respondents by gender and population in the city may be observed.

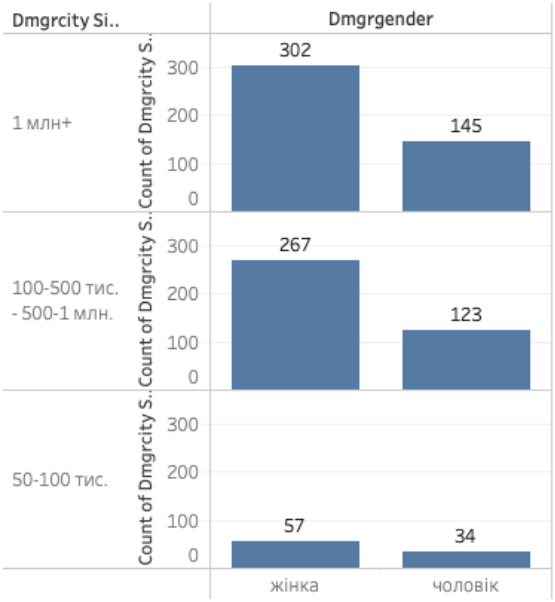

Figure 4. Description of respondents that have been interviewed

The independent variable which shows people's prompt to wear masks in order to prevent being ill by COVID-19 is significantly distributed across respondents. Most of the respondents expressed full agreement or partial agreement to wear masks (with 44% and 23% of answers respectively), while fewer people showed a negative attitude – 20% for partial disagreement and 11% for total disagreement. The answers are quite scattered between possible answers, so it provides analysis with a diversity of opinions. On Figure 5, the distribution of answers by attitude to wearing masks may be observed.

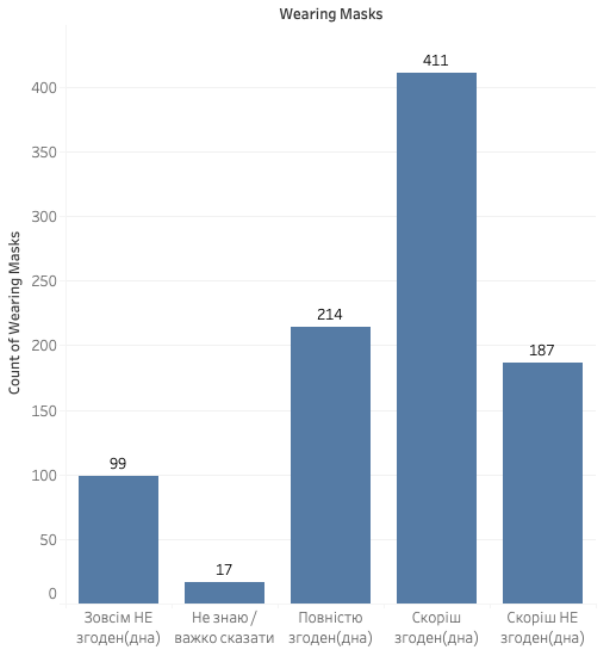

Figure 5. Distribution of answers by attitude to wearing masks

To sum up, the final dataset for analysis of the individual-level factors of social trust and desire to apply preventing measures against COVID-19 in Ukraine has 938 respondents and 10 answers for the social questions. The dataset considered to be reliable for further regression analysis, as all possible social factors and patterns of each individual are included.

Chapter 4

METHODOLOGY

In this study the cross-sectional data is used, thus for the first modeling results we start with an ordinary least squares model. Before estimating the general model, based on the Gründler et al. (2021), we create crisis experience index using principal component analysis and such variables as military expenditures, conflict deaths and disaster deaths.

4.1 Principal Component Analysis (PCA) for crisis experience index for macro-level analysis

Principal component analysis is a statistical technique, which is used for reducing the number of scales.

For the aggregation and summarizing the data and index creation we have to find a function f which maps variable characteristics (m) onto the level of crisis experience (CE):

$$CE_I = f(m_i) \forall\, m_i = m_1, \dots, m_i \qquad (1)$$

where i indicate countries and m is observed in the periods from 2000-2020. To investigate the hypothesis that crisis experience index has impact on the vaccination rate, we use continuous scale, which is able to bring greater discrimination power in empirical researches. In the process of index creation, using PCA we obtain weights for consideration the different levels of importance of factors. Thus, weights w_n define the transformation process of PCA and provide mapping of vectors $m_i$to a new vector which represents principal component scores $s_i =$

$(s_1, .., s_n)$ in the way that implies inheritance of the maximum possible variance of the data. The first weights are denoted in the form of

$$w_1 = \arg\max_{\|w\|=1} \left\{ \sum_i (s_1)_i^2 \right\} = \arg\max_{\|w\|=1} \left\{ \sum_i (m_i \times w)^2 \right\} \qquad (2)$$

Hence, the first principal component is computed using $s_1 = x_i \times w_1$. Using the PCA method for aggregation, we satisfied the effect of partial substitution between aspects of crisis. After computing, we rescale the indicator into the range of $CE_i = (0,1)$.

4.2 General model for macro-level analysis

As the study uses cross-sectional data, we start the estimation process with using ordinary least squares model to investigate raw correlations between variables. The general ordinary least squares regression estimates the conditional mean of the dependent variable across values of the independent variables. OLS model specification is described below:

$$Y_i = \beta_0 + \beta_1 X_i + \cdots + \beta_n X_n + \varepsilon_i \qquad (3)$$

where Y_i – dependent variable, $\beta_1 \ldots \beta_n$ – coefficients, $X_i \ldots X_n$ – independent variables, β_0 – intercept and ε_i – error term.

Designing ordinary least squares regression for vaccination rate and factors, which may impact, the model has following appearance:

$$VR_i = \beta_0 + \beta_1 \log(GDP_i) + \beta_2 GI_i + \beta_3 EP_i + \beta_4 EE_i + \beta_5 SI_i + \beta_6 D_i + \beta_7 \log(HE_i) + \beta_8 IBSG_i + \beta_9 CD_i + \beta_{10} GE_i + \beta_{11} RL_i + \beta_{12} Region1_i + \beta_{13} Region2_i + \beta_{14} Region3_i + \beta_{15} Region4_i + \beta_{16} Region5_i + \beta_{17} Region6_i \quad (4)$$

where, the dependent variable VR stands for vaccination rates. Explanatory variables are GDP, GI, EP which stands for Gross Domestic Product, Gini index, Elderly population, respectively, and represent the economic and demographic factors of impact; EE, SI, D, which stands for expenditures on education, stringency index and democracy index and denote government activity; HE, IBCG, CD which stands for health expenditures, immunization against BCG and confirmed deaths from COVID-19, that represent the health related factors; GE, RL, which stands for government efficiency, rule of law and denotes the social trust; CE is stands for crisis experience index; Regions are added as a control variables for countries i = 1,..,n, where n=94.

As each country has its own patterns which may be the reason of a certain vaccination rate, in analysis will be used control variables, which implies the belonging of the country to the geographical region due to the World Bank specification. Thus, I would include 6 broad geographical regions which in the models would be presented as binary variables: East Asia Pacific, Europe and Central Asia, Latin America, Middle East and North Africa, South Asia and Sub-Saharan Africa, where the Sub-Saharan Africa is a baseline category. Besides, I would control the model for the fact whether the booster vaccination in the country has started on the date of collecting data about vaccination. As some countries may have a higher vaccination rate due to started process of booster vaccination. Thus, I would include binary variable of whether the booster vaccination has been started in September, 2021.

An OLS model is used with a purpose of analyzing the impact of change in independent variables on vaccination rate. Thus, getting parameters provides a variation of the dependent variable when independent variable has a unitary variation. Also,

to continue investigation, I group countries due to the World Bank classification of countries regarding their income. Thus, I obtain 3 groups of countries: law-income, middle-income and high-income countries. As a result, I use OLS regressions in for all 3 groups and estimate the impact of factors in separated groups of countries,

Besides, to support analysis with model's prediction I will use a quantile regression. On the contrary of OLS regression, quantile regression estimates the conditional median and allows to determine quantile for a particular value in the independent variables. The general quantile regression model specification is described below:

$$Q_\tau(y_i) = \beta_0(\tau) + \beta_1(\tau)X_{i1} + \cdots + \beta_\rho(\tau)X_{i\rho} \quad (5)$$

where $\beta_\rho(\tau)$ are coefficients, which are presented by functions with a dependency on the quantile. It is assumed that different quantile of vaccination rates in the dataset may have been observed different impact of the examined social-economic factors. Moreover, a Wild test should be made to test the statistical difference between coefficients in different quantiles. In the Wild test for the quantile regression, H0 is that regression parameter is constant in all quantile levels observed.

4.3 General model for the analysis of survey in Ukraine

As the main goal of this study is to investigate what factors impact the vaccination rate and the survey does not include a straightforward question about vaccinations, I would use questions related to other measures as a proxy. As due to Lam et al. (2022), people's attitude to vaccination against COVID-19 is associated with their attitude to wearing masks. For more accurate conclusions, I would use two dependent variables and apply them to regression analysis, while independent variables will be the same.

4.3.1. People's trust in mask effectiveness against COVID-19

The dependent variable is a categorical and expresses attitude to wearing masks. The question is formulated as: "To what extent do you agree with the following statement: In general, wearing masks in public places is effective in protecting you from COVID-19 (coronavirus)?" This question has 5 possible answers: "Hard to say", "Rather DON'T trust", "DON'T trust at all ", "Rather trust", "Trust completely". However, in the analysis I use aggregated answers. Thus, I group answers "Rather DON'T trust" and "DON'T trust at all" into the "Don't trust" and combined answers "Rather trust" and "Totally trust" into "Totally trust" for simplicity of interpretation of results.

As the dependent variable is categorically distributed and has 3 unordered levels, multinomial logistic regression is the most suitable predictor of probabilities of different possible outcomes. Using this model, results would be provided as separated estimation of binary logistic models of those dummy variables in the dependent variable. Thus, the answer "Don't agree" on the question in the dependent variable is a reference category, which implies that it is a baseline and all results will be interpreted with a comparison to this category. Multinomial logistic model specification in terms of logistic model is described below:

$$\left(log\frac{p_i(x)}{p_j(x)}\right) = \beta_{0j} + \beta_{1j}X_1 + \cdots + \beta_{\rho j}X_\rho \quad (6)$$

where $Y_i = log\frac{p_i(x)}{p_j(x)}$ – dependent variable with a baseline $p_j(x)$, $\beta_{0j} \ldots \beta_{\rho j}$ – vector of coefficients, $X_1 \ldots X_\rho$ – vector of explanatory variables. Moreover, as there is a reference category in the dependent variable, then j=1,…,J−1. The same regarding explanatory variables, as to most variables there is a baseline variable, P=1,…, P−1. As a result, 2 equations will be obtained with regards to answers of

"Hard to say" and "Totally agree" in the dependent variable. Considering independent variables, as all of the variables are also questions with a multiple answers, all of them will have a baseline category. Also for explanatory variables, for the question about size of the city of living I use "more than 1 mn people" as a baseline category, for the question about education – "No education", the gender variable – female, as a baseline category and for age I use "18-24" as a baseline. After the estimation, the set of log-ratios probabilities will be provided.

In order to omit bias, I will include several control variables, which are characteristics of individuals, as each individual may have its own patterns and heterogeneity may take place, I would add gender, age, financial status and size of the city to the model.

Moreover, to ensure the goodness of fit of predictors, I would use a Likelihood Test Chi-square test. In this test, null-hypothesis is that the model contains no predictors.

4.3.2. Probability of wearing mask

The dependent variable is numerical, but in the range from 0 to 100, expressing the probability of wearing a mask. The question is formulated as: "How likely are you to wear a mask in public during the official quarantine?"

This question is a probability question, and has an answer from 0 to 100, expressing the percentage of probability that person will wear the mask, so this variable is interval continuous. Therefore, I use OLS model to estimate the conditional mean of the dependent variable across values of the independent variables. The general formal specification of the OLS model is described by formula (3). However as in this analysis independent variables are also categorical, then the general specification is described as:

$$Y_i = \beta_0 + \beta_{i1}X_{1i} + \beta_{i2}X_{1i} + \beta_{i2}X_{ni} \cdots + \beta_{nm}X_{nm} + \varepsilon_i \quad (7)$$

where, Y_i is a dependent numeric variable in the range from 0 to 100, $\beta_{i1}..\beta_{i2}$ – is a set of coefficients corresponding to categories of the independent variable X_{1i}, where X_{0i} – is a baseline. Control variables and baseline categories for independent variable are used the same as for previous analysis.

Chapter 5

ESTIMATED RESULTS

This chapter aimed to present estimation results of the regressions models discussed in the Chapter 4. Direct output of regressions and other modeling results may be observed from the tables depicted in this chapter.

5.1 Macro-level analysis

In the first stage, using PCA and such variables as military expenditures, conflict deaths and disaster deaths, the crisis experience index was created. Thus, crisis experience index is created to be from 0 to 1. The highest crisis experience index among OECD countries has Israel, while the lowest – Costa Rica.

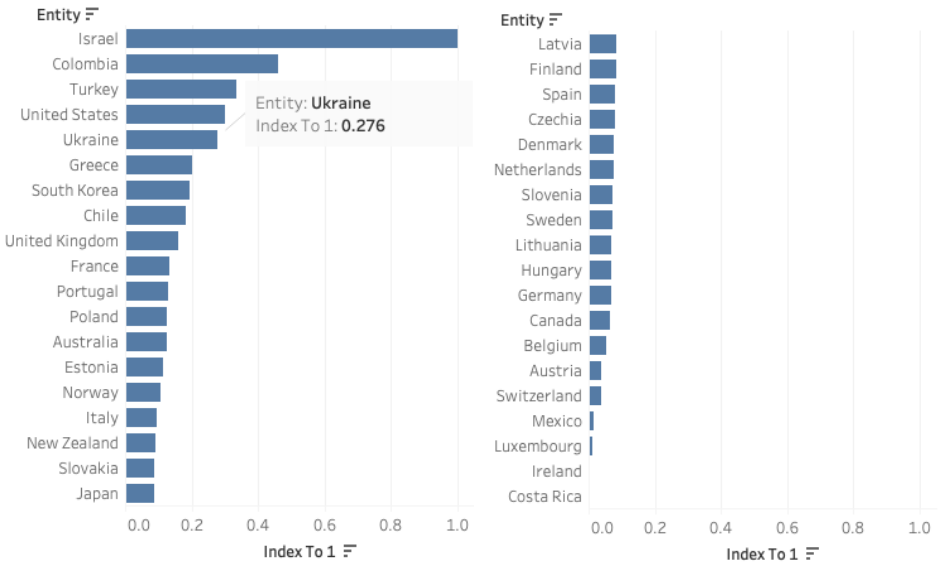

Figure 6. Computed crisis experience index in OECD countries and Ukraine

By the crisis experience index Ukraine is included in top 5 countries, considering OECD sample. Based on Gründler et al. (2021), but with using more simple weights, the distribution of crisis experience index in OECD countries and Ukraine is depicted on Figure 4.

The next step was to use OLS model and quantile to obtain preliminary results by regressing the vaccination rate on such explanatory variables which express as economic, demographic, government and health-related factors, along with newly created crisis experience index. As it is hard to account for all possible factors which may impact vaccination rate in a certain country, in order to prevent biasness at early stage, in regression I use a binary control variable, that corresponds to the geographical region of the country and to the start of booster vaccination process.

Using OLS and quantile regression allows to observe an effect of various factors on the vaccination rate. Moreover, Wald test was made to analyze whether the results of quantile regression are statistically different in various quantiles. As a result, only 2 out of 12 explanatory variables are statistically significant in the OLS model. R-squared = 0.84, variables included into analysis explains 84% of vaccination rates.

As was assumed, the intensity and harder outcomes of the crisis, which the country has experienced, leads to a higher vaccination rate against COVID-19. The OLS model suggests, that on average, a 1 p.p. increase in the crisis experience index leads to a 60.5 dozes increase in vaccination rate. Such a result is supported by the theory of Gründler et al. (2021), where the investigation was made on the basis of OECD countries. However, due to the model such a rule applies to more countries than OECD countries, as my analysis, is based on 98 countries and this factor still has a positive significant impact on the vaccination rate. The explanation of such a confirmed hypothesis is that countries which have experienced crises caused by military conflicts or natural disasters are prone to prevent other possible crises, that's

why invest and promote vaccination more. The first results of the regressing simple OLS and quantile models are presented in Table 3.

Table 3. Estimation results of OLS and quantile models (dependent variable – Vaccination rate)

Variable	OLS	Quantile regression			Wald test
		10%	45%	85%	
Intercept	-225.05***	-199.8	-180.1	-131.9	
Log(GDP per capita)	14.08	20.37	-6.24	-7.14	*
Confirmed COVID-19 deaths	0.005	-0.001	0.15	0.009	*
Elderly population	1.375	1.838	1.096	-3.163	-
Stringency index	0.213	0.067	0.324	0.511	
Log(Health expenditures)	5.54	-1.404	23.197	52.953	**
Crisis experience index	60.524**	-25.767	9.909	-30.807	
Rule of law	111.673***	27.502	65.200	119.451	
Government efficiency	6.194	66.972	99.059	92.118	
Government expenditures on education	3.039	3.929	-1.580	-2.172	-
Immunization of BCG	0.063	0.065	-0.158	0.030	
Democracy index	-0.647	0.708	-0.589	-1.445	
Gini index	-0.52	-0.714	-0.283	-0.206	
East Asia Pacific Region	31.129**				
Europe and Central Asia Region	-7.448				
Latin America Region	47.883***				
Middle East and North Africa Region	--15.797				
South Asia Region	14.239				
Whether booster vaccination has started in Sep 2021	31.954***				
Observations	98	34	39	15	
R-squared	0.848				
Adjusted R-squared	0.813				

Note: "-"p<0.1, "*" p<0.05, "**" p<0.01, "***" p<0.001

At the same time, quantile regression provided negative coefficients in the 10% and 85% quantiles, which implies that in these quantiles, crisis experience has a

negative impact on the vaccination rate. It is an interesting investigation, as it has not been done before. The model suggests, that only 45% quantile crisis experience index does have a positive impact on the vaccination rate. Such a difference in results of OLS and quantile regression may be explained by the theory, as OLS coefficients provide an estimation that shows the relationship between explanatory and dependent variable by average and implies that the estimated coefficient is constant across the quantile, while Quantile regression provides more accurate estimation in a certain quantile.

Another hypothesis which was confirmed by the OLS model relates to the social factor – rule of law in the country. The model suggests, that with a 1% increase in the share of people that believe in the rule of low in the country, vaccination rate would increase by 111.67 administrated dozes against COVID-19 per 100 people. Which implies that if country enhance its justice system – more people will be vaccinated. This result is consistent with the literature of Lee et al. (2002-2003), as people's trust in rule of low stands as a poxy to the trust in government.

At the same time, quantile regression provides some interesting result in terms of various levels of vaccination rate and impact of factors on it. The model suggests that, 10% quantile of vaccination rate decreases by 0.014% for increase in 1 p.p. health expenditures, while at 85% quantile it would lead to increase by 0.52%. Such a result may be explained by the theory that countries which have a low vaccination rate cannot effectively increase it by growing expenditures into the health system. It implies that in the countries with a low vaccination rate, health expenditures are not the main factor which may influence vaccination rate.

However, some result contradicts an expectation: the OLS model implies that higher democracy in the country leads to a lower vaccination rate against COVID-19, as well as a higher Gini index causing a decrease in vaccination rate. Such results might occur due to limitations of data and due to possible causality and endogeneity, which possibly make estimations biased and inconsistent.

As countries are different and policies to promote vaccination, citizens' behavior and country's experience varies, I separate countries into 3 groups to investigate whether certain factors do have an impact on vaccination rate in certain type of countries. Due to the World Bank classification of countries by income, I separate them into low, middle and high income countries. The results of the regressing OLS model in terms of country's income classification are presented in Table 4.

Table 4. Estimation results of OLS (dependent variable – Vaccination rate)

Variable	Low income	Middle income	High income
Intercept	-70.99	-198.36**	-199.87
Log(GDP per capita)	-5.93	29.98*	-28.99
Confirmed COVID-19 deaths	0.09	0.01	0.01
Elderly population	9.21	0.39	-1.99
Stringency index	0.18	0.07	-0.64
Log(Health expenditures)	10.97	-5.53	52.03
Crisis experience index	7.145	-11.85	112.56
Rule of law	123.96	130.61**	155.86*
Government efficiency	-65.13	23.43	-73.44
Government expenditures on education	-2.82	4.65	1.09
Immunization of BCG	0.17	-0.19	-0.24
Democracy index	-2.01	-0.61	-12.17
Gini index	-0.44	-1.53**	3.77*
East Asia Pacific Region		27.81	118.40*
Europe and Central Asia Region		-9.48	59.84
Latin America Region	-31.26	37.79**	103.70**
Middle East and North Africa Region		-24.83	
South Asia Region	-6.41	5.61	
Whether booster vaccination has started in Sep 2021		34.70***	7.62
Observations	20	56	22
R-squared	0.927	0.749	0.963
Adjusted R-squared	0.724	0.626	0.845

Note: "-" p<0.1, "*" p<0.05, "**" p<0.01, "***" p<0.001

Observing results in low income countries, there are statistically zero effects, which implies that there are no statistically significant conclusions. Such an outcome may be caused by the fact that truly significant factors which impact the vaccination rate are omitted. For instance, income countries may have a supply of a vaccine as a main factor which impact the vaccination rate, but as in my model such variable is omitted (due to the difficulties to get such data), the problem of bias occurs. Another possible reason of insignificant results is low number of observations.

Considering middle income countries, I found that country's GDP have a positive impact on vaccination rate. On average, in middle income countries, 1% increase in GDP will lead to increase in vaccination rate by 0.29 doses per 100 people. It may be proved by the economic theory, that GDP represents the development of the country and possibility to afford more. Thus, increase in GDP implies ability of country to afford more vaccine, more promotion of vaccine etc., this will lead to increase in the vaccination rate.

In both middle income and high income countries, such social factor as rule of law is statistically significant and has a positive impact on vaccination rate. In the middle income countries, a 1% increase in the share of people that believe in the rule of low in the country, vaccination rate would increase by 130.61 administrated dozes against COVID-19 per 100 people, while in the high income countries it would lead to higher increase in vaccination – by 155.85 administrated dozes. Also, such a social-economic factor as Gini index has a significant effect on vaccination rate. Gini index represents income inequality between social groups in the country. Thus, in the middle and high income countries the impact of income inequality different. In the middle income countries, increase in the index of income inequality by 1 p.p. will lead to decrease in vaccination rate by 1.53 administrated dozes against COVID-19 per 100 people. While in high income countries impact is completely different, as increase in the index of income inequality by 1 p.p. will lead to

increase in vaccination rate by 3.77 administrated dozes. This is an interesting results and it may be explained by the fact that the higher inequality is, less amount of individuals will have a high income in the country, and as high-income countries more often imposed programs for promoting vaccination, then in order not to be ill on COVID-19 and pay for treatment, people with small income will have a willingness to vaccinate. Thus, different promotions of vaccinations may be imposed more in high-income countries, than in middle-income countries.

5.2 Estimation results in the analysis of survey in Ukraine

To evaluate the impact of people's social attitude to various factors on desire to vaccinate, which is considered to be a preventing measure from COVID-19 illness, I use available survey data from Ukraine. Due to the limitations of data and absent question regarding desire to vaccinate, I use a proxy. Due to Lam et al. (2022) study, people's desire to vaccinate and thoughts about effectiveness, are strongly correlated with their attitude to vaccination. Therefore, I use such preventing measure as mask, as a proxy. Moreover, to analyze it from different perspectives, I build two models, which will include the same explanatory variables and different variables of interest, which will express people's attitude to wearing masks. I consider estimated results may be applied to people's attitude to vaccinate, correspondingly.

Analyzing people's attitude to the effectiveness of wearing masks against COVID-19, I use answers for the question "In general, wearing masks in public places is effective in protecting you from COVID-19?" as a dependent variable. As, there are 5 possible answers, for further analysis Multinominal Logit Model would be proper regression for analysis. As such model account for various answers from the respondents and divide estimated results into possible cases of answers. Moreover, for more efficient interpretation of results, I have grouped answers "Rather DON'T trust" and "DON'T trust at all" into the "Don't trust" and combined answers "Rather trust" and "Totally trust" into "Totally trust". In the analysis, I use

the answer "Don't agree at all", as a baseline category for the dependent variable and "Don't trust" for independent variables. Also for explanatory variables, for the question about size of the city of living I use "more than 1 mn people" as a baseline category, for the question about education – "No education", the gender variable – female, as a baseline category and for age I use "18-24" as a baseline. The results of the regressing Multinomial logit model are presented in Table 5.

Table 5. Estimation results of Multinominal Logit Model (dependent variable – "In general, wearing masks is effective in protecting from COVID-19")

Variable	"In general, wearing masks is effective in protecting from COVID-19"	
	Hard to say	Totally agree
Intercept	-3.35***	-1.11
Trust in Ministry of Health[Totally trust]	0.06	0.59**
Trust in Ministry of Health[Hard to say]	0.86	0.75*
Trust in medical workers [Totally trust]	1.16	0.24
Trust in medical workers [Hard to say]	1.93**	0.21
Trust in online news[Totally trust]	-0.99	0.12
Trust in online news[Hard to say]	1.06	0.37
Trust in WHO [Totally trust]	0.83	0.98***
Trust in WHO [Hard to say]	-0.79	0.22
Rule of law [Totally support]	0.48	1.56***
Rule of law [Hard to say]	0.12	0.50
Gender[male]	-0.16	-0.08
Education [High]	-1.83	-0.03
Education [Phd]	0.17	1.07
Education [Average]	-1.68	-0.75
Education [Not finished high]	-0.67	-0.47
Size of city [100 thnd – 1 mn]	-0.17	-0.27
Size of city [50 thnd – 100 mn]	-0.58	-0.23
Age [25-34]	0.34	0.38
Age [35-44]	1.21	0.60**
Age [45-60]	1.8	0.65**

Note: "-"p<0.1, "*" p<0.05, "**" p<0.01, "***" p<0.001

Due to the Likelihood Ratio Chi-square test, the null-hypothesis is rejected, and I conclude that at least one population slope is different from zero. This implies, that the model may be observed in the following analysis.

The log-odds of being totally agree that wearing masks is effective (relative to "Totally disagree"), for those who totally support applying rule of law in wearing masks is predicted to be 1.56 points higher than for those who don't support applying law punishments for not wearing masks. It provides us a conclusion that those people, that support applying rule of law, more probably would agree that masks are an effective measure against COVID-19 spread and less probably will totally disagree with this, compared to those people, that do not support rule of law in this case. Such a result leads to the conclusion, rule of law is a significant factor, and has a direct impact on people's thoughts that wearing masks and vaccination rate are effective measures. Thus, inside the country law-based and punishment restrictions would increase people's thoughts that wearing masks and to be vaccinated is an effective measure.

The log-odds of being totally agree that wearing masks is effective (relative to "Totally disagree"), for those who trust in Ministry of Health and for those who undecided, is predicted to be 0.59 and 0.75 points higher than for those who don't trust in the Ministry of Health, respectively. Such a result base on the Ukrainian survey corresponds to the results made by Lazarus et al. (2021) on the survey in 19 countries. In mentioned study the strong relationship between trust in government and likelihood to vaccinated have been estimated. This result implies that announcements and actions regarding protection methods against COVID-19 made by Ministry of Health possibly have a positive impact on decision-making of people who trust in this government institution and didn't decide whether they trust.

Due to the model, those people, that do trust in the information provided by WHO, more probably would agree that masks are effective measure against COVID-19 spread comparing to those people, that totally don't trust in WHO

information. As the log-odds of being totally agree that wearing masks is effective (relative to "Totally disagree"), for those who totally trust in the information provided by WHO is predicted to be 0.98 points higher than for those who don't trust in WHO. This implies that people trust in WHO may lead to people's trust in mask effectiveness.

Besides, an interesting observation is that people of the age 35-60 are more probably consider wearing mask as an effective measure, than young people of the age 18-24. Such a results very similar to the result of analysis of Lazarus et al. (2021), where on the basis of survey in 19 countries were estimated that people aged more than 25 are more likely accept a vaccine than people aged 18-24.

Continuing analysis with changing a baseline answer in the explanatory variables and using all 5 possible answers, results of the model slightly changes. Thus, results of the model where baseline is the answer "Totally trust" is presented in the Appendix A. The log-odds of hard to say whether wearing masks is effective (relative to "Totally disagree"), for those who totally don't trust in online news is predicted to be 7.79 points greater than for those who totally trust in online news. Such result implies that those people, that do not trust in news in the internet most probably would not have a certain opinion regarding whether masks are effective measure against COVID-19 spread comparing to those people, that trust in online news.

Secondly, analyzing likelihood that people wear masks against COVID-19, I would use answers for the question "How likely are you to wear a mask in public during the official quarantine?" as a dependent variable. As respondents had to answer the probability, answer is restricted in the range from 0 to 1. For the investigation of relationship, I would use OLS model. All baselines for both dependent and independent variables are the same as in the previous analysis.

The results of the regressing OLS model are presented in Table 6.

Table 6. Estimation results of OLS model (dependent variable – "How likely are you to wear a mask in public during the official quarantine")

Variable	"How likely are you to wear a mask in public during the official quarantine"
Intercept	60.93***
Trust in Ministry of Health[Totally trust]	3.61
Trust in Ministry of Health[Hard to say]	0.35*
Trust in medical workers [Totally trust]	3.71
Trust in medical workers [Hard to say]	0.59
Trust in online news[Totally trust]	5.78**
Trust in online news[Hard to say]	4.06
Trust in WHO[Totally trust]	4.31
Trust in WHO [Hard to say]	-2.40
Rule of law [Totally support]	17.57***
Rule of law [Hard to say]	14.79***
Gender[male]	-3.33
Education [High]	-4.92
Education [Phd]	-5.73
Education [Average]	-1.04
Education [Not finished high]	-3.42
City size [100 th – 1 mn]	-6.39***
City size [50 th – 100 th]	-6.12*
Age [25-34]	1.85
Age [35-44]	3.81
Age [45-60]	1.39
Observations	927
R-squared	0.17
Adjusted R-squared	0.15

Note: "-" p<0.1, "*" p<0.05, "**" p<0.01, "***" p<0.001

The model suggests, that compared with people, that do not support applying rule of law in COVID-19 restrictions all possible options for answering this question, have a significant positive impact on the probability that person will wear a mask. Thus, the probability that the person that supports applying rule of law will wear a mask to prevent COVID-19 disease is by 17.57% higher than of person, who do

not support at all. Moreover, the probability that the person that didn't have a certain opinion about supporting rule of law will wear a mask to prevent COVID-19 disease is by 14.79% higher than of person, who do not support at all. It implies that people which will support or even didn't decide about applying strict law restrictions regarding wearing masks or vaccinations, most probably will apply these measures and wear a mask or make a vaccine.

The probability that a person who trusts in online news will wear a mask in order to prevent COVID-19 disease is by 5.78% higher than of a person, who does not trust in online news at all. Such a result implies despite the fact, that online news is often controversial and there are both beliefs for and against vaccination, people that trust them are more likely to apply preventing measures.

Besides, the model suggests that on average, that probability that people who didn't decide whether they trust in the Ministry of Health of Ukraine, will wear a mask to prevent COVID-19 disease is higher by 0.35% than of a person, who does not trust in in the Ministry of Health of Ukraine at all.

Also, the model suggests, that probability that the person that lives both in a city with a population in the range from 100 thnd to 1 mn people and in the range from 50 thnd to 100 thnd people, will wear a mask to prevent COVID-19 disease is lower than of person, which lives in a big city with a population more than 1mn people by 6.39% and 6.12%, correspondingly. As population of the city express also the size and level of development of the city, such a result implies that people from not developed cities are less likely to vaccinate.

To summarize, both macro-level analysis and survey in Ukraine brought interesting and surprising results. Various models confirmed that only the crisis experience index and rule of law have a significant and positive impact on vaccination rates, which may bring a difference in vaccinations among countries. At the same time, economic and demographical hypotheses were not confirmed on the aggregated data due to data limitations and presence of endogeneity. However, survey in

Ukraine has proved that rule of law has a real impact on peoples' willingness to apply preventing measures against COVID-19.

Chapter 6

CONCLUSIONS

This study is conducted to investigate key factors which impact on vaccination rate against COVID-19 in different countries. To observe all possible factors, I have analyzed possible economic, social, demographic and political factors, taken as macro-level data from various sources, such as World Bank, Our World in Data, World Values Survey, etc. Besides, based on Gründler et al. (2021) study, I have created crisis experience index using PCA analysis to investigate the impact of past crisis inside the countries on their vaccination rate. Moreover, to enhance analysis I have conducted an analysis of a survey in Ukraine, to observe the impact of social factors on vaccination based on the individual-data survey provided by Gradus. Although the survey does not have a question about vaccinations, due to Lam et al. (2022) findings that people's attitude to vaccination against COVID-19 is associated with their attitude to wearing masks, I am using respondents' attitude to wearing a mask, as a proxy.

Investigating macro-level data, I have obtained a surprising result that only social factor and crisis experience index do have an impact on the vaccination rate against COVID-19. Applying the OLS model, I have obtained a result, confirming the hypothesis that countries with strong experience of crisis in the past do have higher vaccination rates because the government of such countries knows how long-lasting the negative effects of crisis might be and therefore they put great effort in vaccination to prevent crisis. Such a result not only confirms the findings in Gründler et al. (2021) study that crisis experience has an impact on vaccination rates in OECD countries, but also ensures that such impact exists on average, in all countries, as this thesis investigates 98 countries. Moreover, the hypothesis that such social factor as rule of law in the country has a high impact on the vaccination rate has been confirmed, providing an estimation that on average, a 1% increase in the

share of people that believe in the rule of law in the country, vaccination rate would increase by 111.67 administrated dozes against COVID-19 per 100 people. Moreover, such an impact of rule of law has been confirmed in both middle and high income countries, showing that in high-income countries the effect is even higher. Although the OLS model hypothesis regarding the impact of demographical and economic factors was not confirmed, due to the data limitations and endogeneity problem, quantile regression, has provided interesting results. Thus, the model suggests that, increase in health expenditures at 10% quantile slightly decreases the vaccination rate, while at 85% quantile it would lead to an increase in vaccinations. Such a result brings an assumption that those have a low vaccination rate cannot effectively increase it by immediately growing expenditures into the health system, thus health expenditures may be not the main factor of impact on the vaccinations for such countries.

To observe deeply sociological factors and their impact on people's desire to apply to prevent measures, a survey in Ukraine have been analyzed. As a result, rule of law in the country, especially applying strict punishments for not wearing a mask/being vaccinated, has a significant and positive impact on people's probability to wear masks/vaccinate and persons' trust in its effectiveness. Also, the hypothesis that citizens who trust in the WHO and trust in the Ministry of Health, compared to those who don't trust, has a positive impact on the persons' thoughts about effectiveness of preventive measures, however it would not have an effect on probability of following these measures.

Also, analysis in Ukraine provided the same pattern as an analysis of international surveys of Lazarus et al. (2021): people aged 25-60 are more likely to think that wearing masks and having a vaccine are an effective measure. Moreover, the place of living has a great impact on the probability that a person will apply preventing measure, as people who are living in average-size cities in Ukraine, are less likely to wear a mask/vaccinate than people that live in big cities.

As my study has data limitations, there is still room to add additional value to the research. On the macro-level analysis, exploring more countries and adding variables accounting for the supply of vaccines in the country may show more significant results. Moreover, getting rid of endogeneity may provide significant results regarding the impact of GDP per capita on the vaccination rate. Besides, this study opens an opportunity to continue analyzing based on Gründler et al. (2021), whether the such a country as Israel drives crisis experience to have a significant impact on vaccination. In the case of micro-level analysis, the research based on the straightforward question about citizens' attitudes to vaccination should be done, to ensure that results are consistent with results based on the proxy in this thesis.

In general, as this research is consistent with the theory and literature, it confirms the impact of crisis experience and the rule of law on vaccination rates against COVID-19 in the countries. Moreover, the research has continued the study of Gründler et al. (2021) and ensures that crisis experience has an impact on vaccinations not only in OECD countries, but in more countries.

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APPENDIX. A

Table 7. Estimation results of Multinominal Logit Model (dependent variable – "In general, wearing masks in public places is effective in protecting you from COVID-19") in case when answer "Totally trust" – is a baseline.

Variable	"In general, wearing masks in public places is effective in protecting you from COVID-19"			
	Hard to say	Totally agree	Rather agree	Rather DON'T agree
Intercept	13.65***	28.89**	28.32*	29.94*
Trust in Ministry of Health[DON'T trust at all]	0.49	0.97	1.24	2.39**
Trust in Ministry of Health[Hard to say]	2.10	2.16*	2.69*	2.67*
Trust in Ministry of Health[Rather DON'T trust]	1.30	1.57*	1.77**	2.29**
Trust in Ministry of Health[Rather trust]	0.71	1.87**	1.81**	2.02**
Trust in medical workers [DON'T trust at all]]	-11.33***	-12.08**	-10.96***	-11.20***
Trust in medical workers [Hard to say]	-9.67***	-10.93***	-9.89***	-10.24***
Trust in medical workers [Rather DON'T trust]	-11.66***	-10.70***	-10.00***	-10.16***
Trust in medical workers [Rather trust]	-10.47***	-10.64***	-9.89***	-10.08***
Trust in online news[DON'T trust at all]	7.79***	-5.52	-5.73	-6.15
Trust in online news[Hard to say]	8.64***	-5.66	-5.35	-5.50
Trust in online news[Rather DON'T trust]	7.18***	-5.88	-5.96	-5.58
Trust in online news[Rather trust]	6.51***	-5.88	-5.90	-5.59
Trust in WHO [DON'T trust at all]	-12.09***	-12.32***	-12.16***	-10.13***
Trust in WHO [Hard to say]	-11.52***	-10.88***	-11.22***	-9.59***
Trust in WHO [Rather DON'T trust]	-9.91***	-11.07***	-10.63***	-9.30***
Trust in WHO [Rather trust]	-9.98***	-10.61***	-10.50***	-9.75***
Rule of law [DON'T support at all]	-2.57**	-5.91**	-3.88***	-2.16***
Rule of law [Hard to say]	-1.35	-2.45***	-2.07**	-1.51
Rule of law [Rather DON'T support]	-1.06	-3.05***	-1.43**	-0.41
Rule of law [Rather support]	-0.89	-1.57**	-0.59	-0.23
Gender[male]	0.37	0.18	0.32	0.25
Education [High]	-1.14	0.47	0.05	0.25
Education [Phd]	17.42***	18.15***	17.63***	16.60***
Education [Average]	-0.35	0.12	0.49	1.07
Education [Not finished high]	-0.19	-0.18	0.09	0.39

Table 7. – Continued

Observations	927
Log likelihood	-965.27

Note: "-"p<0.1, "*" p<0.05, "**" p<0.01, "***" p<0.001