Community roots of COVID-19 infection rates between population composition and regional systems in Romania

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Abstract

This is an analysis of local and regional conditions favouring the COVID-19 infections in Romanian local communities, between February 2020 - April 2021. The general hypothesis that is tested here is that reported infections with the new coronavirus are higher in communities of higher direct social interactions with people from extra-local communities. These interactions are favoured by socio-human capital, the regional capital, migration abroad experience and modernity at the local level. Other factors are captured by the cultural areas as subregions of historical regions of the country. Nuclei of higher infections with COVID-19 are located in developed communities around large cities, high modernity areas, and communities of high emigration abroad. This is, to my knowledge, one of the first approaches to the topic at the local community level. Policy implications are specified in the conclusions.

Introduction

The disease in general, the pandemic in particular, has a strong social determination. Naturally, in the confrontation with COVID-19, the speed of the spread of diseases and, especially, the reduction of its incidence and consequences, mattered and counts. However, understanding the social mechanisms of contagion also requires reporting for longer periods. This is what we will do next, for the case of Romania, using a set of data available at the locality level, regarding the incidence rates of infections from February 2020 to the end of April 2021.

The mainstream of the emerging social sciences literature on COVID-19 focuses on the consequences of this pandemic crisis, on the pandemic patterns at the national level (Sigler et al. 2021), or on changes that are induced in different societies (Matthewman & Huppatz, 2020). The diffusion of COVID in the same society is addressed mainly at the county or regional level (OECD 2020, Andersen et al., 2021). Our analysis here focuses on factors contributing to the spread of the disease at a local level in a particular society. To what degree contribute local and regional patterns of social interaction to the spread of the disease from its launch in February 2020 up to starting of its decline for the third wave at the end of April 2020 in the Romanian society? This is the research question of this analysis. The approach is one of the first in the social science literature to focus on local communities in the process of COVID infections. A better understanding of community mechanisms in the diffusion of COVID-19 infections could contribute to grounding public policies in the area and, also, to explaining the differential rates of vaccination against COVID-19. Even if our data refer to COVID-19 infections in the third stage of pandemic, it could be relevant, also for the next of its waves of the pandemic process.

The first section of the analysis presents the methodological frame of the approach. The following sections are devoted to the results of the analysis based on the meanings identified for the specific effects of different blocks of variables used to predict the cumulative rates of infection of the local population with the new coronavirus. A last section of the results introduces the findings of the relations between COVID-19 as infections and vaccinations at the locale level. Policy implications are also

specified. More technical tables with the results of the multiple regression analyses are included in the annexes and the supplementary material (XXXXX, 2021b).

Methodology

The hypothesis from which we started claims that the infection rates at the level of localities in Romania, cumulated for the period February 2020-April 2021, were favored by a series of factors relevant to their specific social interaction in the reference areas. Such models/patterns derive from the socio-cultural and economic profile of the localities. We took the concept of community capital from the community development analyses (Emery & Flora 2006) and we built for each locality the related profiles. Based on the available data, we determined profiles on six blocks of variables, relevant for six types of community capital - vital or demographic, socio-human, regional, migration, cultural-religious and cultural area. We adopted six working assumptions based on the six types of community capital considered.

The demographic profile was measured by the average age of the adult population in the locality and the total population increase (Figure 1). The expectation is that in the dynamic localities, with a marked increase in population, the interactions will be of high density and, consequently, the infection rate with the new covid will be high. The high average age of the local population increases the risks of contamination with the new covid and, implicitly, can lead to high infection rates.

Figure 1 near here

Similarly, we assumed that the social interactions that could affect the transmission of the new coronavirus were also dependent on the educational profile of the population, on the local socio-human capital. From three indicators we built an index of the socio-human capital of the locality, similar, in many respects, to the human development index calculated by UNDP at the national level (Stewart, 2019). The constitutive indicators, aggregated by a factor score, are the stock of education, the internet penetration rate at the level of households in the locality, and the material capital index - revenues to the local budget from own sources, consumption of gas for household consumption, and living space per dwelling (XXXXX 2020b).

In the series of population composition indicators, we also included those related to migration abroad. The data for this aspect are older and come from the National Institute of Statistics (INS), the 2011 last population census. Although in the meantime the state of migration flows abroad has changed, the differences between localities in terms of migration have likely remained largely the same. We first used an index of local migration experience based on data from 2011 and 2002, XXX, and secondly, the rates of temporary emigration from the locality to the UK (2011). The expectation is that in the localities with high rates of departures abroad, intense phenomena of contamination with the new coronavirus will be registered.

In the series of indicators of cultural composition of the population we tested, before making a decision, the effect of ethnicity (Hungarians, Roma) and religious denomination (Adventist, Pentecostal, Catholic)

depending on the data available locally, from the last census since 2011. The only significant predictor for new local coronavirus infections remained membership in the Pentecostal religious cult.

Regardless of other factors, the relevant social interactions for the transmission of the new coronavirus were, most likely, conditioned by the position of the locality in the urban-regional system. We assumed that the social interactions are stronger the locality is closer to large urban centers and is central, in the county system, in the sense that it is not on the edge of the county (XXXXX 2003: 262).

Another set of position indicators in the regional system is given by the locality belonging to one of the 15 current cultural areas of the country (XXXXX, 2020a), as subregions of historical regions, consisting of counties with similar profiles by demographic, economic, cultural and social indicators. We expect that the localities that are in the cultural areas of some big cities, such as Timiș, Cluj, Sibiu, and Brașov, for example, will have, *caeteris paribus*, high rates of infection with the new coronavirus. Similarly, localities in Ilfov county, near the capital city of Bucharest, are expected to record high rates of infection.

The sensitivity of COVID infections rates to regional configurations will be tested by using not only cultural areas as subregions of historical regions (Moldova, Dobrogea, Muntenia, Oltenia, Banat, Crisana-Maramures, and Transilvania) but also development regions as NUTS 2 (XXXXX 2021b).

The only normative regions (EUROSTAT 2010) with fixed limits and institutional functions are counties and development regions (XXXXX, 2013). Cultural areas and historical regions are analytical or functional regions. All these types of regional configuration will be considered here from the point of view of inequalities among infection rates of localities.

Results Of The Analysis

How important is the size of the locality?

If we disregard the dynamics of the infection process and take into account only the cumulative rates of this contamination, it results that the tendency has been for the local infection rates to be higher in localities of large demographic size. The specific impact was, as expected, maximum for cities with more than 200 thousand inhabitants (Table 1). The communes with less than 4 thousand inhabitants were the ones with the lowest COVID infection rates. Differentiated effects appear between the two extremes. Localities, communes or cities, with a population between 4 thousand and 20 thousand inhabitants are part of the category of those who have disadvantaged COVID infection effects. Small towns with 20 thousand inhabitants are typical of the national average infection rate of about 38 infections per 1,000 inhabitants.

Cities with a population of over 50 thousand inhabitants have favored, in the statistical logic, not the case by case, high infection rates.

However, if we look at the patterns of infection in regions of development, the images are different. The highest infection rates occur in Transylvania, within the development regions 5 (West), 7 (Center), and in

the south, in Bucharest-Ilfov. Here, the big cities of over 200 thousand inhabitants recorded by far the highest infection rates, over 80 ‰. In the Old Kingdom (Moldova, Muntenia, Dobrogea, and Oltenia as historical regions), the main nucleus of the concentration of infections was in Ilfov county.

In very large cities (on the scale of Romania, of course) the measures of social distancing were the least observed in conditions of maximum social heterogeneity, high density, and high-intensity migratory circulation. The reverse is valid for communes with less than 4 thousand inhabitants⁶. The reference to migratory circulation considers all types of migration - internal and external, external for long or short periods, and also circulatory-external, shuttle type abroad. The latter is practically unquantified but most likely expanding.

Table 1 near here

After specifying the regional context of Covid infections one can go further and see better-specified models that consider Covid infections function of local community characteristics and cultural areas including them.

Socio-human and regional capital

The new analysis (Annex 1) allows for the identification of the specific effects of different factors (Figure 1) on COVID contamination. From there we learn that it was not the size of the cities as such that counted as an independent factor in determining the infection rates with the new covid, but the socio-human capital⁷ associated with the size of the cities. Social interactions tend to be more intense in cities with a high level of education, developed communication infrastructure, and a good financial situation. Here, in localities with high socio-human capital, we record increased rates of infection with the new Covid. There seems to be a style of life of higher educated people, with better internet connection and good material situation that favors higher social interactions and territorial mobility. All these favored higher rates of Covid infections at the local level.

The proximity to the big cities also made a notable contribution to the spread of the Covid-19 pandemic. An overview, in this sense, provides the 20 localities in the country that had the highest Covid infection rate at the end of April 2021 (Figure 2). Most of them are communes or small towns in Ilfov and Timiș counties. The highest infection rate, of 175 ‰ was registered in the commune of Dumbrăvița from Timiș, very close to the city of Timișoara. But also in the series of this chart appear common or strongly developed cities near Bucharest, Cluj, Iasi, Sibiu. With the data of the updated local human development index (XXX 2018)⁸, Chiajna, Corbeanca, Otopeni, Voluntari, and Dumbrăvița are the first five localities in terms of human development level in Romania.

Figure 2 near here

We now find that such peri-urban localities are not only highly developed but also „favorable” to COVID infections. Where does this situation come from? We do not have complete data for the answer. It is very

likely that in their case, or those similar to them, it is a composite effect. In this effect, we will find both socio-cultural and economic components. The rich population, in most cases, for such localities, was motivated by its way of life of intense territorial circulation, in the country and abroad, by the multiple social interactions it has, to carry out several diagnostic tests of possible COVID-19 infections. In addition, the increased financial facilities available to the population of localities close to large cities have facilitated testing for COVID by financial resources. Several tests could also lead to the detection of several infections.

The validity of the above findings could be questioned on the assumption that the population residing in communities close to large cities would be under-registered more than for other categories of localities. Consequently, the denominator given by the population of the locality used to calculate the infection rates would be, in reality, higher. This set of figures would result in an overestimation of COVID infection rates for communities near large cities. Hypotheses are contradicted by the partial data we have: the population growth rate between 2002 and 2018 is 118% for localities close to large cities, larger than for other categories of localities depending on the distance they are located from large cities (calculations not shown here). In addition, the estimation gap between the local population by domicile, the known one, and the one by usual residence, at a local level, but unknown, is well controlled in the regression equation in Annex 1 by the migration index abroad and by the total growth rates of the population between 2002 and 2018. The results of the multiple regression analysis are fully interpretable. If the distortions given by the unknown ratios between the population by domicile and by usual residence were very high, the interpretability of multivariate analyses would be problematic.

What about migration? In the series of initial questions, we mentioned it as the primary source of COVID-19 interactions. Does this factor still matter when the analysis is done with cumulative data throughout over a year and controlling for several other factors? In addition, migration data at the locality level are old, from 2011, since the last census in Romania. Meanwhile, the levels, the intensity of migration flows have changed.

Migration interactions

Yes, the migration from 2020-2021 period was no longer the one from 2011, as recorded in the last census. Despite this, the migration experience measured at the level of the 2011 census continued to be significant for the COVID-19 contamination mode in the local-regional profile. According to the results of the analysis in Annex 1, the localities that had many people abroad in 2011 and 2002 had high rates of COVID-19 infection the years later. Why? For the simple reason that, although the configuration of local migration fields from Romania to certain foreign countries has changed in the meantime, the hierarchies of migration experiences between localities have had, very likely, strong inertia over time. Migration social networks with those abroad and with those at home have been maintained. Job losses abroad due to the economic crisis associated with the pandemic have led to more or less forced returns to the country, permanently or temporarily. Such changes inevitably had consequences on the probabilities of COVID-19 infection. In addition, increased labor demand, especially in the agriculture of immigrant countries such

as Germany, the United Kingdom, France, or the Netherlands, has stimulated emigration or re-migration decisions in the country. This kind of economic migration through strong demand on the labor market abroad has favored, directly or indirectly, social interactions which, in turn, have favored COVID infections.

With analysis data that we do not present here, it resulted that COVID infections were favored especially for the localities that had a tradition of migration on the Romania-Great Britain corridor. Why is this so? More data on the subject that we do not have could clarify the problem.

The local experience of migrating abroad counts for the rates of infection with the new coronavirus not only about social interactions with people from different contexts and social networks. It also counts as an experience that brings modernization, with a specific lifestyle, based on multiple social contacts, rationality, etc. That this is the case is also proved by the fact that the localities with an increased index of demographic, housing, and institutional modernity are not only with a large number of inhabitants, increased education stock, and high-level urban-regional capital but also communities with a strong tradition of temporary migration abroad (Annex 2).

Migration experience, socio-human capital of locality, and COVID-19 infections scores go together by locality size. The larger the size of locality, the larger migration experience values, socio-human capital, and infection rates of COVID-19 at locality level (Table 2). It is very likely that locality size conditions, in a positive way, the migration experience, and its socio-human capital. These two factors facilitate higher social interactions within and out of locality and, implicitly, higher rates of COVID-19 infections.

Table 2 near here

COVID-19 infections and vaccinations

The rates of COVID-19 infections are predictors of the high relevance of COVID-19 vaccinations at local levels. A regression model that used a set of predictors that are very close to those in Annex 1 proved that the infections with COVID-19 are an important predictor of the local rates of vaccinations even if one controls for community context variables (XXXXX 2021a). The higher the recorded rates of COVID-19 infections, the higher the vaccination rates against the virus at the local level. Territorial vaccination patterns tend to be similar to those of infections. Localities of higher development levels that are better connected to large cities and with a higher migration abroad experience have, also, higher-rated vaccination against COVID-19. The regional patterns by cultural areas are not so similar. What is constant is the fact that localities from a cultural area of large urban cities, like Brasov-Sibiu-Cluj-Timis had not only high infection rates but also high rates of vaccinations. On the contrary, localities in Ilfov, in the proximity of Bucharest, the capital city of the country, recorded, on average, high rates of COVID-19 infections but low rates of vaccinations against this virus. Further research is needed to find the explanation.

Conclusions

As expected, local communities acted as important matrices in favoring or disfavoring social interactions with a direct impact on the cumulative rates of SARS-CoV-2 infection. The material presents the conclusions of an analysis that tries to answer the question "what about from the profile of communes and cities in Romania has favored/disadvantaged the cumulative rates of infection of the population?". Data provided by the National Institute of Public Health at the local level were related to social, demographic, economic, cultural, and regional characteristics of the communes and cities in the country.

Cumulative infection rates for more than one year were strongly dependent on local community characteristics with a direct impact on social interactions. Large cities, with their increased socio-human capital, and migration abroad seem to have played a key role in the process of infesting the population with SARS-CoV-2. Social interactions specific to large cities and communities close to them acted as environments of immediate relevance for the speed of infestation and its spread. The cultural areas around large cities such as Bucharest, Timisoara, Cluj, Sibiu, Brasov, and Iasi stood out, especially as living and production environments that favored high levels of COVID infection. Municipalities and communes in the peri-urban areas of the mentioned large cities have been registered as places of maximum intensity infection, beyond the variability of the health system conditions or the local health policies adopted.

A second family of factors that favored COVID infections is given by the social interactions associated with migration abroad. Although the data for measuring the community migration experiences are old, they continue to be relevant, given the very high inertia of migration processes. As in a huge social experiment, we managed to control, through appropriate statistical procedures of multiple regression, the role of some factors to highlight the impact of other factors on the phenomenon in question. Thus, we could find that COVID infections were significantly higher in communities with a large number of departures abroad.

Of course, this cannot be a complete analysis. It would have been optimal to work with data that combine individual characteristics with community characteristics, in a mixed model approach. Based on the available data, so far, we have obtained the first image at the national level on the community-regional conditions that have favored the social interactions relevant for the spread of COVID-19 infections during the third wave. There is no doubt that a better specification of local data by mentioning infections by periods and vaccination rates would have helped us considerably in better understanding the process analyzed.

A whole series of fertile questions come along the lines of this analysis. Why does the migratory circulation to Great Britain bring, more than the one on other corridors on which the Romanians circulate, increased probability of COVID-19 infection? Why does the poor cultural area of Botoșani-Vaslui favor the type of infection in question? Is the explanation already suggested, regarding the proximity of the two counties to the strong urban center of Iași, sufficient? Why in the localities with a higher share of Pentecostals, *caeteris paribus*, were the COVID-19 infection rates higher? Is the explanation for the high

level of COVID-19 infections in the cultural area of Southern Muntenia sufficient about the Bucharest effect? Probably not. Why did the small, highly developed communes and towns in the peri-urban big cities have maximum COVID-19 infection rates? Did only the culture, the proximity to the big cities, and the high degree of development matter? Again, I don't think so. Details on the demographic composition of the population and other similar issues should be seen. Why, for example, Dumbrăvița, one of the most developed communes in Romania, has the highest COVID-19 infestation rate? How much did the migration corridor to Germany or the share of religious minorities matter here, apart from the explanatory factors already mentioned?

Policy implications of the approach could be mentioned. The very high concentration of infections in the communes surrounding large cities suggests, for example, the need to invest more in public transportation of daily commuters to reduce the degree of agglomeration of passengers circulating between rural homes and urban workplaces. Poor rates of vaccination in isolated rural areas are not only an effect of negative attitudes on anti-COVID vaccination but also an effect of poor medical facilities in such areas. Public communication by government institutions and media on localities of high COVID infections, on short and long term periods, could help a lot. This could help local communities and microregions to get the necessary awareness on the local causes of high COVID infections and/low vaccination against COVID.

Annex 1 about here

Annex 2 about here

Declarations

Author Contribution Conceptualization: Secondary data analysis, writing the article.

Data Availability: All data used for analysis in this study are publicly available at the following sites: 1. Infection rates by COVID-19, at the local level, <https://data.gov.ro/dataset/transparenta-covid/resource/d3280256-07cc-4f93-957a-9815085899be> (accessed 31 May 2021). 2. Migration abroad experience and modernity at the local level in Romania (sav file), xxx (accessed 23 May 2021). 3. For data on local human development values (XXX 2018) xxx.

Declarations Conflict of interest The author declares no conflicts of interest

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Tables

Tables 1-2 are available in the Supplementary Files section.

Figures

Figure 1

Blocks of variables used in predicting cumulative rates of infection with COVID-19. Ellipses are, as in AMOS analyses, latent variables, not directly measured. By rectangles, we represented directly measurable variables. Continuous line arrows represent causal relationships and dotted lines measure measurement relationships between latent variables and those used to estimate them. Initially, the factorial score for regional capital was a measure with inverse scaling, with maximum values for isolated localities. By multiplying by -1 we obtained a direct scaling of the score in the sense that the maximum value is assigned to the maximum intensity of the reference phenomenon. The relations of direct proportionality, positive, are marked by + and those of inverse proportionality, negative, by -.

Figure 2

Top 20 localities with maximum cumulative COVID-19 infection rate. Data source: INSP, own calculations. Infection rates are calculated by reporting the number of infections in the period February 2020-April 2021 reported per 1000 inhabitants with permanent domicile in the locality, in 2018. (National Institute of Statistics, NIS, calculates only at the census the population with usual residence in the locality.) The graph shows, by way of example, the first 20 localities with the maximum infection rate. To the left of the figure is the scale of infection rates. The series from which the data regarding the infection rates are extracted has the minimum value of 1.1 ‰ for Dubova commune from Mehedinți county and the maximum of 175 ‰ for Dumbrăvița commune from Timiș. The simple average of the series is 27.6 ‰, and the weighted average with the population of the localities is 47.1 ‰. Example: for the city of Bragadiru in Ilfov county, the cumulative rate of COVID-19 infections was, at the end of April 2021, 167 ‰, the second-largest, after that of Dumbrăvița in Timiș. The local human development index (XXX 2018) for 19 of the 20 localities in the graph was very high, on a scale between 0 (minimum development) and 100 (maximum development). The city of Chiajna, with a very high infection rate, had a maximum XXX 2018 of 100. For Dumbăvița, the level of development was also very high, with XXX 2018 worth 97.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

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