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Abstract

There is widespread debate on the drivers of heterogeneity of adverse COVID-19 pandemic outcomes and, more specifically, on the role played by context-specific factors. We contribute to this literature by testing the role of environmental factors as measured by environmentally protected areas. We test our research hypothesis by showing that the difference between the number of daily deaths per 1,000 inhabitants in 2020 and the 2018-19 average during the pandemic period is significantly lower in Italian municipalities located in environmentally protected areas such as national parks or regional parks. After controlling for fixed effects and various concurring factors, municipalities with higher share of environmentally protected areas show significantly lower mortality during the pandemic than municipalities that do not benefit from such environmental amenities.

Keywords: COVID-19, mortality, protected areas, pollution.

1. Introduction

The COVID-19 pandemic has been a major, partially unexpected, world shock that is leading to reformulate expectations and strategies of private and public actors. The pandemic has made clear the urgent need of reducing vulnerability to such health risks in the future. This goal has stimulated research to identify drivers of adverse outcomes of the pandemic spread (contagions, deceases) in order to devise proper policies aimed to reduce the impacts of the shock.

The scientific debate around the drivers of the COVID-19 epidemics reflected formation and school of thoughts of (social and natural) scientists working in different domains. On the one side, we can think to an extreme benchmark model where geographical heterogeneity in contagions and deceases only depends on the dynamics of viral circulation (i.e., location of epidemic outbreaks, circulation, and interaction among people before and after lockdown measures). On the other side, we can argue that, beyond these base ingredients, other socio-demographic and environmental factors matter and contribute to explain the stark variation in adverse epidemic outcomes across regions and countries even close to each other.

Our paper aims to contribute to this debate by formulating and testing a research hypothesis on the role of environmental factors. To this purpose, we use an ex-ante formulated definition of the environmental quality of Italian municipalities, i.e., the share of their surface occupied by protected areas, which is exogenous to the circumstances of the COVID-19 epidemics. Protected areas in Italy are classified into national parks, regional natural parks, and natural reserves, as regulated by the Law no. 394 of 6 December 1991. Their objective is to preserve the ecological equilibrium, apply management and conservation tool for a natural human-environment relationship, promote educational and research activities, and preserve hydro-geological equilibrium.

To test our research hypothesis, we use three different park-municipality definitions. First, based on 2020 data from the Ministry of the Environment and Protection of Land and Sea processed by Ancitel, we select 2,073 municipalities within any protected natural areas - that is, municipalities with areas that are part of national, regional, provincial, or local parks, natural reserves, and sea natural areas. Second, we consider only municipalities within national parks (502 municipalities). Third, we take into consideration municipalities with at least 45% of their surface area in parks, reserves, or naturally protected areas (251 municipalities). The latter were defined as Environmental Economic Zones (EEZ) by a 2019 decree-law, with the government fixing forms of support to new or incumbent enterprises engaging in environmentally friendly programs or investments in these municipalities.

Based on these characteristics our paper aims to contribute to different strands of the literature. The first relates to the effect of parks and, more in general, green areas (including urban green areas) on health. A relatively common finding in this literature is that people in contact with nature reveal better health conditions (Frumkin, 2017 provides an interesting review). In general, nature contact have both psychological benefits as well as immunologic, social, and environmental benefits (Frumkin, 2017). More specifically, national parks provide opportunities to increase rigorous physical activity, thereby reducing obesity. The connection with cleaner natural environment reduces pollution with positive effects on health and generates lower levels of stress, improving as well mental health. Several studies show that living close to parks and other recreation facilities is consistently related to higher physical activity levels, improving physical but also mental health (Humpel et al. 2002; Sallis and Kerr, 2006; Gordon–Larsen et al., 2006; Shoup and Ewing, 2010; Mowen, 2010; Branas et al. 2011). More recently, natural sounds have been found a positive source for both mental health as well as other health outcomes such as heart rate, blood pressure, perceived pain, skin conductance, cortisol, and t-wave amplitude (Buxton et al., 2021).

Our paper also speaks to the recent literature that analyses the socio-economic determinants of COVID-19 outcomes, such as lockdown measures, human mobility, economic activities, and environmental conditions. For example, in the United States, Greenstone and Nigam (2020) estimate that social distance might have saved 1.7 million lives. In China, Fang et al. (2020) have found that without the restrictions on human mobility the number of cases might have been approximately 65% higher, excluding Hubei province, the region of Wuhan, where the first COVID-19 cases were detected. In Italy, a number of authors have investigated the socio-economic determinants of the heterogeneous spread of the virus. For examples, Becchetti et al. (2022a) and Gatto et al. (2020) analyse the role of lockdown measures, Liotta et al. (2020) the role of social connectedness among the elderly, Alacevich (2021) and Perone (2021) the role of demography and the health care sector, and Becchetti (2022b) and Perone (2021) the role of environmental factors.

More specifically on outdoor pollution, Krupnik et al. (1995) demonstrate that air quality improvement leads to significant health benefits in many Central and Eastern Europe countries. In the same direction, Pope and Dockery (2006) discuss in their survey empirical findings from an ample literature and conclude that long term exposure to particulate matter increased the likelihood of inflammatory responses to respiratory diseases. The Forum of International Respiratory Societies Environmental Committee provides an updated survey on empirical research documenting the effect of air pollution on respiratory diseases and life expectancy over the world (Schraufnagel et al. 2020). Since the COVID-19 virus has been found responsible of respiratory and pulmonary diseases several papers have tested whether particulate matter has worsened patient reaction to the virus consistently with predictions from this literature. In this respect Dominici et al. (2020) find a significant and positive nexus for US council, while Becchetti et al. (2022a) found similar results for Italian provinces.

Our findings show that park municipalities display a significantly lower daily difference of deaths per capita during the period of the COVID-19 epidemics with respect to the average of the same period in the two previous years. Results persist when we control for municipality fixed effect and show that park municipalities exhibit a more favorable dynamics of daily deaths per capita than non-park municipalities.

Our findings contribute to both the research fields described above by showing that park areas play an important positive role in health outcomes also in the specific context of a pandemic, and that environmental factors matter for the geographical spread of the disease. Regarding policy implications, measures ranging from reforestation to urban green policies and enhancement of preservation of natural areas may be able to reduce exposure to environmental as well as pandemic risk.

Research hypothesis

The null hypothesis of the current study is that environmental factors do not matter and geographical heterogeneity of COVID-19 outcomes depends only on the dynamics of viral circulation, e.g., location of epidemic outbreaks, circulation and interaction among people before and after lockdown measures. If this is the case, environmental factors should not matter after controlling for these factors.

The reasons to believe in the alternative hypothesis are explained in the literature review summarized in the introduction, which we sketch here in three points: i) the COVID-19 virus infection can cause (mainly, but not only) respiratory and pulmonary diseases; ii) long-term exposure to particulate matter – as captured by the particulate measures PM10 and PM2.5 and other pollutants such as nitrogen bioxide (NO2) – weaken lungs and alveolus response to respiratory and pulmonary viruses, thereby increasing the likelihood of inflammatory responses and adverse outcomes in presence of such viruses; iii) the COVID-19 generates mainly more negative outcomes in terms of respiratory and pulmonary diseases in areas with higher pollution such as those without national parks and/or preservation of natural resources.

The environmental variable we use as our key explanatory variable relates to three different classifications of Italian municipalities as "green municipalities" explained in the introduction. In the first, municipalities are defined "green" if at least a small portion of their surface belongs to national or regional park areas. In the second, they are classified as such if at least a small portion of their surface belongs to areas of national parks, regional parks, or environmentally protected areas. In the third, if at least 45 percent of their surface belongs to national park areas.

Our hypothesis is that a share of municipality geographical area located in national parks makes their environment cleaner and less exposed to pollutants. If the literature observes that urban green contributes to better quality of air (Nowak et al., 2006; Jim and Chen, 2008; Cavanagh et al., 2009; Yin et al., 2011), it is reasonable to assume that the quality of air is much better when a sizeable portion of a municipality is in a natural park. Using natural park related measures as a proxy for quality of air has two advantages. First, it is impossible to have data on pollutants disaggregated at municipality level because of lack of pollution monitoring devices and of reliable atmospheric measures disaggregated at council level. Second, the variable is free of measurement errors that might be related to the specific location of the monitoring devices in urban areas. Third, the chosen measure is highly policy relevant since the establishment of protected areas like natural parks responds to environmental policy goals. In this respect, our research hypothesis indirectly assesses the additional benefits that may arise from the implementation of such policies, specifically in terms of reduced exposure to pandemic risks and their adverse health and economic outcomes.

2. **Data and methods**

Our main dependent variable is the difference between the number of daily deceases per 1,000 inhabitants in 2020 and the 2018-19 average at municipality level. Data on deceases has been released by the Italian National Statistical Institute (ISTAT) and cover a representative sample of 87% Italian municipalities (see https://www.istat.it/it/files//2020/05/Rapporto_Istat_ISS.pdf).

The deaths difference between the COVID-19 year and the average of the two previous years has been increasingly used to investigate the impact of COVID-19 on mortality (see, for instance, Konstantinoudis et al., 2021). and it is preferred to the use of deaths officially attributed to COVID-19 for several reasons. First, the latter exists only at provincial level and is highly incomplete. Second, COVID-19 deaths strongly depend on the certification policy that may vary across countries and regions within the same country. Under the most restrictive approach, COVID-19 deaths are only those of patients who directly died because of COVID-19. Under a less restrictive approach, COVID-19 deaths include those of patients that died with COVID-19. Even though the difference is not so clear-cut since an exact distinction would require knowledge of the counterfactual (i.e., would the patient already having serious pathologies have stayed alive without COVID-19), differences across regions can be substantial.

Further differences can arise also according to the phases of the epidemic. In the first period, and in regions where the intensive care units were saturated, medical authorities tended to procrastinate tests in order to avoid further hospital congestion. This approach is likely to have caused several COVID-19 home deaths misclassified as non-COVID-19 deaths.

Another advantage of the total official ISTAT measure is that it includes also indirect COVID-19 effects since during the epidemics there has been reduced attention toward other pathologies, also because of patients' fear to access hospital. Hence, it is possible that in this period COVID-19 has been indirectly responsible for deaths due to other pathologies because of the likely reduction of medical care or the unexpected patients' behaviours.

Our preferred measure of the COVID-19 spread is the number of deaths, while we do not focus also on contagion for several reasons. First, contagions are not recorded officially at municipality level. Second, they are recorded at province and regional level, but the measurement error is likely to be severe conditional to the intensity of the epidemic. As mentioned above, the guidelines followed by the different Italian Regional Health Systems, especially in the days of epidemic peak, varied markedly and in most cases tended to delay tests in order to avoid hospital congestion (Bosa et al., 2021). For this reason, testing was taken into account only in presence of several days of fever above 37.5°C. In many cases it arrived several days later. Many people recovered from the virus becoming negative (or, unfortunately, died) without a test.

In Figures 1A-1D we plot four Italian maps showing the intensity of per capita deaths and the park municipality areas. Park municipalities cover a non-negligible share of the total Italian municipalities: around 29 percent have at least a small portion located into a naturally protected area (the first wider definition), 5.6 percent have a portion in national parks, and 2.6 percent have no less than 45 percent of their surface into a naturally protected area (variables legend and detailed descriptive statistics are presented in Tables A1-A3 in Appendix). The figures suggest that park municipalities and the geographical distribution of per capita deaths overlap. The sample period considered in our data goes from February 24th 2020 to April 15th 2020 (the last day for which ISTAT data on deaths by municipality are available). The 2018-19 average share of deaths is 7.5 per 1,000 inhabitants against 8.9 in 2020. This implies 1.4 deaths more per 1,000 inhabitants corresponding to an increase in one year by 18.7 percent. If we examine the same phenomenon across park and non-park municipalities, we find that the change is close to 0 for the wider park municipality area and even negative for the national park and the EEZ areas (between -3 and -2 deaths per 1,000 inhabitants) (Figures A1A-A1C).

The dynamics of daily per capita deaths over the epidemic period confirm that in 2018-19 deaths in non-park municipality areas are higher than in park municipality areas, and that in 2020 both trends increase during the epidemic period and their difference becomes much larger (Figures 2A-2D).

In order to control for concurring factors, we estimate the following pooled OLS specification:

$$\Delta Deaths_{it} = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \alpha_3 t^3 + \alpha_4\, Park_i + \alpha_5 Over65_i + \alpha_6 Employees_i + \alpha_7 Density_i + ß_k \textstyle\sum_{k=1,\dots 20} Region_k + u_{it}$$

Eq. 1

where the dependent variable is the change in total deaths per 1,000 inhabitants between day *t* in 2020 and the 2018-2019 average of total death in the corresponding day. Among regressors, t, t^2, and t^3 capture respectively the linear, the quadratic, and the cubic daily trend to take into account the non-linear dynamics of the epidemic, $Park_i$ is our main regressor of interest, i.e. a dummy equal to one if municipality i is defined as a park municipality (according to one of the three definitions explained in section 1); $Over65_i$ is the number of municipality residents aged above 65, per 1,000 inhabitants; $Employees_i$ is the number of workers of any economic activity operating in the municipality, per 1,000 inhabitants; $Density_i$ is the population density in municipality i. Region dummies are included to control for all time invariant regional effects including, among others, differences in Regional Health Systems since Italian regions enjoy a high degree of autonomy with respect to the healthcare policies. Standard errors are clustered at the province level to account for possible error correlation across municipalities within the same province.

3. Results

The results of the pooled estimates are shown in Table 1. Municipality parks display a significant lower number of deaths in 2018-19 and in 2020, with the latter being almost double in absolute value (-0.026 vs. -0.015). This difference is statistically significant, as confirmed by the same regression using as dependent variable the difference between the number of deaths in 2020 and the average number of deaths in 2018-2019 (Table 1, column 3). In terms of magnitude, over the entire population the difference would be 582 deaths less per day if all the country consisted of park municipalities. Among the regressors, the number of municipality residents aged above 65 is positively and significantly associated with a higher number of deaths, but it is not significant when we consider the deaths difference. Note that any trend or seasonality effect is captured by the dummies Day and Day^2;

the significance of these variable suggests that the number of deaths and the difference observed between 2020 and the previous years have a non-linear trend.

We also examine the marginal role of national parks and EEZ (Table A4 in Appendix). The coefficient of park remains negative and statistically significant when controlling also for national parks and EEZ. The coefficient of national park is also negative and statistically significant when we exclude municipality located in regional but not national parks.

Robustness checks

In order to control for unobserved time-invariant municipality-specific factors we run a fixed-effect panel OLS regression, where the role of the park-municipality effect is assessed by interacting park areas with time trend.

The equation we estimate is

$$\mathit{\Delta Deaths}_{it} = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \alpha_3 t^3 + \alpha_4 Park_i * t + \alpha_5 Over65_i * t + \alpha_6 Employees_i * t + \alpha_7 Density_i * t + ß_k \sum_{k=1,\dots 20} Region_k * t + u_{it}$$

Eq. 2

where the *Park* variable is now interacted with the time trend. This specification allows us to test the differential effects of park areas on the trend in mortality changes. If α_4 is statistically different from zero, park municipalities have a different trend in the death difference with respect to non-park municipalities, net of unobserved time-invariant municipality-specific characteristics.

In Table A5 in Appendix we find that the best fixed effect model specification is that including the cubic trend variable and the interaction between the park and the trend variable. Estimate findings presented in Table 2 show that α_4 is negative and statistically significant for the EEZ (columns 3 and 5), implying that the dynamics of the daily deaths difference in park municipalities is significantly less severe than that in non-park municipalities. This finding implies that, beyond the time-invariant effect of park municipalities on deaths that is absorbed into municipality fixed effects, the dynamics of the epidemic – driven, for instance, by factors such as location of epidemic outbreaks, circulation and interaction among people before and after lockdown measures – is significantly mitigated in park municipalities where the park area is larger.

As a robustness check, we test whether the significance of the park effect in pooled estimates is robust when we exclude big cities (Population ≥ 190,000 inhabitants), small villages (Population ≤ 1,000 inhabitants) or when we estimate the subsample of small towns (1,000 < Population ≤ 50,000) or small villages. In an additional robustness check, in line with Borri (2021), we control for the number of employers or the number of firms in essential economic activities, as defined by the Prime Ministerial Decree of 25 March 2020 (the decree is available at https://www.gazzettaufficiale.it/eli/id/2020/03/26/20A01877/sg; a full list of essential sectors is provided at the bottom of Table A7 in Appendix). These activities are the only activities that have not been halted during the national lockdown (i.e., 10 March—4 May 2020). The significance of the park variable is robust to all these checks (Tables A6-A7 in Appendix).

4. Discussion

Econometric findings discussed above reject the null of absence of significant effects of park areas on yearly changes in daily per capita deaths during the COVID-19 pandemic. Park area incidence can in principle follow a structural (time invariant) and a time varying direction. Pooled estimates allow us to capture both at the cost of omitting possible time invariant factors beyond those effectively introduced in the regressions. Fixed-effect panel estimates where time trend is interacted with the park area indicator allow us to control for all possible concurring time-invariant factors at the cost of averaging out the same potential structural (time-invariant) effects of the park area indicator (such as long-term lower exposure to particulate matter, which is a notably crucial driver of pulmonary diseases as pointed out by Pope and Dockery, 2006). Our pooled estimates using the three different park measures show that the wider (including all regional parks) and less restrictive (regardless the share of the municipality located in a park) park measure is sufficient to show statistically significant and negative effects on changes in daily deaths between COVID-19 and pre-COVID-19 period. Our fixed-effect panel estimates show that the tighter and more restrictive definition of park area – as proxied by the EEZ measure – is necessary to find significant and negative trend in these areas compared to non-park areas.

Our results obviously open the questions about causality links. As is well known it is impossible to perform a randomized experiment on an ongoing phenomenon (i.e., implement ex-ante a controlled experiment with treatment and control samples with balanced properties). The ex-post analysis of the drivers of COVID-19 deaths we carried out cannot therefore ascertain a causal interpretation to the observed significant correlations.

In tackling this issue, we should, however, consider that the creation and the definition of park areas at the basis of our three park municipality measures is obviously antecedent to and unaffected by the outbreak of COVID-19. Therefore, we rule out potential endogeneity determined by reverse causality. The remaining concern is whether omitted variables can be correlated both with the park municipality definition and our dependent variable, thereby creating a spurious correlation among the two. The obvious candidate is quality of air, but this is exactly our hypothesis: mortality rates at the time of COVID-19 have been significantly lower in park municipalities when compared to those in the two previous years, most likely because residents' exposure to pollutants such as PM2.5, PM10 and NO2 is presumed to be significantly smaller in these areas. Another potential omitted variable that could contribute to explain our results is the presence of economic activities that may negatively affect the quality of the natural park resource. Related to this point, we expect that policies aimed to preserve value and attractiveness of the natural resources contained in parks and preserved areas will discourage such activities. Again, this is an expected result of environmental policies focusing on preservation of natural resources and could therefore be considered an effect of a policy aiming to expand park areas. Consider, however, that we partially control for industry characteristics in the robustness checks summarized in Table A7. The same reasoning applies for the possibility of performing physical activity in a clean environment with positive consequences on health. More in general, these omitted factors, being themselves a direct intended consequence of the creation of park areas or a driver of the nexus between park municipality and mortality, do not weaken but reinforce our policy conclusions: the creation of park areas has beneficial effects on health and exposure to health (pandemic) risks; a policy aiming at expanding such areas will eventually improve quality of air and discourage (or explicitly bans) more polluting economic activities that can harm preservation of the natural resource.

A final issue is that park municipalities may be characterized by a low volume of human interaction; this can be a factor determining also the significantly lower adverse COVID-19 outcomes in such areas. Note, however, that the models estimated in this paper control for this factor in three ways. First, we look at per capita deaths and therefore scale our dependent variable by the local population, thereby implicitly considering the role of human interactions that are significantly higher in number when more population is concentrated in the municipality area. Second, we include municipality population density as control in our pooled estimates. Third, the "structural" time invariant effect of human interactions in each municipality is absorbed into the fixed effect when we implement panel regression models.

Our findings and the related discussion can stimulate further research in this direction testing, for instance, the "external validity" of our results in different countries affected by the epidemic.

If our significant findings do reveal a causality nexus a straightforward implication of our paper is that natural park areas not only have a positive and significant effect on health and the quality of the environment but also reduce exposure to health shocks. The policy issue is obviously whether it is possible to avoid a trade-off between the health and environment domains, on the one side, and the economic activity and job domains on the other side. The trade-off is clearly highlighted by the economic significance of our results taken to the extreme. If Italy were made by park municipalities with significant areas in natural parks, and if we interpret our findings as causal, based on the magnitude of the EEZ park municipality coefficient in Table A6, we would have around 582 less COVID-19 deaths per day during our sample period. However, many observers would note that economic life and employment would suffer under such extreme scenario.

The trade-off may however be just apparent if we examine the issue from a different perspective. Pini and Rinaldi (2020) show that Italian regions mostly hit by the pandemics exhibit a far higher rate of firm and job destruction and a far lower rate of firm and job creation in March-April 2020. The presence of areas with characteristics that are opposite to those of our park municipalities have therefore made the lockdown much starker with dramatic negative consequences on economic activities. As well, innovation in terms of circular economy, dematerialization/digitalization and, more in general, improvement of energy efficiency of manufacturing and agricultural production may reduce the trade-off even in non-extreme times as those of the COVID-19 epidemics. Evolution along this path can lead us to a productive system in which the creation of economic value is decoupled from deterioration of natural resources, thereby eventually mitigating the trade-off.

5. Conclusion

In this article, we analysed how excess daily deaths in municipalities within protected areas differ from that outside during the first lockdown in Italy. We found that mortality in protected areas was already lower than in the rest of the country before 2020. During the lockdown, while mortality increased overall, excess deaths in park municipalities increased at a lower rate than elsewhere. Moreover, we have performed several robustness checks to see the role of different types of natural parks (i.e., EEZ), the role of essential firms which continue to operate during the lockdown, and what happens if we exclude large and small cities that may create a bias. We also estimate both pooled and fixed-effects models to test the overall and the time-trend effect of a park on mortality. All our findings confirm the negative effect of natural parks on mortality. Finally, we suggest how policy-makers can follow our evidence and promote one health policies that benefit at the same time the environment and the health of people.

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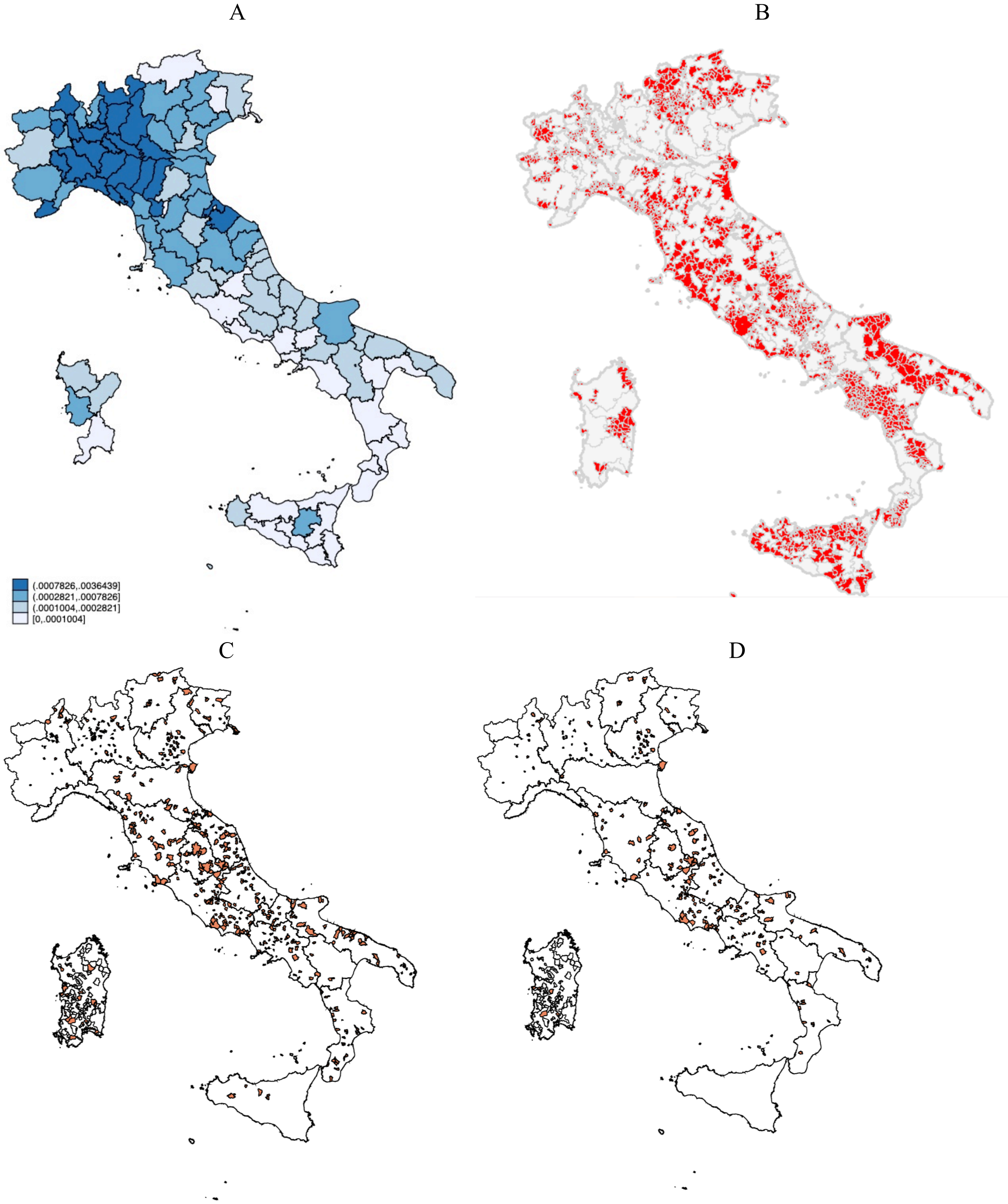
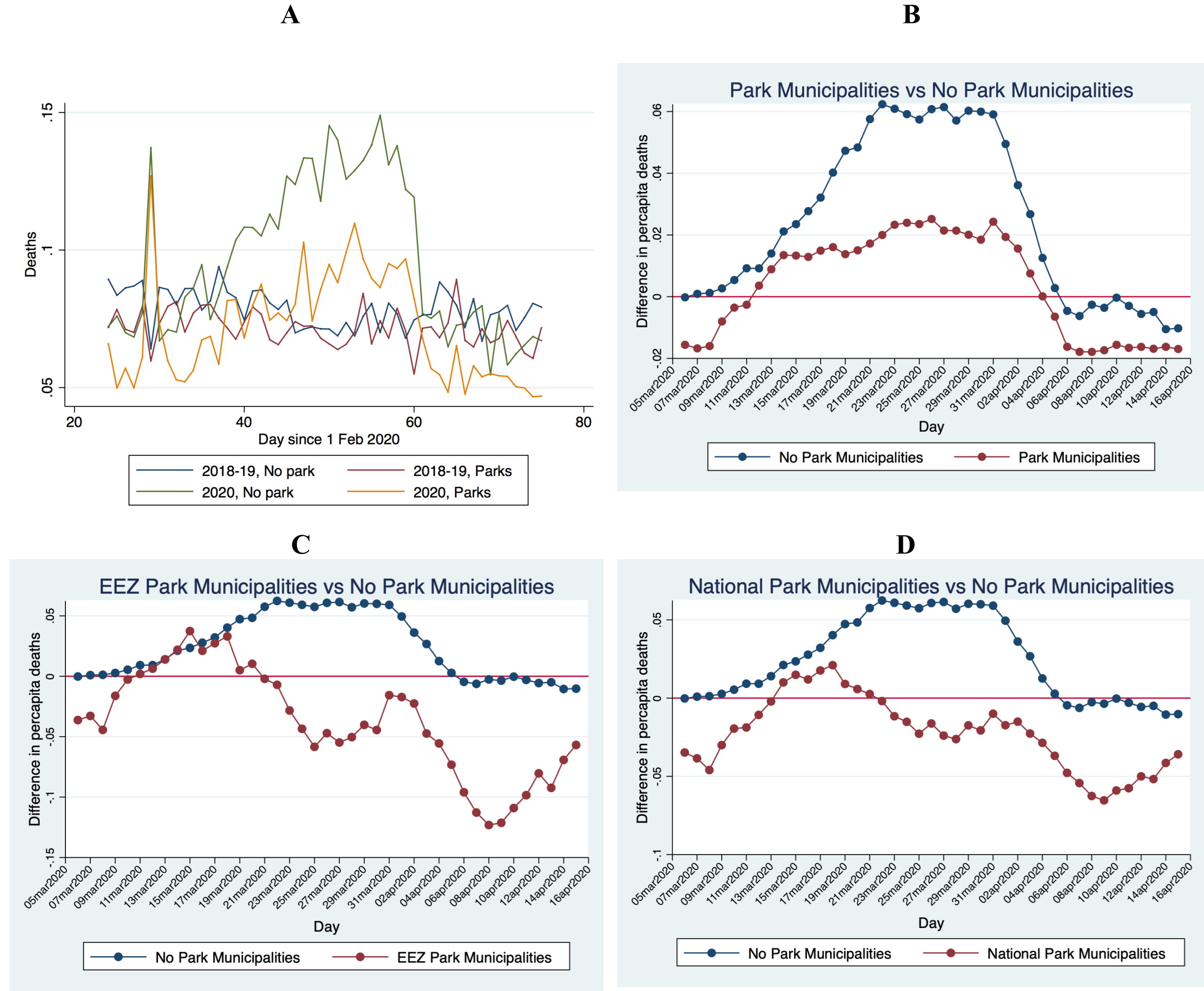
FIGURES 1A-1D: GEOGRAPHICAL DISTRIBUTION OF PER CAPITA DEATHS (1A), PARK MUNICIPALITIES IN PROTECTED AREAS (1B), IN NATIONAL PARKS (1C), IN EEZ (ENVIRONMENTAL ECONOMIC ZONES) (1D)



FIGURES 2A-2D: DYNAMICS OF THE ONE-YEAR DIFFERENCE IN DAILY DEATHS PER 100,000 INHABITANTS BETWEEN PARK AND NON-PARK MUNICIPALITIES



Legend: A: Daily deaths between park and non-park areas in 2018-19 and 2020; B: Deaths difference between park and non-park areas; C: Deaths difference between national park and non-park areas; D: Deaths difference between EEZ and non-park areas.

TABLE 1. MORTALITY IN PARK MUNICIPALITIES (POOLED OLS).

VARIABLES	(1) Deaths 2018-19	(2) Deaths 2020	(3) ΔDeaths
Park	-0.0145***	-0.0260***	-0.0116**
	(0.00278)	(0.00539)	(0.00473)
Over65	0.00104***	0.00108***	3.31e-05
	(7.58e-05)	(0.000109)	(9.78e-05)
Density	-1.19e-05***	-2.11e-05**	-9.10e-06*
	(3.99e-06)	(8.64e-06)	(5.22e-06)
Employees	-0.000101***	-8.60e-05***	1.53e-05
	(1.54e-05)	(1.88e-05)	(1.85e-05)
Day	-0.000526	0.00286	0.00342
	(0.00119)	(0.00377)	(0.00394)
Day^2	-2.67e-06	4.04e-05	4.26e-05
	(2.52e-05)	(6.70e-05)	(6.89e-05)
Day^3	7.69e-08	-9.08e-07**	-9.83e-07**
	(1.71e-07)	(4.06e-07)	(4.12e-07)
Constant	-0.0844***	-0.196**	-0.113
	(0.0265)	(0.0865)	(0.0863)
Region dummies	Yes	Yes	Yes
Observations	186,979	186,980	186,979
R-squared	0.075	0.056	0.017

Note: Pooled OLS model. Over65, and Employees are expressed per 1,000 inhabitants.
Standard errors are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.

TABLE 2. MORTALITY AND PARK MUNICIPALITIES (FIXED EFFECTS).

VARIABLES	(1) All ΔDeaths	(2) All ΔDeaths	(3) All ΔDeaths	(4) National & non-park ΔDeaths	(5) EEZ & non-park ΔDeaths
Day	0.00147	0.00144	0.00129	0.00318	0.00302
	(0.00378)	(0.00377)	(0.00376)	(0.00451)	(0.00468)
Day^2	9.34e-05	9.34e-05	9.41e-05	8.39e-05	8.61e-05
	(5.96e-05)	(5.96e-05)	(5.95e-05)	(7.01e-05)	(7.32e-05)
Day^3	-1.24e-06***	-1.24e-06***	-1.24e-06***	-1.24e-06***	-1.27e-06***
	(3.64e-07)	(3.64e-07)	(3.63e-07)	(4.24e-07)	(4.41e-07)
Park # Day	2.43e-05	7.17e-05	0.000153		
	(0.000135)	(0.000121)	(0.000134)		
National park # Day		-0.000251		-0.000121	
		(0.000351)		(0.000371)	
EEZ # Day			-0.00174***		-0.00148**
			(0.000659)		(0.000659)
Over65 # Day	1.41e-06	1.49e-06	1.90e-06	-4.28e-09	1.29e-07
	(4.59e-06)	(4.58e-06)	(4.54e-06)	(5.30e-06)	(5.50e-06)
Density # Day	-4.29e-09	-7.50e-09	-1.83e-08	1.91e-08	5.70e-09
	(5.27e-08)	(5.32e-08)	(5.37e-08)	(5.67e-08)	(5.89e-08)
Employees # Day	7.35e-09	-3.09e-09	-1.91e-08	-2.62e-07	-1.09e-07
	(7.01e-07)	(7.03e-07)	(7.01e-07)	(7.47e-07)	(7.55e-07)
Constant	-0.0661	-0.0661	-0.0657	-0.0822	-0.0823
	(0.0616)	(0.0616)	(0.0615)	(0.0727)	(0.0761)
Observations	186,979	186,979	186,979	143,380	137,208
R-squared	0.004	0.004	0.004	0.004	0.004
Number of municipalities	7,748	7,748	7,748	6,203	5,954

Note: Panel FE model. Over65, and Employees are expressed per 10,000 inhabitants. Standard errors are clustered at province level.
*** p<0.01, ** p<0.05, * p<0.1.