Differences between urban and rural municipalities in the spread of COVID-19 in the Catalan territory

Regional Quantitative Analysis Research Group (AQR–UB)

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BACKGROUND AND OBJECTIVES

The growing availability of statistical information on the spread and incidence of COVID-19 with territorial detail is making it possible to monitor the spatial distribution of the epidemic and link its incidence with various characteristics of the territories. In the case of Catalonia, the Catalan Agency for Health Quality and Assessment (AQuAS) has been providing, since the end of March, information on the daily number of positive cases of COVID-19 by Basic Health Areas (BHA) and by municipalities.

In previous short letters we have shown evidence of the association between the geographical distribution of COVID-19 and some factors of interest, such as population density, meteorological factors or the socio-economic conditions of the population in the different territories, among other factors. The aim of this research note is to analyse the differences in the spread of COVID-19 between urban and rural municipalities and its temporal evolution. In this analysis we define as a rural municipality the one with less than 2000 inhabitants. This criterion allows to divide the 947 municipalities in Catalonia in two groups consisting of 353 urban municipalities and 594 rural municipalities. This division is shown in Figure 1. In the first group, approximately 95% of the population live, although they represent only 35% of the 32,108 km2 of Catalan territory. Obviously, these figures translate into very different population densities between the two groups of municipalities, this being one of the factors that have been shown to be relevant in the transmission of COVID-19. This research is not intended to provide new evidence on the effects of density (an aspect picked up in a previous research note) but, understanding that this is a relevant dimension in the comparison between urban and rural areas, we intend to analyse whether there are other factors that may have contributed to the differences observed between both groups of municipalities. In this sense, the interactions, both in frequency and intensity, of the populations of rural areas may be different from those of urban areas, which probably affected both the arrival of the virus in different types of municipalities and the speed of their spread in them. Therefore, once pre-lockdown patterns of behaviour and mobility have been recovered, rural areas may still be at risk of COVID-19 even though no cases have been reported to date. This problem makes rural places statistically invisible, creating a false sense of rural immunity.

Figure 1. Urban (0) and rural (1) municipalities in Catalonia

Source: Own elaboration based on IDESCAT data

This note summarizes some of the results on the analysis of the geographical distribution of COVID-19 in Catalonia that is being carried out by researchers from the AQR Research Group of the UB (http://www.ub.edu/aqr/). Special emphasis is placed on considering geographic and territorial aspects, facts of special interest in the research for the group.

The detailed results that have been used in this note are available to the interested reader.

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DIFFERENCES BETWEEN RURAL AND URBAN MUNICIPALITIES

As can be seen in Figure 2, the temporal evolution of positive cases has been similar in urban and rural municipalities with the difference that the disease came later in rural areas compared to urban ones. Figure 3 complements the above information by showing an estimate of the distribution of the number of days in which the first positive case of COVID19 occurred in rural and urban municipalities (counting from February 24, the day before the first recorded infection in Catalonia). As can be seen in Figure 3, the vast majority of urban municipalities recorded the first case during the first 30 days, while the distribution by rural municipalities is shifted to the right. Figure 4 shows the same information accumulated by days. Thus, it can be seen that while in the middle/end of March a positive case was detected in almost 100% of the 353 urban municipalities, this situation had only occurred in half of the rural municipalities. In fact, at the end of May this percentage has not yet exceeded 60% of rural municipalities. There are, therefore, 237 rural municipalities where no contagion has been confirmed at the time of writing this research note.

Figure 2. Evolution of positive cases in rural and urban municipalities in Catalonia (observed values and centered moving average of order 7)

Source: Own elaboration based on data from the Department of Health of the Generalitat de Catalunya and AQuAS

Figure 3. Days to the first positive from February 24th in urban and rural municipalities

Source: Own elaboration based on data from the Department of Health of the Generalitat de Catalunya and AQuAS

Figure 4. Percentage of municipalities in which a positive case has been detected

Source: Own elaboration based on data from the Department of Health of the Generalitat de Catalunya and AQuAS

Figure 5 shows the evolution of the rate of positive COVID per 10,000 inhabitants in all municipalities of Catalonia distinguishing between urban and rural, while Figure 6 shows the same information but only for municipalities where some cases have been detected, that is, excluding municipalities with 0 cases (1 urban municipality and 237 rural). As can be seen, the view offered by both figures is quite different. The first figure clearly shows a gap between rural and urban municipalities so that in rural areas there is a lower incidence of the disease. This gap has widened over time so that, according to the latest data, it is, on average, around 40 points, almost half the rate observed in urban municipalities. Instead, the second figure shows us a different view: during the onset of the pandemic, the incidence in rural municipalities where some cases had been confirmed was higher than in urban areas and was only from mid-April that the situation was reversed. In summary, Figure 7 shows the evolution of the average gap between rural and urban municipalities based on the rates shown in the previous

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This differential behaviour is also observed if the evolution of the average R0 rate in rural and urban municipalities is analysed considering only those municipalities where at least one contagion has been confirmed (Figure 8). The R0 rate is higher in rural areas during March and April.

In order to analyse what factors might be associated with this behaviour, a count data model has been estimated for the rate of cases accumulated up to March 30th and up to April 24th. In such model we control for the effect of weather conditions (temperature and relative humidity two weeks before the dates considered), levels of air pollution (nitrogen dioxide and suspended particles less than 10 μm in size) average during the last 3 years, the percentage of population aged 65 and over in each municipality, the number of residences for the elderly per capita, as well as indicators of municipal income per capita and unemployment rate. It also adds the number of days elapsed since the first case confirmed in each municipality (and its square) as well as a dummy variable for the municipalities of the Òdena Basin that suffered a particularly intense initial outbreak. Specifically, a zero inflated negative binomial model has been estimated, where as variables related to the probability that there is no case, we have used the variables of population density, distance to the city of Barcelona and its square\(^2\), while the population of each municipality has been used as an exposure variable. The results, which are available upon request to the authors, show that after checking for the influence of all these factors, the ratio of the incidence rate associated with rural municipalities is statistically higher than 1\(^{iii}\). Therefore, and contrary to what seemed from the comparison of the raw data, once the effect of the variables mentioned above is controlled, a higher rate of infection is observed in rural municipalities in relation to urban ones, a difference that
is reduced substantially (but not completely eliminated) in the model with more recent data. These results are also confirmed when an alternative to this modelling is used, specifically a linear regression model with the variables transformed into logarithms (except the unemployment rate, relative humidity, the percentage of population aged 65 or over and the number of days from the first case and its square).

A possible speculation about the reason behind this result would be related to the fact that during the month of March and before strict lockdown measures were adopted, interactions in the rural world were less frequent but more intense (in the field family or friends in much closer circles) than in the urban setting, thus contributing to a greater spread of the coronavirus. It could also be influenced by the fact that movements for labour or study reasons tend to be much longer in urban areas. Another factor to consider would be the possible effect of leisure mobility from urban areas to second homes and tourist areas, an aspect that we will analyse in future research notes. However, once the state of alarm began, social distancing and the reduction of labour, study and leisure flows would have had an equal or greater impact than in the urban sphere, thus reducing its importance.

**CONCLUSION**

The results summarized in this research note suggest that the differentials observed between rural and urban areas could hide a much more complex reality than those showing the comparison of gross rates of infection. Specifically, although rural areas have characteristics that make them more resistant to the spread of COVID-19, the analysis of the differentials observed from decomposition methods show how during the first weeks of pandemic spread, the intensity of the contagions was higher in rural areas relative to urban ones. This circumstance may be particularly important for monitoring outbreaks of the epidemic in general and in particular during periods of deconfinement. Given the experience derived from the expansive phase of the disease, regrowths in any rural municipality should not be underestimated since, due to the type of mobility and interactions existing in these areas, it could extend to a significant proportion of its population with the additional problems of having a degree of aging of the rural population significantly higher than the urban one and that the mobility and sanitary capacities of the rural areas are clearly lower than the urban ones.

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2. The distance from the Òdena Basin was also considered but its effect was not statistically significant.

3. This result shows the need to test urban population as this population is more likely to suffer the most serious consequences of exposure to COVID-19 as shown in Souch et al (2020). Souch, J. M., Cossman, J. S. (2020), A Commentary on Rural-Urban Disparities in COVID-19 Testing Rates per 100,000 and Risk Factors, The Journal of Rural Health, forthcoming. [https://doi.org/10.1111/jrh.12450](https://doi.org/10.1111/jrh.12450)