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AKADÉMIAI KIADÓ

The economic and social determinants of vaccine hesitancy in Romania during the COVID-19 pandemic

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ABSTRACT

The COVID-19 pandemic affected all countries both in social and economic dimensions. Currently, vaccination is considered to be one of the most efficient solutions which can stop the further spread of the virus. Therefore, the paper aims to understand the factors that determined the social approval of the COVID-19 vaccines in Romania. To get a detailed picture on the situation, we looked not only at economic variables, but also at social and demographic components. Accordingly, the findings of the analysis list the variables that significantly influence the vaccination rate nationwide. The social approval (or the refusal) of these shots is a complex issue, thus it is essential that policymakers make decisions based on scientific evidence. The practical relevance of the paper lies in the two policy implications suggested (i.e., transparent and predictable policymaking and adjustments on the level of the education system in the long run for similar situations), which also highlight the importance of evidence-based decision-making processes in public health. Our analysis method consists of multivariate cross-sectional OLS regressions.

KEYWORDS

vaccination, vaccine hesitancy, COVID-19, pandemic, Romania

JEL CLASSIFICATION INDICES

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1. INTRODUCTION

COVID-19 can be considered one of the most severe pandemics so far, based on the number of infections. Our paper focuses on Romania, a country that has major deficiencies in preventive medicine. Based on the data provided by European Centre for Disease Prevention and Control (ECDC), Romania was well below the European average COVID-19 vaccination rate, as shown in Figure 1. Despite its often-deadly nature and the severe post-COVID conditions, not even half of the Romanian population decided to pursue prevention. Our research attempts to identify the factors that strongly influence the vaccination rate in Romania, considering all (urban and rural) settlements. We aim to understand the factors that have deterministic effects on the approval (and refusal) of COVID-19 shots.

The COVID-19 vaccination rate in Romania was significantly influenced by socio-economic factors. We believe that the percentage of minorities in a given settlement (social aspect), the number of firms, total revenue/profit or the unemployment rate (economic factors) could have a deterministic effect on the approval of the vaccination by people. Trust in the government, from our perspective, also plays a crucial role in the phenomenon, therefore, participation rate in the last parliamentary election was considered a proxy.

Our method – using country-specific regression models with municipalities as observations – is novel in the literature, as the behavioural issues such as vaccine hesitancy are usually analysed using survey data. We believe, however, that using individuals as observations – given strong datasets – yields more robust results than conducting analyses on the level of municipalities. However, to maximize the precision of our analysis given the data and resource constraints that researchers generally face in Romania, we decided to test our results' robustness within the bounds of these constraints. Large-scale survey data-based research is still relatively rare in Romania, and we strongly encourage both academia and the public sector to increase their support on the quantitative analysis of social issues.

The policy implications (i.e., two main implementable recommendations for Romania) concluded from the analysis offer a high practical relevance for the paper. To save human lives, both short-term adjustments and long-term implementations are needed by policymakers. Such papers highlight the importance of evidence-based decision-making, an approach greatly

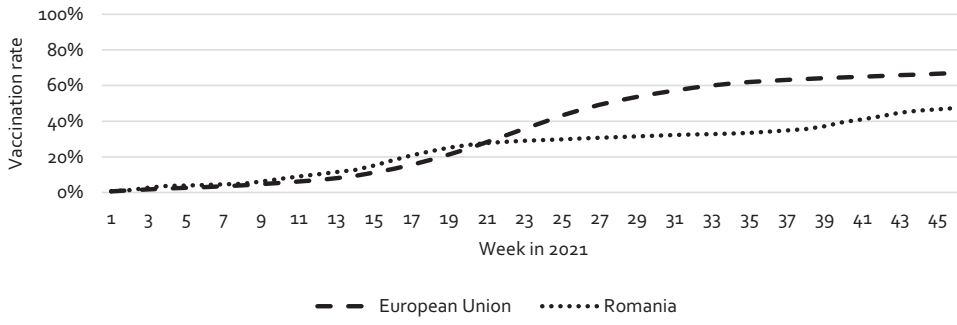

Fig. 1. Vaccination in the EU and Romania, 2021 (%)
Source: ECDC (2022) and own construction.

neglected in Romania. The theoretical relevance is directly connected to the practical benefit. No such scientific research (i.e., influencing socio-economic factors of the vaccination rate) has been delivered for Romania or to other countries which have low vaccination rates at this moment.

The structure of our paper is as follows: Introduction is followed by a detailed review of the current literature. Afterwards, data collection, explanatory and dependent variables and issues in our data are explained, followed by the presentation of the methodology (i.e., cross-sectional OLS regression). The following section presents the analysis of results, which leads to the policy implications. We reconsider the main aspects of the results and present the paper's limitations and further research implications in the conclusion.

2. THEORETICAL BACKGROUND

The literature on vaccine hesitancy/refusal and its historical precedents is vast. Following the recommendations of Durach et al. (2017), we have conducted a systematic literature review to identify and summarize relevant findings in the literature. We utilized several combinations of keywords to retrieve a sample of potentially relevant literature: "vaccination", "vaccine hesitancy", "COVID-19", "pandemic", "Romania". The search has been performed in the Clarivate Web of Science database on June 18, 2022. The keyword-based search resulted in an initial pool of more than 500 articles. After the elimination of duplicates, abstracts were read to restrict our sample to relevant topics, complemented by full-text analysis, which resulted in 22 relevant articles: 3 with qualitative approach and 19 using quantitative methods, out of which 5 use regression models, as behavioural phenomena such as vaccine approval and/or hesitancy are mainly analysed based on surveys. Figure 2 shows the exact distribution of the papers, based on the chosen method.

The approach we have used (regression model focusing on a specific country) is relatively original: of the 5 previously mentioned articles using regression models, only 2 consider the case of a particular country in the era of the pandemic (Italy and the UK). One country-specific article covers an earlier period, and the other two did not focus on countries. Furthermore, no paper was delivered on this specific topic for countries like Romania, where vaccine refusal is high. These papers – regardless of their scientific approach – consider multiple dimensions as

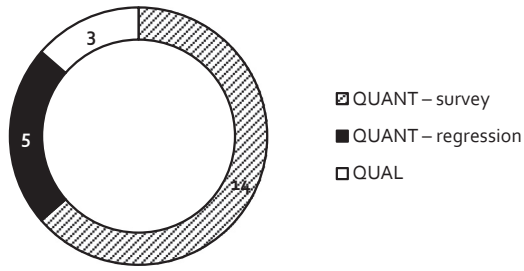

Fig. 2. Distribution of the articles analysed in the theoretical background
Source: Own construction.

potential factors of vaccine hesitancy/approval (Nagy et al. 2021). We have reviewed the literature based on 5 dimensions: education, economy, trust, nationality and marital status.

Education is generally considered the main driving force behind vaccination (almost all articles include it as a determinant). Some scholars certify public opinion: Soares et al. (2021) found that individuals with a university degree were more likely to take the COVID-19 vaccine than those with lower-level education. Some surveys conducted in Romania underline a similar effect: citizens with university studies have higher vaccination rate than those without (Manolescu et al. 2021; Citu et al. 2022). The same finding has been concluded in more developed countries such as France (Schwarzinger et al. 2021). In the US, Malik et al. (2020) have found that reported acceptance of the COVID-19 vaccine increases with years of education. In Italy low education level of parents has been identified as a significant predictor of vaccine refusal (Bertoncello et al. 2020). The reason behind the negative relationship between education and vaccination is due to the gaps in knowledge of the low-educated cohort on efficiency and safety (Hudson – Montelpare 2021).

However, some papers have reached differing results: in Romania, the group that weakly opposes getting vaccinated (the *stricto sensu* vaccine hesitant) is the most educated cohort (IRES 2021a, 2021b). Some scholars even stated that secondary education graduates have the lowest vaccination acceptance rate (Viswanath et al. 2021). Furthermore, even one year of college education can be a significant predictor of anti-vaccinationism (or used to be before the pandemic) (Tomeny et al. 2017). However, it is almost generally accepted that vaccination correlates negatively with education but only to a certain extent: people educated to GCSE level were less likely to take the vaccine than both more and less-educated groups (Robertson et al. 2021). To conclude, in the case of education-vaccination relation only one pattern is clear: education does not consistently imply confidence (Larson et al. 2016).

Contradictory conclusions were identified in the case of the economic dimension as well. When referring to unemployment, some scholars state that unemployed people report a lower acceptance rate of a COVID-19 vaccine (Malik et al. 2020). Bertoncello et al. (2020), however, have found that employment status was not crucial (the study was based on the pre-COVID data and had even internal validity during the pre-COVID period). Scholars disagreed on unemployment and income: some papers state that those who lost income during the pandemic are more likely to delay take-up (Soares et al. 2021), which is exactly the link between economic welfare and vaccine hesitancy that we look for in our model. Others identify incomes above $200.000 as significant predictors of anti-vaccinationism (Tomeny et al. 2017). Despite this, almost all agree that economic hardship is a significant determinant of vaccine hesitancy (but not refusal).

Referring to the level of trust, some scholars state that lack of confidence in authorities is a leading cause of anti-vaccinationism (or used to be before the pandemic) (Kata 2012). Surveys from Romania have concluded similar results: Two of the main reasons for vaccine refusal nationwide are lack of trust in vaccines and the government (IRES 2021c). The former is often caused by the perception of financial gain of the pharmaceutical companies on vaccines (Miko et al. 2019). Romanian healthcare employees also see it as one of the two main reasons for hesitancy (Kose et al. 2021). Besides lack of trust in government, disagreement with government measures also drives vaccine refusal (Soares et al. 2021), although they looked at data from Portugal, a country with extremely high vaccination rates. Based on the explanations above, we can conclude that the lack of trust in the government can increase the chances of someone getting the vaccine (Dabla-Norris et al. 2021).

Besides these, minority origins are also a determinant factor, as they are significantly less likely to take the vaccine (Robertson et al. 2021). Studies have also documented unequal impact on morbidity and mortality in communities of immigrants and people of colour (Viswanath et al. 2021).

Our research also considers marital status, unlike most existing literature. Al-Mohaithef – Padhi (2020) stated that vaccine approval can be identified in the case of married couples, whereas singles account for the largest proportion of refusal.

Table 1 contains all the papers considered in this section, with general information and a collection of variables that the scholars included in their model (one or more variables constitute a dimension). In the case of two other dimensions (age and gender), no variables were included in the table, as these were not considered in our analysis (explained later). In the case of age, all articles state that older people are likelier to vaccinate themselves. However, in the case of gender, contradictory conclusions can be identified. In the UK men were statistically significantly more likely to take the vaccine than women (Robertson et al. 2021), whereas in Romania (in the case of healthcare workers) studies found that women were more willing to accept vaccination (Manolescu et al. 2021).

To summarise the above the COVID-19 vaccination rate in Romania is significantly influenced by education, economy, trust, nationality and marital status.

3. DATA AND METHODOLOGY

3.1. Data

Table 2 contains all used explanatory (11 by number) and dependent (3 by number) variables. Three variables – number of firms per person in a given town, firm revenues per person in a given town and the percentage of the population that qualifies as regular library-goers – could not be identified in any of the reviewed articles, as they cannot be interpreted when the observations are individuals. In all cases, the most recent available data was used. As to the independent variables, we used the total revenue and net income reported in the municipalities to find the relationship between the economic potential and vaccine hesitancy in a specific Romanian settlement. As shown in the scatterplot (Figure 3), the correlation between the two variables is robust and has a positive sign (correlation coefficient: 89%). Therefore, both could be used as a proxy for the economic prosperity of a particular municipality. In the end, we used revenue per capita.

Table 3 contains the descriptive statistics of all the independent variables used. In all cases, we used the most recent data available, thus these are not from the same period. The data were collected from official, government-led databases (i.e., the National Institute of Statistics), except for the three proxies of the economic potential (revenue per capita, profit per capita and number of companies). Well-known and reliable company registers (listafirme.ro and topfirme.ro) were used in these cases. These platforms collect information based on the latest balance sheets submitted by companies to the Ministry of Finance. The data for the participation rate in the 2020 elections variable – showing the voter participation rate in the 2020 December Romanian parliamentary elections – was collected from the database of the Permanent Electoral Authority of Romania.[1]

[1]Available at: https://prezenta.roaep.ro/parlamentare06122020/romania-map

Table 1. Articles considered and their variables

#	Author	Year	Method	*firm*	*reve*	*vote**	*mino*	*unet*	*libr*	*sing*	*marr*	*wido*	*divo*	*hhsl*
1	IRESa	2021	Survey					X						X
2	IRESb	2021	Survey			X								X
3	IRESc	2021	Survey											
4	Robertson et al.	2021	Regression				X							X
5	Soares et al.	2021	Regression					X						X
6	Dabla-Norris et al.	2021	Regression											
7	Bertoncello et al.	2020	Regression				X	X						X
8	Kata	2012	Identification											
9	Tomeny et al.	2017	Regression											X
10	Malik et al.	2020	Survey				X	X						X
11	Al-Mohaithef – Padhi	2020	Survey				X				X			X
12	Gerretsen et al.	2021	Survey				X	X						X
13	Viswanath et al.	2021	Survey				X	X						X
14	Karafillakis et al.	2016	Interview											
15	Deleanu et al.	2019	Survey											X
16	Kose et al.	2021	Survey											
17	Manolescu et al.	2021	Survey								X			X
18	Miko et al.	2019	Survey				X							
19	Citu et al.	2022	Survey				X				X			X
20	Schwarzinger et al.	2021	Survey					X						X
21	Hudson – Montelpare	2021	Review				X							X
22	Larson et al.	2016	Survey					X						X

Note: *or trust in vaccine/authorities. For eplanation of variables see Table 2.
Source: Own construction.

Table 2. Explanation of used variables

Variable	Explanation	Type	Year	Source
firm	Number of firms per person in a given town	independent	2020	listafirme.ro
reve	The natural logarithm of the firm revenues per person in a given town	independent	2020	topfirme.ro
vote	The participation rate in a given town in the 2020 December Romanian parliamentary elections	independent	2020	Permanent Electoral Authority of Romania
mino	The percentage of a given town's population that belongs to an ethnic minority group	independent	2011*	National Institute of Statistics
unet	The average unemployment rate in a town, from between August 2020 – July 2021	independent	08/2020 – 07/2021	National Institute of Statistics
libr	The percentage of the population of a town that qualify as regular library-goers	independent	2019	National Institute of Statistics
sing	The percentage of population that has never been married (omitted)	independent	2011*	National Institute of Statistics
marr	The percentage of population that is married	independent	2011*	National Institute of Statistics
wido	The percentage of population that are widowers	independent	2011*	National Institute of Statistics
divo	The percentage of population that is divorced	independent	2011*	National Institute of Statistics
hhsl	The percentage of population that graduated secondary education between 2010–2019	independent	2010–2019	National Institute of Statistics
vjul	The percentage of the population that was vaccinated at least with one dose by July 2021	dependent	05/07/2021	vaccinare-covid.gov.ro**
voct	The percentage of the population that was vaccinated at least with one dose by October 2021	dependent	05/10/2021	vaccinare-covid.gov.ro**
grpp	The difference between the vaccination rate in October and July (in percentage points)	dependent	–	own calculation

Note: *latest population census, **National COVID-19 vaccination information platform.
Source: Own construction.

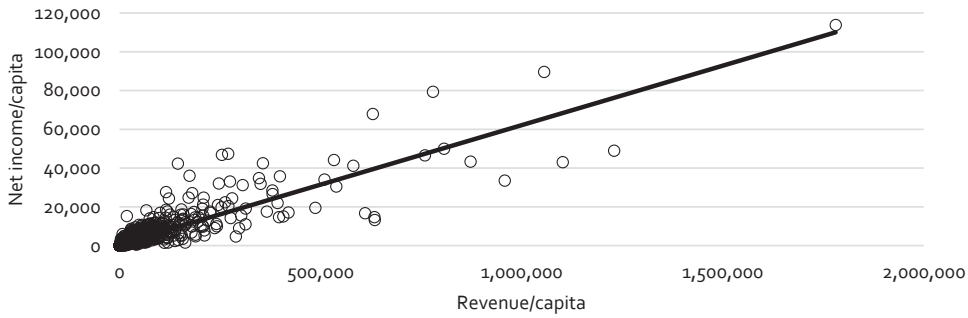

Fig. 3. Correlation between net income and revenue, 2020 (RON/capita)
Source: Topfirme.ro and own construction.

Table 3. Descriptive statistics of the explanatory variables

Category	*firm*	*reve*	*vote*	*mino*	*unet*	*libr*	*sing*	*marr*	*wido*	*divo*	*hhsl*
Mean	0.07	9.08	0.36	0.12	0.04	0.11	0.38	0.47	0.12	0.03	0.13
Standard error	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.06	8.99	0.34	0.02	0.02	0.09	0.38	0.47	0.11	0.03	0.12
Mode	0.08	8.42	0.37	0.00	0.02	0.07	0.40	0.50	0.11	0.03	N/A
Standard deviation	0.04	1.36	0.11	0.23	0.04	0.08	0.06	0.04	0.03	0.01	0.09
Sample variance	0.00	1.84	0.01	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.01
Kurtosis	11.00	0.88	3.58	5.76	16.47	4.54	1.53	0.92	0.57	1.03	2.87
Skewness	2.49	0.17	1.39	2.54	2.92	1.64	0.63	−0.52	0.60	0.71	1.34
Range	0.39	13.27	1.06	0.99	0.49	0.73	0.53	0.35	0.23	0.09	0.62
Minimum	0.01	1.12	0.08	0.00	0.00	0.00	0.20	0.24	0.02	0.00	0.00
Maximum	0.40	14.39	1.13	0.99	0.49	0.73	0.73	0.59	0.26	0.09	0.62
Observations	2,689	2,689	2,689	2,689	2,689	2,689	2,689	2,689	2,689	2,689	498

Source: Own construction.

In the case of the percentage of the population that graduated secondary education, the number of observations available was lower, therefore we drew up two regression models: one without (with 2,689 observations) and one including (with 498 observations) the percentage of population that graduated secondary education. To examine if the two regression models are equally representative, we analysed whether the means of the used explanatory variables are similar in the two datasets (Table 4). 10 independent variables were included in this process, as the data related to the field of education (i.e., the percentage of population that graduated secondary education) had been considered only in one regression. We compared the sample

Table 4. Comparison of the explanatory variables

Variable	Mean with *hhsl*	Mean without *hhsl*	Difference
firm	0.07	0.09	0.02
reve	9.08	10.03	0.95
vote	0.36	0.31	0.05
mino	0.12	0.12	0.00
unet	0.04	0.02	0.01
libr	0.11	0.16	0.05
sing	0.38	0.38	0.00
marr	0.47	0.48	0.01
wido	0.12	0.10	0.02
divo	0.03	0.04	0.01

Source: Own construction.

averages of each variable from the two datasets. The results show that the means are similar, except the number of firms per person. Elsewhere, the difference in the means was minor enough to conclude that the economic significance of this distinction was negligible. Unfortunately, in the case of the firm revenues per person, as the difference was large, the significance of the issue is more considerable.

Our aim was to find the variables affecting vaccine hesitancy, the vaccination rate was used as the dependent variable. The value of the rate in the beginning of July 2021 (05/07/2021) and October 2021 (05/10/2021) was used to have a reliable result. Data was extracted from the official COVID-19 database of Romania (vaccinare-covid.gov.ro). The descriptive statistics of the variables can be found in Table 5.

We also analysed whether the difference in the vaccination rate between the municipalities could occur because of the distinct availability of vaccination centres. Public health authorities set up several locations in all areas of the country where citizens could vaccinate themselves, however, some had to be closed due to low levels of interest. Numerous opinion polls also concluded that the location of the vaccination centres had not influenced the vaccination rate. One poll delivered by IRES in September shows that the main reason for refusal is the low or lack of trust in the vaccine, followed by the conviction that vaccination is unnecessary and the fear of adverse effects (IRES 2021c). An opinion poll led by the ICCV (ICCV Romanian Research Institute for Quality of Life 2021) uncovered lack of information as a new reason for refusal. Even though we have a spatial distribution of observations, we did not consider geographical/access issues. The reason for this is that none of the opinion polls pointed out distance or availability as a considerable determinant factor (Romania had multiple vaccination centers per municipality, thus the waiting time has been low at almost all times).

Table 5. Descriptive statistics of the dependent variables

Category	*vjul*	*voct*	*grpp*
Mean	0.13	0.17	0.03
Standard error	0.00	0.00	0.00
Median	0.12	0.15	0.03
Mode	0.12	0.10	0.03
Standard deviation	0.07	0.07	0.01
Sample variance	0.00	0.01	0.00
Kurtosis	1.06	0.85	2.54
Skewness	0.98	0.87	1.06
Range	0.44	0.47	0.11
Minimum	0.00	0.00	0.00
Maximum	0.44	0.47	0.11
Observations	2,689	2,689	2,689

Source: Own construction.

The cases considered in the analysis, as shown by the observations, are the municipalities of Romania. We use the following synonyms: cities, towns, settlements.[2] Based on data provided by MAE[3] (2010), Romania currently has 2,685 communes (these being formed by 13,285 villages), and 263 towns (out of which 82 cities). The most detailed data was available on this level, thus we decided to consider localities (communes and towns) as observations in order to increase the relevance of the results. However, in the case of some variables, data was missing for certain municipalities, thus the number of observations is lower than the number of municipalities (i.e., 2,948).

3.2. Methodology

We used a multivariate cross-sectional OLS regression, with the observations being different municipalities in Romania. Our primary dependent variables are the COVID-19 vaccination rate in July and October 2021 and the difference between the two (interpreted as the growth rate of vaccination) in the Romanian towns (the relevance and usefulness of this variable come from the reasons discussed in the previous section). As discussed in the previous section, the explanatory variables refer to different economic and social characteristics of the Romanian towns. We used, instead of the simple revenues/population variable, its log value – it is reasonable to

[2]According to the administrative division of Romania, the country is formed of communes (consisting of villages) and towns (municipalities being the more important towns).

[3]Ministry of Foreign Affairs.

suppose that the marginal effect of an increase in firm revenues relative to the population is decreasing. As mentioned before, many of the explanatory variables are not from the same time period as the dependent variable: firm revenues per person, number of firms per person, and the participation rate in the 2020 parliamentary elections are from 2020, minority population (i.e. the percentage of a given town's population that belongs to an ethnic minority group) and other demographic variables are from the 2011 census, the percentage of population that graduated secondary education is an aggregate from 2010–2018, the percentage of the population that qualify as regular library-goers is from 2019, while the unemployment rate (i.e. the average unemployment rate in a town between August 2020–July 2021) variable is an average from the months between August 2020 and July 2021.

3.3. Variables

Our model underlying the regression estimations assumes that the fundamental causes of vaccine hesitancy or refusal stem mainly from the social and economic circumstances, proxied by the aforementioned variables. Firm revenues and the number of firms per capita in towns are assumed to be good indicators of the level of general economic development, reflecting complex underlying historical, political, geographical causes and incentive structures that led to certain towns becoming relatively affluent (see Figure 4 for the bivariate relationship between the vaccination rate and per capita firm revenue).[4] Compared to these underlying historical developments, our economic indicators represent proximate causes; however, we assume that the primary and overwhelmingly important channel through which these underlying causes led to behavioural changes in the population (e.g. vaccine hesitancy) is the material base – i.e. precisely the level of economic prosperity and development.[5] The underlying causes can be interpreted as "institutions"[6] and institutional fluctuations in the way that Acemoglu and Robinson defined them. We impose additional restrictions: assume that the behavioural factors that we are interested in are only *indirectly* caused by these institutions, through education (as we will see) and their economic welfare (Acemoglu – Robinson 2012).

The unemployment rate is also a gauge of social welfare, which mirrors the effect of social disparities. These economic variables also act as controls for the voter participation rate variable, which measures trust in the authorities.[7] Trust in leaders is an essential determinant of vaccine hesitancy/refusal, but it is also directly determined by how well the "system" is perceived to work for people – and the measure of that is the level of prosperity attained in a particular region, e.g. a city. The minority ratio is another factor through which we can measure underlying historical

[4]Inequality, unfortunately, is not directly taken into consideration in our model, even though that would add an important degree of nuance to the effects of absolute "richness": it should be a central preoccupation of the Romanian researchers to gather data and map the current state of inequality on the micro level.

[5]The point to emphasize here is that there is no endogeneity resulting from leaving out these "underlying" causes from our model, as they aren't in a direct causal link with our dependent variable except through variables that we included in our regressions. There are exceptions to this, like education or the minority ratio, discussed separately.

[6]We use Douglass North's definition for institutions: 'Institutions are the rules of the game in a society, or, more formally, are the humanly devised constraints that shape human interaction.' (North 1990)

[7]Trust does not necessarily mean approval. We assume that someone voting or not is a good proxy of whether they believe that their voices are heard and that the democratic system represents the people, acting towards what is best for the population.

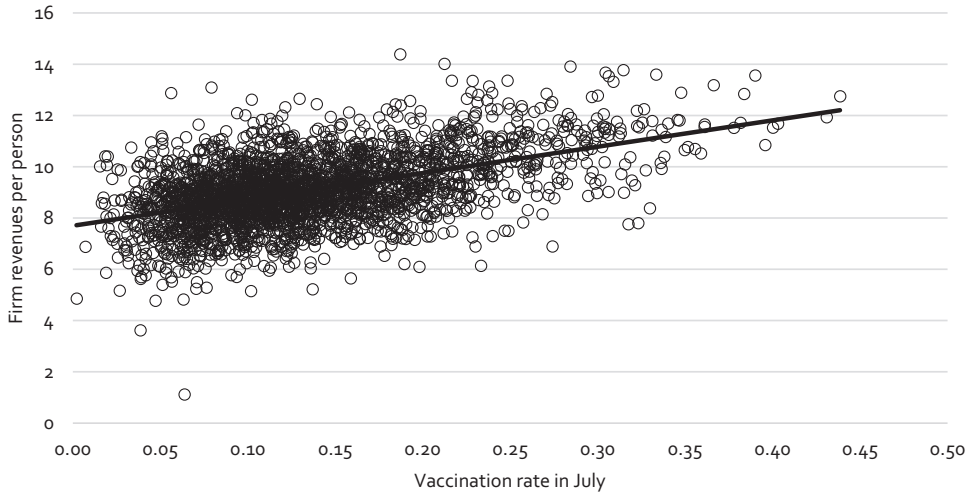

Fig. 4. Relationship between the vaccination rate and log per capita firm revenue, 2021
Source: Own construction.

effects: the distribution of minorities in the Romanian towns is the result of fundamental past processes, and it is related to vaccine hesitancy through the particularities of the complex relationship between minority communities and authorities/majority populations. The education rate is also an outcome of the institutional environment in Romania and the academic past of certain towns. It can directly affect whether people accept vaccines, as we have and will see. Marital status is an additional factor that might have behavioural importance. Taking the presented model and our assumptions as true, we believe that endogeneity does not significantly affect the conclusions of this paper.

It is worth mentioning that the link between trust in medical/political authorities and health outcomes is well documented.[8] It is not hard to see that there is a correlation between trust in the medical or political authorities and health outcomes. In the Romania's case, it might be true, for example, that trust in the medical authorities is driven directly by various failures of the health system, which is well known both on the population and on the official institutional level (Vlădescu et al. 2010).

The reason why the time distance between the recording of data doesn't lead to issues with identification is twofold: first, the voter participation rate, the unemployment rate, the revenue

[8]In particular, Alsan and Wanamaker's (2018) seminal paper on the Tuskegee experiment underscores this. The Tuskegee experiment (conducted in the US by the United States Public Health Service and the Centers for Disease Control and Prevention) aimed to document the effects of syphilis on older black men by giving mostly poor and illiterate subjects incentives to participate in the experiment and to leave their illness untreated – resulting in a painful and near-certain death. Most weren't even aware of what was going on, and thought they were getting some kind of treatment. The experiment was started in 1932, but after the press revealed what was happening in 1972, it was shut down – however, as the authors showed, the experiment had a long-term impact on older black mens' behaviour in the subject area: after it was revealed, there was a significant increase in medical mistrust and mortality among older black men, and physician interactions also declined.

and firm data are all from 2020–2021, from the COVID-crisis. This means that their observation is very close to that of the vaccination rate, both temporally and situationally, allowing us to treat them as observations from the same time period. The percentage of the population that qualify as regular library-goers, recorded in 2019, is close to our observation date. Although libraries were mostly closed during the COVID-crisis, the structural "cultural" effect that they proxy most probably stayed the same. The demographic variables are from 2011, from the main source of demographic data in Romania, the 2011 census – but they do not form a central part of our analysis.

In the case of the percentage of population that graduated secondary education, which is an aggregate of 10 years before 2018 and of which we already discussed the weaknesses, we constructed a new dataset and reran all regressions, with the percentage of population that graduated secondary education included. As shown in Table 6, the difference is that the education dataset contains only 498 observations, while the no-education dataset has 2,689 observations. Due to this, we treated the coefficients from the education-inclusive regressions with a grain of salt. It is important to mention that the percentage of population that has never been married variable is omitted since the variables standing for marital status are collectively exhaustive.

Running linear models, even though our dependent variable is bounded at 0 and 1, is justified by the fact that it is continuous and a negligible number of observations get close to its bounds. No observations had vaccination rates close to 100% – in July, the maximum was 43.85%, while in October it was 47.19% – and only 31 observations out of 2,689 in July had values lower than 3%, the rest being above it. The issue of heteroskedasticity is addressed by using heteroskedasticity-robust standard errors.

By running separate regressions, with the same explanatory variables, for the vaccination rate in July and October and their difference, we ensured that our observed effects aren't simply noise and determine the propensity to vaccinate at all points in time. As we will see, our results confirm this hypothesis. We ran three different regressions for the vaccination rate in July, October, the growth variable and the July vaccination rate with education, respectively. First, we used our main independent variables – the participation rate in the 2020 parliamentary elections, the minority population, the unemployment rate, the percentage of the population that qualify as regular library-goers – and added the number of firms per person as the variable representing general economic development. Then, we ran the same regression, replacing the number of firms per person with the natural logarithm of the firm revenues per person, in order to check for potential differences due to the characteristics of the two variables. Finally, we added the marital status variables to this second specification in order to check the sensitivity of our results to them.

The regressions we used are of the following form:

$$y_i = a + \sum_k^K \beta_{ik} x_{ik} + \varepsilon_i$$

where K is the number of variables, between 5 and 9, depending on the specification of the regressions. Our results can be seen in Tables 6 and 7.

4. ANALYSIS AND RESULTS

We primarily refer to the results from the regressions with the vaccination rate in July 2021 (Table 6), as the estimated coefficients for October indicate mostly the same effects – a look at

Table 6. OLS regression results based on vaccination rate in July 2021

Variables	(1) *vjul*	(2) *vjul*	(3) *vjul*	(4) *vjul*	(5) *vjul*	(6) *vjul*
reve		0.0222***	0.0175***		0.0334***	0.0238***
		(0.000970)	(0.000935)		(0.00223)	(0.00239)
vote	0.00583	0.0717***	0.0285***	0.0154	0.108***	0.0829**
	(0.00944)	(0.00998)	(0.0106)	(0.0366)	(0.0364)	(0.0363)
mino	0.0144***	0.0129**	0.0432***	0.00285	−0.0108	0.0172
	(0.00541)	(0.00570)	(0.00600)	(0.0139)	(0.0118)	(0.0117)
unet	−0.304***	−0.302***	−0.148***	−0.852***	−0.804***	−0.389***
	(0.0317)	(0.0306)	(0.0275)	(0.134)	(0.108)	(0.108)
libr	0.0593***	0.0619***	0.0252**	0.0958***	0.109***	0.0488
	(0.0133)	(0.0137)	(0.0126)	(0.0310)	(0.0340)	(0.0298)
marr			0.386***			0.410***
			(0.0281)			(0.0763)
wido			0.0567			0.0666
			(0.0436)			(0.127)
divo			1.609***			2.207***
			(0.105)			(0.199)
firm	0.875***			0.996***		
	(0.0354)			(0.0762)		
hhsl				−0.00776	−0.00211	−0.0596**
				(0.0316)	(0.0337)	(0.0267)
Constant	0.0751***	−0.0915***	−0.278***	0.0903***	−0.188***	−0.367***
	(0.00434)	(0.00980)	(0.0144)	(0.0139)	(0.0244)	(0.0381)
Contains education	No	No	No	Yes	Yes	Yes
Observations	2,689	2,689	2,689	498	498	498
R-squared	0.349	0.286	0.389	0.499	0.459	0.594

Note: Robust standard errors in parentheses; $^{***}P < 0.01$, $^{**}P < 0.05$, $^{*}P < 0.1$.
Source: Own construction based on Stata.

Table 7 should make this clear. Regression (1) in Table 7, which includes the July vaccination rate as an independent variable, is different for reasons that we discuss below. We will interpret the results for the growth rate afterwards. Looking at the models we constructed, one can discern

Table 7. OLS regression results based on vaccination rate in October and the difference between the vaccination rate in October and July 2021

Variables	(1) *voct*	(2) *voct*	(3) *voct*	(4) *grpp*	(5) *grpp*	(6) *grpp*
reve		0.0241***	0.0185***		0.00178***	0.000961***
		(0.00106)	(0.00101)		(0.000198)	(0.000212)
vote	0.00416	0.0757***	0.0255**	−0.00210	0.00389*	−0.00300
	(0.0104)	(0.0110)	(0.0116)	(0.00218)	(0.00219)	(0.00236)
mino	0.00439	0.00270	0.0383***	−0.0102***	−0.0102***	−0.00495***
	(0.00580)	(0.00617)	(0.00635)	(0.00113)	(0.00117)	(0.00125)
unet	−0.361***	−0.361***	−0.179***	−0.0555***	−0.0595***	−0.0317***
	(0.0359)	(0.0347)	(0.0308)	(0.00744)	(0.00762)	(0.00728)
libr	0.0598***	0.0632***	0.0217	0.000751	0.00132	−0.00352
	(0.0144)	(0.0149)	(0.0136)	(0.00312)	(0.00315)	(0.00315)
marr			0.473***			0.0879***
			(0.0298)			(0.00664)
wido			0.0509			−0.00661
			(0.0479)			(0.00993)
divo			1.774***			0.165***
			(0.112)			(0.0231)
firm	0.952***			0.0832***		
	(0.0383)			(0.00622)		
Constant	0.105***	−0.0751***	−0.298***	0.0292***	0.0166***	−0.0203***
	(0.00480)	(0.0108)	(0.0154)	(0.00103)	(0.00216)	(0.00311)
Observations	2,689	2,689	2,689	2,689	2,689	2,689
R-squared	0.351	0.284	0.398	0.136	0.108	0.184

Note: Robust standard errors in parentheses; ***$P < 0.01$, **$P < 0.05$, *$P < 0.1$.
Source: Own construction based on Stata.

several possibly strong determining factors of the vaccination rate in Romania. First, we can see that the number of firms per person and the firm revenues per person – both serving as proxies of economic development in different towns – are highly significant and positive in each regression. The coefficient on the number of firms per person implies that an increase of 0.1 in that variable could lead to a jump of nearly 9 percentage points in the vaccination rate in any

given town,[9] while a one per cent rise in firm revenue per population would lead to a jump of 2–3 percentage points in the vaccination rate. Similarly, the unemployment rate - which also serves as an indicator for economic prosperity – has a negative effect on the vaccination rate: our regressions predict that a one percentage point fall in the unemployment rate could lead to a vaccination rate higher by 0.15 or as much as 0.85 percentage points (the regression with demographic variables predicts a lower effect, suggesting that the other variables are filtering out omitted variable bias from the regressions - but the coefficient is still highly significant).

Both are linked to the effect of economic development on the vaccination rate, confirming the results of Bertoncello et al. (2020) and possibly those of Soares et al. (2021), who argued that those who lost income during the pandemic were more likely to refuse or delay the vaccine. We propose that there are two main channels through which economic development and these variables can affect vaccine hesitancy: through individual factors and through the "authority channel". Individual factors imply that a lower economic development and prosperity leads to a less educated population (as education has not only direct costs – especially because of the importance of private tutoring in the Romanian education system – but also, essentially, opportunity costs: children who are in schools cannot work to complement their family income, often an issue of central importance in the Romanian families), and to fewer valuable connections – people who can help them make the right choices and stay well-informed. However, as we will soon see, the relationship between the education level and vaccine hesitancy is tenuous and perhaps counterintuitive, so accounting for solely the individual factors might not be enough. The "authority channel" proposes that causality runs as follows: if the economy and the "system" doesn't work for you (meaning that one does not feel like one has a fair opportunity of providing for oneself or one's family), it can originate a feeling of being left behind due to poverty, thus the distrust in authorities (considered as being responsible for systemic failures). The consequence of this is that the authorities' guidance is ignored. It is important to mention here that the link between economic growth/development and social trust is well-established (e.g., Bjornskov 2012; Miniesy – AbdelKarim 2021), but causality is usually understood to point in the other direction – i.e., from social trust to higher growth (Kalish et al. 2021). In that sense, our variables can be seen as both proxies or determinants of social trust/trust in the government.

The importance of trust in the government as a determinant of vaccine hesitancy is reinforced by the participation rate in the 2020 parliamentary elections, which is highly significant and positive in most regressions. The voter turnout – which is an indirect method of measuring trust in the government, as e.g., Perry (2021) argued – can predict the vaccination rate because those who did not vote in the 2020 Legislative Elections in Romania most probably (but not exclusively) did so because of their lack of faith in democracy and the state. Inequality and the inefficiency of the local and the national political institutions can all lead to less trust in the state, which is well proxied by the vote ratio.

The minority population variable, which shows the percentage of ethnic minorities in the population of a given town, is positive and highly significant in the regressions that do not contain the percentage of population that graduated secondary education, possibly hinting at the fact that ethnic minorities are less vaccine hesitant. However, we observe that in the models

[9]It is worth mentioning that the maximum observed value of the number of firms per person is only 0.398.

including the percentage of population that graduated secondary education and minority population becomes insignificant and, in regression (5), it even becomes negative. A possible explanation is that including the percentage of population that graduated secondary education eliminates some endogeneity. This implication should not be surprising; it tells us that there isn't necessarily an intrinsic relationship between being part of an ethnic minority in Romania and vaccine hesitancy or refusal: the differences are determined by the different economic and social positions (expressed, e.g., by educational possibilities) of the given minorities, which can be the result of particular historical development trajectories. However, the regressions on the growth rate show a different result: we will return to this question shortly.

The percentage of population that graduated secondary education is statistically insignificant in all regressions (even the simple bivariate relationship between the vaccination rate and education is only weakly positive, see Figure 5). There are two good explanations for this observation: first, since our variable shows the percentage of recently graduated people, it is correlated with the age distribution of the town – and, as the IRES research shows from January 2021, older cohorts are likelier to take the vaccine than younger groups (IRES 2021b). Thus, the age effect that increases vaccine hesitancy might simply counterbalance the effect of education, that is reducing it. However, the IRES 2021b also found that the vaccine hesitant group (i.e., those who answered that they would probably not take the vaccine) was, in relative terms, the most educated. Similarly, Robertson et al. (2021) found that GCSE-level educated people were less likely to take the vaccine than *both* more and less educated groups. It is also possible that other variables – especially the economic ones, like the log of revenue per capita or unemployment – act as confounders between the percentage of population that graduated secondary education and vaccination rate in July, for the reasons enumerated when we discussed the interpretation of the coefficients on the natural logarithm of the firm revenues per person, the number of firms per person and unemployment rate. That is to say, education might simply be a channel through which the economic factors influence the vaccination rate – which is why we see that the effect reflected in the coefficients on economic variables only, not on the percentage of population that graduated secondary education. Overall, the common rhetoric that proposes that low education levels in Romania lead to vaccine hesitancy should be scrutinized: further research is necessary in this area.

We added variables concerning the marital status of the population, however, adding them did not change our results significantly, and it would be problematic to interpret the coefficients

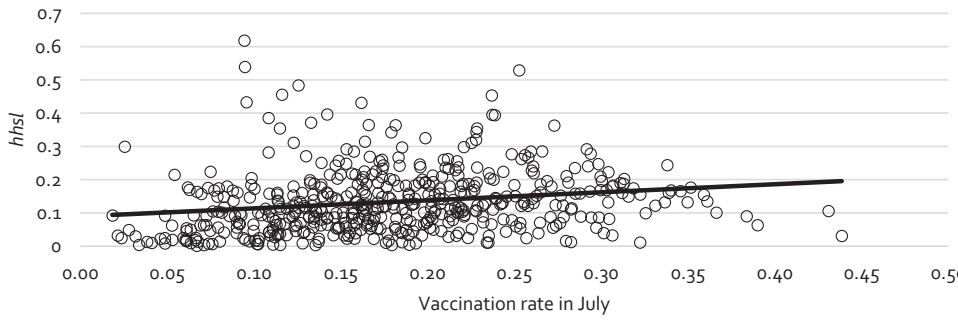

Fig. 5. Relationship between the vaccination rate and education, 2021
Source: Own construction.

on them as the effect of marital status manifests itself primarily on the individual level, and understanding their exact macro-level effect is beyond the scope of this paper.

Regression (1), Table 7 (October regressions) indicates that the July vaccination rates are very strong predictors of the October vaccination rates, explaining most of the variation in them (hence the high R^2 value). This is reflecting the fact that the persistence in vaccination rates is high, and that initial economic and social conditions were of overwhelming importance in determining vaccine hesitancy in the period analyzed by us. Here, the coefficients on the participation rate in the 2020 parliamentary elections and minority population are negative, for reasons discussed below, in the case of the growth regressions.

Compared to the levels regressions, a significant difference in the growth regressions is that the estimates on the voter participation rate in regressions (4) and (6) are negative and insignificant (in (5) it is still positive and significant). This could indicate a "fixedness" of the effects of this variable: for example, those who vote and vaccinate themselves when the government asked them to, probably did that right away and didn't wait until after July.

In addition, we can see that the estimates on the minority population variable switched signs and became significantly negative for growth rates – this seems to mirror the findings of e.g., Robertson et al. (2021) that some minorities are significantly less likely to take the vaccine than those in the Romanian majority (which, again, links to trust: minorities, often mistreated by authorities, have reason for social mistrust). This seemingly odd switch of signs could have an intuitive explanation: if the ethnic minority populations are more polarized than the majority populations – which, in this case, could mean that fewer people are sitting on the fence about vaccination – then a larger part of minorities would have requested the vaccine early on compared to the majority Romanian populations. Later, however, the vaccine hesitant in the majority population would have started getting the vaccine, while those who refused the vaccine initially in the minority populations would have kept doing so.

Regression (1) in Table 7 would suggest that the municipalities experiencing successes until July in the vaccination campaign are likelier to maintain their early lead, and those performing badly are unlikely to change. Looking at the data, we find a Pearson correlation coefficient of 0.426 between the vaccination rate in July and the growth variable, and one of 0.986 between the July and October vaccination rates. This indeed implies that the initial momentum predicts the future performance well, and that the authorities weren't able to overcome the fundamental determinants of hesitancy (Figure 6). Figure 7 shows the vaccination rates in histograms as well.

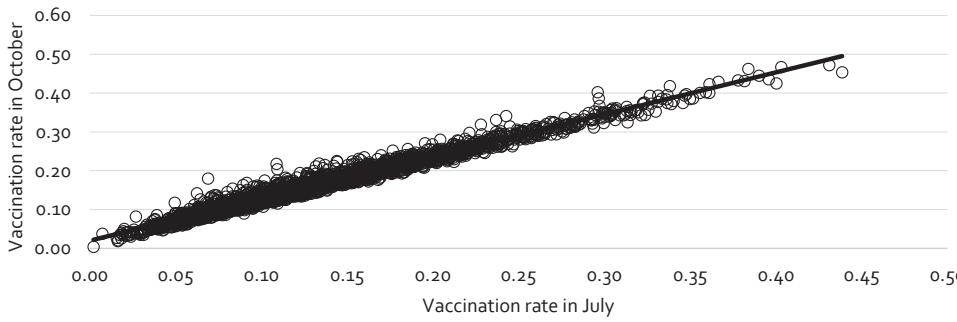

Fig. 6. Relationship between the vaccination rate in July and in October, 2021
Source: Own construction.

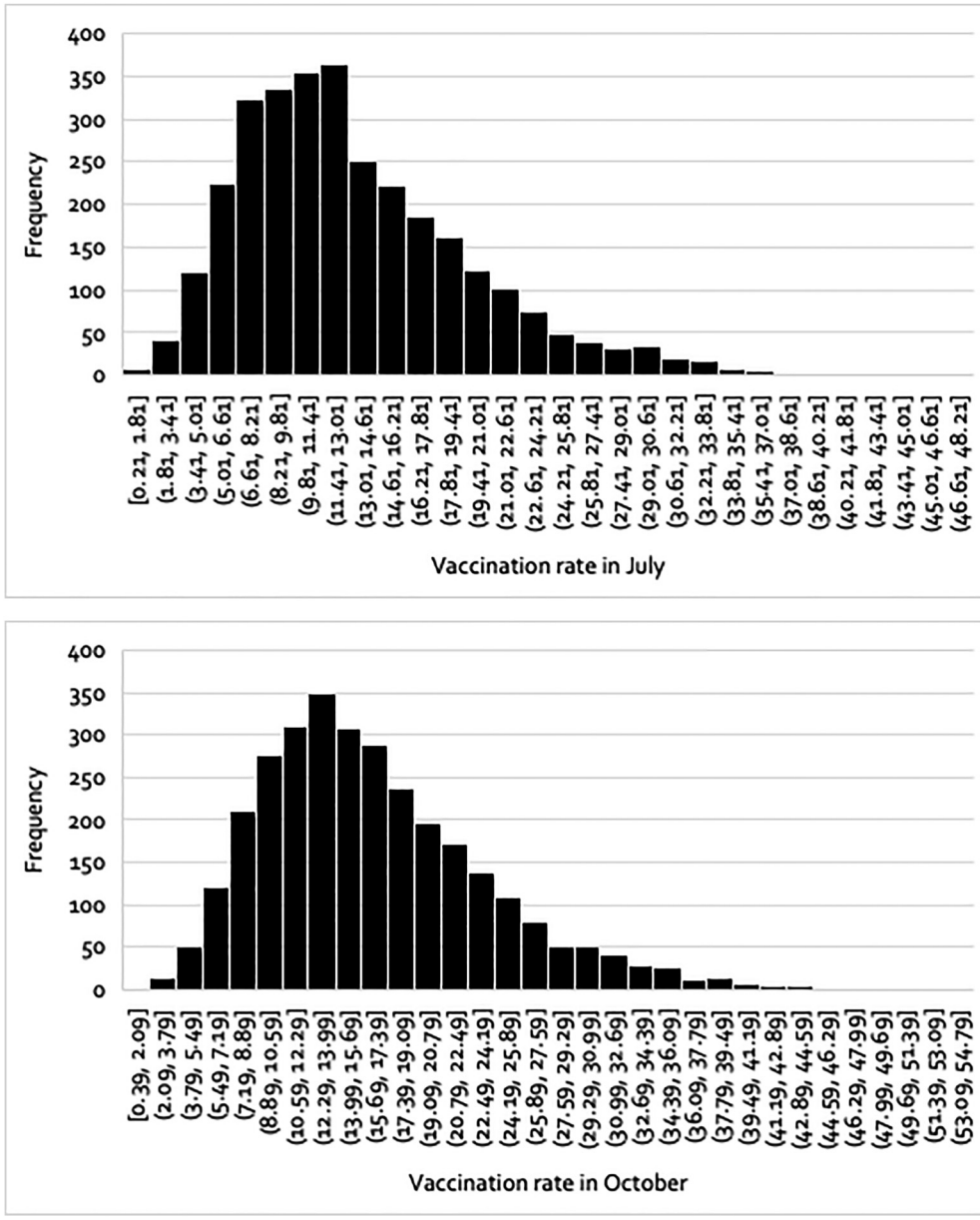

Fig. 7. Vaccination rates in July and October, 2021 (%)
Source: Own construction.

Consequently, our model carries a significant traction (with some caveats, as seen in the analysis of results) and can explain an important part of the variation in Romanian vaccine

hesitancy and refusal during the COVID-19 crisis. Without educational data, our R^2 value is between 0.286–0.389, and with it, it is 0.459–0.594. However, as usual, R^2 values should be taken with a grain of salt, and we can see that there is still scope for further research and possible explanatory variables and more comprehensive databases.

5. DISCUSSION AND CONCLUSION

5.1. Discussion

Our results lead to several possible policy implications. We believe that it is essential that the population follow the government's recommendations in emergency situations, such as pandemics. Governments, whether local or national, can influence the micro- and macroeconomic factors through legislative and executive action to reach their vaccination goals: these possible lines of action form the objective of this section.

It is important to underscore here one of the fundamental lessons of this paper: if conditions are unfavourable – e.g., trust in authorities is low due to the failures of the economic system – there might not be any short-term solution to issues like vaccine refusal or hesitancy in the Romanian towns. This is because most of the channels discussed in this paper are the results of deep underlying structural issues, which cannot be resolved in the short-term (possibly including the length of the COVID-19 pandemic). They can, however, be acted upon in the long-term, as we will see, and it is essential that governments do so. Even if the coronavirus vaccine campaign in Romania is to go down as a failure, there is still ample room for authorities to prepare for other emergency situations, where it is similarly central for the population to follow government recommendations.

We believe that there are two main implementable recommendations that the Romanian and perhaps foreign authorities should consider. First, the importance of economic development and welfare – proxied through income – is one of the main channels to reduce vaccine hesitancy. But this poses an obvious issue: if economic development were a simple and uncontroversial policy issue, all countries of the world would already be on a rapid growth path. Alas, that is not the case. From our results, it can be inferred that making business conditions more favourable and incentivizing a healthy competitive entrepreneurial spirit, as well as aiming to reduce unemployment through stimulative macroeconomic policies (possibly by adding unemployment reduction to the National Bank of Romania's primary goals, next to price level stabilization) can work. However, discussing the issue of general development is much beyond the scope of this paper. Instead, we propose a much more straightforward and easily implementable policy that is especially relevant during the coronavirus pandemic.

During the coronavirus pandemic, economies experienced two different (albeit interlinked) kinds of uncertainty. First, fundamental uncertainty relates to the natural line of development of the pandemic and the virus strains: mutated strains and the exact timing of different waves, for example, are always subject to some exogenous uncertainty. Second, there is the uncertainty that arises from government action. The fact that consumers and firms cannot foresee when authorities plan to introduce restrictions or ease them. It is important to emphasize that these two uncertainties are different: governments often react to the unforeseeable "shocks" of the virus, but it is clear that several policies are only tangentially related to the actual path of the

COVID-19 pandemic. One such policy was implementing a "trigger" strategy for lockdowns in Romania in January 2021. This implied that whenever certain towns or counties surpassed different thresholds, characterized by certain infection rates, those areas would go under different kinds of lockdown regimes. However, the rules underlying this strategy were so complicated that it was near-impossible to foresee when a lockdown would be imposed. In addition, as there were different kinds of lockdowns, firms had a hard time anticipating when they could open and when they would have to close, and consumers did not know which restaurants or shops would be open at any given time. It is quite clear that such policies can lead to agents postponing investment and purchasing decisions, leading to a slump in aggregate demand, as argued before. We believe that governments should reduce this second kind of uncertainty as much as possible by making all coronavirus-related policies simple, transparent and predictable (to the degree that the path of the pandemic itself allows for this), setting out clear "roadmaps" and dates concerning restrictions, as was the case in the United Kingdom, for example. As our results suggest, if the population doesn't lose income due to unnecessary and harmful government restrictions, they are likelier to heed governmental advice related to vaccines.

Our second recommendation concerns education. The *absence* of a positive causal link between secondary education and the vaccination rate suggests that the Romanian education system fails to transmit fundamental knowledge about health and hygiene-related issues to students. This is not a new observation: the weaknesses and failures of the Romanian education system are well-known. However, the COVID-19 pandemic could lend momentum to the proposals to reform at least the biology curriculum and make lessons related to health issues easier to grasp and more relevant to the needs of the general pupil. We encourage the Romanian government to learn from the recent events and aim to introduce elements in the material that can prevent deeply harmful behavioural reactions, like vaccine refusal or hesitancy.

Such a curriculum would focus more closely on standard medical procedures and personal hygiene-related issues. We believe that it is of the essence that students understand the basics of medical care, meaning not only how vaccines work, but also the effects of certain common medications or pills. This would not only provide students with immediate practical advantages, but it can also help them understand the medical system and, consequently, place more trust in it. It can also aid them in making rational choices in the markets of the healthcare sector. This proposal is important especially as too often parents are not able to provide their children with the relevant knowledge, they themselves not understanding the issues at hand.

5.2. Conclusion

Our paper's goal was to identify the factors that explain the vaccination rates in Romania, the observations consisting of all Romanian towns. The policy implications offer a high practical relevance, as evidence-based decision-making is needed to influence vaccination to increase COVID-19 prevention. To the best of our knowledge, no such scientific research was delivered by the Romanian scholars until this moment.

Based on our multivariate cross-sectional OLS regression, significant results can be concluded: we can see that economic development (through the number of firms and firm revenue per population) have a significant and positive impact on the vaccination rate: the more developed a locality, the higher the approval of vaccination. Similarly, the higher the unemployment rate, the lower the

vaccination rate, hinting at the detrimental effect of economic stagnation on social cohesion. Trust in government (i.e., participation rate in the 2020 parliamentary elections) is also highly significant and positive. If a citizen lacks faith in the efficiency of democracy and the state, they are more likely to refuse the government-offered vaccines. Surprisingly, we can also state that the higher the ratio of people who graduated secondary education in the past ten years, the lower the vaccination rate in the locality. Thus, a negative relationship can be observed between education and vaccination.

On the other hand, the more people use local libraries, the more will get vaccinated. Therefore, a negative relationship between the level of education and vaccine hesitancy is possible, but further research is necessary in this area. As our last result, some of the models constructed has shown that minorities are less reluctant than the majority to accept the COVID-19 vaccine, which is a remarkable result, as the mistreatment of minorities usually leads to a lower willingness to follow government advice. However, in the other models, the minority population has become insignificant. Thus, this result has to be considered with caution. It is also essential that there are slight differences in our results concerning the growth of the vaccination rate. There, we can see the parameter values implying a "constancy" or a "fixedness" of the effects of culture and civic conscientiousness, while the coefficients on the minority population variable imply a potential polarization in the minority communities.

When discussing policy implications for the results mentioned above, we have listed two. Firstly, we reckon that coronavirus-related policymaking should be as simple, transparent and predictable as possible to decrease uncertainty and, thus, have a positive effect on incomes and welfare (which, as seen above, will also increase vaccination propensity). If the population does not lose income due to the restrictions imposed by the government, approval of vaccination will grow. The second policy implication concerns education. The absence of a positive causal link between the level of education (i.e., secondary education graduates) and the rate of vaccination suggests that the education system in Romania is weak: it fails to transmit the basics about health and hygiene-related issues to its students.

One important research limitation can be linked to the data collection: there have been only a few publicly available data sources at our disposal. We strongly recommend the National Institute of Statistics to increase its efforts concerning data collection in the field of education, economics (e.g., per capita incomes per municipality) and inequality, which are all of central importance in pinning down the determinants of social issues. In addition, a good understanding of the problems faced in the educational sector and those related to inequality will be a key in understanding the Romanian economic and social crises and the population's response to these. Thus, we encourage both public institutions and academia to put more emphasis on quantitative social and economic research, as this ensures a clearer and more robust analysis of current issues than simple qualitative evaluations.

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