1. Introduction

Does the degree of subnational autonomy, along several dimensions, affect the impact and effectiveness of public policies and interventions? The answer to this question is particularly relevant when the policy intervention is aimed at addressing a problem that is not confined by subnational administrative boundaries but is affecting the population at a more aggregate scale, such as the current COVID-19 pandemic. This paper aims at exploring this issue by examining the relation between the outcomes of the pandemic (as measured by total deaths) and subnational autonomy measured along different dimensions and proxied by different indicators, while also controlling for the localized dimension of restrictive measures.

2. Subnational autonomy: why should it matter?

How is the organization and division of powers between different levels of government related to the effects of a pandemic such as the one caused worldwide by COVID-19? In the context of the economics of fiscal federalism, a general principle suggests that, for situations in which externalities are relevant and their spatial reach is wide, production, distribution and regulation of the related goods and services should be guaranteed by the central, not local government (Inman and Rubinfield, 2017). The existence of economies of scale, both in production and in public procurement, might further suggest the advantages of a centralized structure. For example, focusing on the availability of protective devices (such as face masks and sanitizers) along with the capacity to secure appropriate vaccines, benefits from centralized planning and purchase are evident. Similarly, when considering testing and lockdowns, a centralized approach, especially in the presence of subnational spillovers, might be more effective. A first set of considerations thus might suggest that dealing with the consequences of COVID-19 should be, at least in terms of the general policy orientation, dealt with at the central level.

However, in several non-unitary countries, both the containment measures and the health-related responses are being decided at the local level, as, for example, in the United States (US), Canada and Germany, although to different degrees. In some countries, the overall organization of several aspects of the economy and policy-making, are organized at the subnational level, including health services, policy (e.g. the case of Italy), along with defensive measures against a pandemic (such as the number of hospital beds, specialized medical equipment and the number of certified personnel).

Agnew (2021), Kettl (2020) and Xu and Basu (2020) examine the response of the US to the COVID-19 pandemic and stress potential problems related to the federalist system which have led to suboptimal policy measures, suggesting that a centralized and, possibly more importantly, coordinated response is preferable. Haffajee and Mello (2020) focus on the weakness of the federal response in the US, stressing however how local knowledge possessed by State officials, if gathered and coordinated at the central level, would have helped in alleviating the negative impacts of the pandemic.

An analysis of the Canadian experience shows that a coordinated response by the lower levels of government (provinces) has been a success factor in mitigating the negative effects of COVID-19 (Migone, 2020). Hattke and Martin (2020) analyze the German case and show that in the context of a federalist country, coordinated local action by lower tiers of government has proven successful in mitigating the negative effects of the current crisis. Deslatte et al. (2020) argue that local governments are more capable of putting in place adequate recovery and prevention measures. A strand of literature has been developing aimed at understanding the consequences of this situation in single country studies and different scholars have been highlighting benefits and downfalls of centralized versus decentralized responses.

The aim of the present paper is to provide evidence as to the existence of a correlation between the form of government (centralized versus decentralized) and the fatal consequences of the current pandemic in a cross section of countries, in order to contribute to this emerging literature that has been focusing mainly on single (or few) country studies. The choice of focusing only on confirmed death cases by COVID-19, rather than extending the analysis to confirmed infections and the case fatality rate, is related to differences in how countries perform testing and record cases (Sorci et al., 2020), making cross-country comparative analysis difficult. These differences might also affect how deaths are accounted for, although there is evidence that the problem is less pronounced than with the count of confirmed cases of infection (Backhaus, 2020).

3. Model and data

The empirical model is aimed at exploring the relation between subnational autonomy and a measure concerning the impact of COVID-19, namely cumulated deaths due to COVID-19 per 1,000,000 inhabitants, while controlling for relevant demographic, economic and institutional characteristics. The analysis is conducted at the country level, with information on 90 countries (see list in table A.1). According to the different proxies used to measure regional autonomy, the sample varies (table A.1). The dependent variables are evaluated at four time points, to account for the evolution of the pandemic and to verify if the data generating process has changed over time, while the independent variables are constant across the models, as the variables they refer to are not likely to change significantly in the time frame considered and are also not available at high frequency. The time points considered have been selected by analyzing the evolution of reported COVID-19 deaths across the world, roughly defined as first, second and third wave (figure 1) and correspond to July 30, 2020; October 1, 2020; January 12, 2021 and February 11, 2021.

Figure 1: Selection of data estimation points

Source: Our World in Data

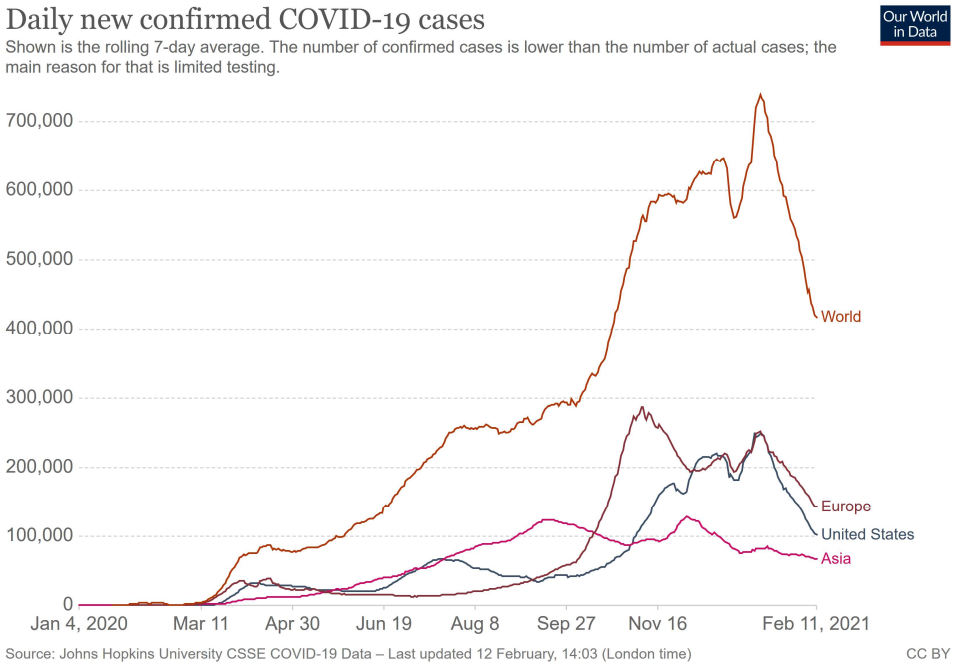

Table 1 lists the data used in the analyses and indicates the source and year of measurement while table 2 provides descriptive statistics.

Table 1: Sources of raw data

Variable	Source	Time	Notes
deaths/1,000,000 inhabitants	Our World in Data	2020/2021	Total deaths attributed to COVID-19 per 1,000,000 people
Federalism	http://www.forumfed.org/countries/	2020	Centralized or federal
Regional authority Index	Hooghe et al., 2016	2015	Regional authority index as the sum of self and shared rule
Political decentralization index	Ivanyna and Shah, 2012	2012	Political, fiscal, and administrative dimensions of decentralization, and localization
Territorial self-governance	Trinne and Schulte, 2020	2000-2018	four regional character types of self-governance
Area	World Bank		square kms
Population	Our World in Data	2020	Number of inhabitants
GDP p.c.	Our World in Data	2020	Gross domestic product at purchasing power parity (constant 2011 international dollars), most recent year available
Population >70 yrs	Our World in Data	2015	Share of the population that is 70 years and older in 2015
Hospital beds	Our World in Data	2010-2020	Hospital beds per 1,000 people, most recent year available since 2010
Institutional quality	Charron et al., 2020	2010-2017	European Quality Index
Closures and lockdowns	Porcher, 2020	2020	Count of local and national proactive measures

Table 2: Descriptive statistics

Descriptive Statistics	Observations	Mean	St. Dev.	Minimum	Maximum
Deaths/1000 inhabitants July 2020	88	134.5258	181.868	0.831	849.036
Deaths/1000 inhabitants October 2020	88	207.4316	232.783	0.845	984.567
Deaths/1000 inhabitants January 2021	88	536.1283	451.856	0.96	1742.422
Deaths/1000 inhabitants February 2021	88	654.9571	542.88	1.146	1859.509
Federalism	89	0.224719	0.41976	0	1
Regional authority Index	80	9.64625	9.75598	0	37
Political decentralization index	89	0.589438	0.22061	0	1
Territorial self-governance	72	0.902778	1.24651	0	3
GDP p.c.	87	26177.96	18734.6	1653.17	94278
Density	86	243.9195	907.43	3.250122	8321.58
Population >70 yrs	86	8.120884	4.31672	1.447	18.493
Hospital beds	86	3.442337	2.43627	0.3	13.05
Institutional quality	80	0.5625	0.49921	0	1
Localized school closures (%)	87	0.495779	0.45483	0	2.085106
Localized domestic lockdowns (%)	87	0.739101	1.12862	0	6.333333
Localized restaurant closures (%)	87	0.974417	1.17409	0	9.3125

Regression results are obtained by OLS, with robust standard errors and the estimated coefficients are presented as beta coefficients. [1] The dependent variable is considered at four different points in time, as discussed above, while the independent variables are analyzed at the same time point, thus leading to the estimation of four separate cross-sections.

4. Indicators of subnational autonomy

In order to examine the correlation between COVID-19's fatal impact and the centralized or decentralized structure in different countries, several indicators have been considered as proxies for the organization of the different tiers of government.

In the empirical sections below, the choice of the proxies used has been motivated by accounting for different definitions of decentralization, from a simple dichotomous variable classifying countries as unitary or federalists (*federalism*), to more nuanced definitions of subnational autonomy beyond federalism (*regional authority index, political decentralization index, territorial self governance*). Indicators have also been selected to ensure the widest geographical scope and recent collection of the data.

Harguindéguy et al. (2019) provide a critical review of different available indexes of decentralization, showing how they differ, among other features, in the underlying definition of territorial autonomy. They conclude that the Regional Authority Index (see table 1) is among the most complete indicators.

The first indicator considered (*federalism*) takes on value 1 for federalist countries and 0 for unitary countries, where a federal country, or federation, is one where the Constitution divides power between one or more orders of government, which are directly elected by their citizens.[2]

The Regional Authority Index (Hooghe et al., 2016) classifies regional government levels in 81 countries along the political, administrative and fiscal dimension according to a scale based on twelve indicators, based on self and shared rule. The resulting aggregate index for each country is increasing in subnational authority, with regional decentralization consisting in possessing authority over certain political actors and areas at a given time.

The Political Decentralization Index (Ivanyna and Shah, 2012) summarizes data for 182 countries which are ranked on the basis of legislative and executive elections and direct democracy to account for the degree of political decentralization. The resulting aggregate indicator refers to home rule for local self-governance, with higher values given to more decentralized countries.

Finally, the Territorial Self Governance Index (Trinne and Schulte, 2020) classifies subnational autonomy and decentralization based on the identification of eight specific types of territorial self-governance, which account for weaker forms of constitutionally protected standard types, focusing on both standard and special subnational units, if present.[3]

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[1] Results are however robust, with minor differences, to an alternative specification of robust errors, clustered around a country's expenditure for the health sector over GDP in 2018, to account for differences in national health care systems and financing. Results are available upon request.

[2] http://www.forumfed.org/

[3] Given the frequency and distribution of these types in the present dataset, I have further aggregated the categories in three, with the first term in parentheses referring to standard subnational units and the second to special subnational units, if present: 0 (DC-deconcentrated entity and TR-territorialized entity); 1 (RG-regionalized entity and DV-devolved entity); 2 (SF-semi federated entity and SA-semi autonomous entity); 3 (FD-federated entity and AN-autonomous entity).

5. Empirical results and discussion

In what follows, results of the empirical model are presented with respect to the four time points considered described above with confirmed COVID-19 deaths per 1000000 inhabitants as the dependent variable and different proxies for subnational autonomy in the various columns (table 3).

Starting from the main variables of interest, those measuring different aspects of subnational autonomy, the main message is that non unitary states seem to be characterized by a stronger impact in terms of COVID-19 deaths. This is especially true when considering whether a country is federalist or not (*federalism*), the degree of regional authority (*regional authority index*) and *territorial self-governance*. Higher degrees of political decentralization (p*olitical decentralization index*) are also associated with higher deaths, albeit only when looking at data in July 2020. The association between the dependent variable and indicators of subnational autonomy is relatively stable over the first wave (July and October 2020) but becomes indistinguishable from zero in January and February 2021 for most indicators, with the exception of the regional authority index, whose associated coefficient is always positive and statistically different from zero.

There are several potential explanations for these findings: given the nature of the problem and the scale of diffusion of the virus, unitary states with centralized decision-making might be better equipped to design and enforce policy measures that are more effective in containing the spread of the virus and can better organize the public health response, ultimately resulting in lower death counts. This might be due to a better match between the scope of the problem and the level at which the policy making process takes place. Other potential explanations could be that, for various reasons, non-unitary countries might be more able to detect and identify COVID-19 cases and deaths thus leading to higher numbers; these countries could share some underlying characteristics, not fully captured by the model, that make them more susceptible to the adverse effects of the virus. The inclusion of economic, demographic, institutional quality and health system variables should help in controlling for these aspects, but more research is needed to formally rule out these alternative explanations.

With respect to the other variables, deaths are higher in more developed countries (positive and statistically distinguishable from zero coefficient for *gdp per capita*, although this association does not appear to be particularly robust across models nor over time), and for those in which there is a higher proportion of senior citizens (*Population >70 yrs*). More densely inhabited countries experience, on average, lower deaths, possibly due to a higher availability and concentration of health services (*Density*). A higher availability of hospital beds per 1000 inhabitants (*hospital beds*), signaling a strong and well organized health system, is related to lower deaths, at least in the first two time points considered, as is the case in countries with good institutional quality (*institutional quality*), although the estimated coefficient is not distinguishable from zero in the last time point.

Table 3: Main results

	Dep. Var. COVID-19 Deaths per 1000 inhabitants (July 30 2020)				*Dep. Var. COVID-19 Deaths per 1000 inhabitants (October 1 2020)*				*Dep. Var. COVID-19 Deaths per 1000 inhabitants (January 12 2021)*				*Dep. Var. COVID-19 Deaths per 1000 inhabitants (February 11 2021)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
GDP p.c.	0.245**	0.18	0.268**	0.249**	0.175*	0.1	0.190*	0.178*	0.016	-0.031	0.03	0.033	0.029	-0.039	0.014	0.019
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.003]	[0.004]	[0.003]	[0.004]	[0.003]	[0.004]	[0.003]	[0.004]
Population >70 yrs	0.586***	0.360**	0.507***	0.593**	0.443***	0.203	0.341**	0.405*	0.656***	0.503***	0.583***	0.575***	0.711***	0.577***	0.644***	0.618***
	[8.035]	[7.282]	[8.340]	[10.644]	[8.734]	[8.845]	[9.319]	[12.346]	[13.14]	[15.63]	[14.03]	[20.13]	[15.44]	[18.95]	[16.39]	[23.34]
Hospital beds	-0.454***	-0.449***	-0.462***	-0.517***	-0.370***	-0.361***	-0.342***	-0.389***	-0.123	-0.125	-0.132	-0.107	-0.153	-0.159	-0.163	-0.133
	[11.41]	[9.423]	[10.882]	[10.262]	[11.74]	[9.37]	[11.42]	[11.62]	[28.38]	[28.55]	[30.02]	[28.01]	[34.37]	[34.47]	[36.11]	[33.68]
Institutional quality	-0.234*	-0.144	-0.245**	-0.256	-0.356**	-0.265	-0.368*	-0.345*	-0.213	-0.147	-0.221*	-0.164	-0.191	-0.13	-0.199	-0.13
	[50.04]	[56.23]	[46.75]	[70.53]	[72.40]	[83.58]	[70.93]	[95.65]	[120.79]	[142.14]	[118.53]	[153.68	[139.79]	[161.93]	[137.11]	[177.08]
Density	-0.131***	-0.076	-0.160***	0.133	-0.123***	-0.068	-0.151***	0.011	-0.105**	-0.078	-0.127***	-0.069	-0.107**	-0.085	-0.128***	-0.084
	[0.009]	[0.010]	[0.009]	[0.216]	[0.011]	[0.011]	[0.011]	[0.260]	[0.022]	[0.025]	[0.022]	[0.451]	[0.027]	[0.029]	[0.026]	[0.504]
Federalism	0.209*				0.194				0.152				0.129			
	[54.25]				[71.95]				[115.82]				[132.11]			
Regional authority Index		0.461***				0.445***				0.244*				0.20*		
		[2.763]				[3.52]				[6.146]				[6.71]		
Political decentralization index			0.138				0.214*				0.147				0.14	
			[86.91]				[140.91]				[218.43]				[254.31]	
Territorial self-governance				0.263**				0.254**				0.119				0.097
				[19.05]				[24.83]				[41.26]				[48.17]
Observations	76	69	76	65	76	69,000	76,000	65	76	69	76,000	65	76	69	76	65
R-squared	0.241	0.371	0.2141	0.269	0.168	0.304	0.168	0.178	0.244	0.244	0.239	0.200	0.279	0.267	0.278	0.234

*Note: Beta coefficients. Standard errors in brackets. *: 0.10: significance level. **: 0.05 significance level. ***: 0.01 significance level.*

Looking at the evolution of the estimated coefficients over time, while some coefficients are relatively stable (*Population >70 yrs* and *regional authority index*), others seem to suggest a different relationship between some control variables and confirmed COVID-19 deaths, especially when considering July and October 2020 versus January and February 2021. This might signal that during the course of the pandemic, other factors might have arisen as relevant correlates of the outcome, due to the life cycle of the virus (which is beyond the scope of this paper) and a learning curve by policy-makers and citizens. With respect to the paper's main research question, the association between subnational autonomy indicators, as measured by the regional authority index and the dependent variable, remains remarkably stable suggesting the importance of focusing on the identification of relevant level of government that should design the policy response to a pandemic. While no attempt has been made in the current analysis in terms of causality, a first indication is that the policy response might be more effective if taken at the central government level.

5.1 The local dimension of restrictive measures

In order to rule out the possibility that subnational autonomy indices are a proxy for the local dimension of restrictive measures, the model is enriched by adding information on the percentage of policy responses that are spatially localized (Porcher, 2020). To this end information on whether countries have put in place three types of restrictive measures (school closures, domestic lockdowns and restaurant closures) and the percentage of these that had a localized nature, are added.

Data provide information on whether restrictions are adapted at a local scale and not on the whole national territory, but give no indication on the level of government (central or local) that decided on the measure. Thus a local domestic lockdown could be decided by the central or local government and there could be coordination- or a lack of- between the different levels of government. What these indicators are capturing is whether the policy response was spatially differentiated or not across the national territory. What instead is not captured is whether the measure was taken by the central or local government.

Specifically, information is provided with respect to the localized school closures (table 4), localized domestic lockdowns (table 5) and localized restaurant closures (table 6). The indicator for each of these dimensions is presented as the percentage of localized restrictions over the total, cumulated over time from January 1 to October 1, 2020. The model estimated is the same used in the previous section, with the addition of the variable on localized measures and an additional indicator variable indicating whether a country has put in place restrictive measures at a national level above or below the average, with the variable taking on value one and zero, respectively. The correlation between the percentage of localized restrictions and COVID-19 deaths is assessed as contemporaneous, using data on deaths from October 2020 (first panel of tables 4-6), and with a lag, using data on deaths from January 2021 (second panel of tables 4-6).

The main results pertaining to the control variables used in the previous Sections are unaltered, so will not be explicitly discussed here, where the focus will be solely on the estimated parameter for the localized restriction indicators. It should be noted that adding indicators describing the local dimension of restrictions does not affect the estimated parameters of the indicators of our main variables of interest, namely federalism, regional authority, policy decentralization and territorial self-governance.

Table 4: Localized school closures

	Dep. Var. COVID-19 Deaths per 1000 inhabitants (October 1 2020)				*Dep. Var. COVID-19 Deaths per 1000 inhabitants (January 12 2021)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP p.c.	0.162	0.084	0.172	0.169	-0.004	-0.056	0.004	0.007
	[0.001]	[0.00]	[0.001]	[0.002]	[0.003]	[0.004]	[0.003]	[0.004]
Population >70 yrs	0.456***	0.213	0.352*	0.399*	0.676***	0.528***	0.607***	0.610***
	[8.986]	[9.245]	[9.791]	[12.85]	[13.91]	[16.24]	[15.25]	[20.74]
Hospital beds	-0.387***	-0.384***	-0.408***	-0.398***	-0.159	-0.164	-0.173	-0.149
	[11.63]	[9.573]	[10.98]	[12.81]	[27.89]	[27.65]	[29.69]	[27.73]
Institutional quality	-0.338**	-0.246	-0.333**	-0.322	-0.207	-0.146	-0.203	-0.154
	[79.88]	[95.85]	[75.06]	[104.9]	[128.0]	[155.6]	[125.1]	[160.9]
Density	-0.118***	-0.068	-0.146***	-0.022	-0.101*	-0.074	-0.120**	-0.083
	[0.011]	[0.011]	[0.012]	[0.289]	[0.025]	[0.029]	[0.025]	[0.468]
Federalism	0.214				0.146			
	[78.55]				[124.3]			
Regional authority Index		0.451***				0.239*		
		[3.398]				[6.347]		
Political decentralization index			0.250*				0.164	
			[149.1]				[228.9]	
Territorial self-governance				0.272**				0.115
				[26.09]				[43.55]
Localized school closures (%)	-0.004	-0.007	0.001	-0.022	0.131	0.138	0.135	0.138
	[59.13]	[61.86]	[54.64]	[60.77]	[117.3]	[144.1]	[111.2]	[125.2]
Country-wide school closures	0.085	0.035	0.122	0.043	0.034	0.007	0.059	0.005
	[60.60]	[60.39]	[62.30]	[66.74]	[100.6]	[111.2]	[102.2]	[114.8]
Observations	73	67	73	63	73	67	73	63
R-squared	0.192	0.321	0.198	0.201	0.263	0.27	0.264	0.227

*Note: Beta coefficients. Standard errors in brackets. *: 0.10: significance level. **: 0.05 significance level. ***: 0.01 significance level*

Table 5: Localized domestic lockdowns

	Dep. Var. COVID-19 Deaths per 1000 inhabitants (October 1 2020)				*Dep. Var. COVID-19 Deaths per 1000 inhabitants (January 12 2021)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP p.c.	0.156	0.085	0.161	0.173	0.01	-0.033	0.018	0.042
	[0.001]	[0.002]	[0.001]	[0.002]	[0.003]	[0.004]	[0.003]	[0.004]
Population >70 yrs	0.438***	0,199	0.338*	0.368*	0.668***	0.502***	0.575***	0.517***
	[8.930]	[8.853]	[9.638]	[12.19]	[13.87]	[15.72]	[15.31]	[19.94]
Hospital beds	-0.393***	-0.387***	-0.413***	-0.407***	-0.134	-0.139	-0.152	-0.1
	[12.61]	[10.03]	[12.17]	[12.94]	[24.64]	[25.32]	[28.10]	[23.37]
Density	-0.126***	-0,077	-0.151***	-0,026	-0.104**	-0.081	-0.130**	-0.133
	[0.0116]	[0.0114]	[0.0127]	[0.258]	[0.0226]	[0.0255]	[0.0242]	[0.447]
Institutional quality	-0.352**	-0,251	-0.350**	-0.317*	-0.238*	-0.159	-0.235*	-0.145
	[76.57]	[91.08]	[74.91]	[97.25]	[124.6]	[146.1]	[121.0]	[155.4]
Federalism	0.21				0.226*			
	[82.40]				[124.5]			
Regional authority Index		0.458***				0.297**		
		[3.510]				[6.667]		
Political decentralization index			0.232*				0.203*	
			[144.5]				[221.4]	
Territorial self-governance				0.291**				0.203*
				[26.73]				[43.10]
Localized domestic lockdowns (%)	0.027	0.015	0.048	0.028	-0.167**	-0.170**	-0.138*	-0.170**
	[20.32]	[17.82]	[20.80]	[20.77]	[30.05]	[30.35]	[31.74]	[31.30]
Country-wide domestic lockdowns	0.017	-0.026	0.055	-0.082	-0.078	-0.105	-0.034	-0.183
	[60.69]	[56.34]	[55.57]	[59.61]	[95.98]	[99.63]	[93.09]	[100.4]
Observations	73	67	73	63	73	67	73	63
R-squared	0.187	0.321	0.191	0.206	0.275	0.286	0.262	0.259

*Note: Beta coefficients. Standard errors in brackets. *: 0.10: significance level. **: 0.05 significance level. ***: 0.01 significance level*

Table 6: Localized restaurant closures

	Dep. Var. COVID-19 Deaths per 1000 inhabitants (October 1 2020)				*Dep. Var. COVID-19 Deaths per 1000 inhabitants (January 12 2021)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP p.c.	0.147	0.067	0.152	0.157	-0.015	-0.073	-0.01	-0.004
	[0.002]	[0.002]	[0.002]	[0.002]	[0.0032]	[0.004]	[0.003]	[0.004]
Population >70 yrs	0.434**	0.203	0.323*	0.388*	0.665***	0.515***	0.582***	0.579***
	[9.224]	[8.852]	[9.964]	[12.89]	[13.78]	[16.41]	[14.88]	[21.35]
Hospital beds	-0.381***	-0.367***	-0.403***	-0.391***	-0.15	-0.152	-0.166	-0.126
	[12.00]	[9.246]	[11.39]	[12.62]	[28.35]	[28.69]	[30.27]	[27.87]
Density	-0.111**	-0.044	-0.140**	-0.022	-0.106*	-0.069	-0.128**	-0.1
	[0.0126]	[0.0123]	[0.0135]	[0.277]	[0.0264]	[0.0298]	[0.0261]	[0.482]
Institutional quality	-0.340**	-0.236	-0.336**	-0.311	-0.195	-0.109	-0.192	-0.12
	[81.21]	[98.86]	[81.37]	[100.1]	[133.0]	[159.3]	[130.2]	[159.4]
Federalism	0.219*				0.17			
	[72.52]				[119.3]			
Regional authority Index		0.464***				0.254*		
		[3.225]				[6.277]		
Political decentralization index			0.248*				0.182*	
			[147.8]				[221.8]	
Territorial self-governance				0.265**				0.133
				[24.83]				[41.40]
Localized restaurant closures (%)	0.024	0.05	0.018	0.026	-0.016	-0.007	-0.021	-0.012
	[16.54]	[16.09]	[16.34]	[17.06]	[25.80]	[27.23]	[25.67]	[27.88]
Country-wide restaurant closures	0.086	0.141	0.101	0.101	0.009	0.049	0.02	0.042
	[59.15]	[59.77]	[60.68]	[64.99]	[101.0]	[109.6]	[103.9]	[111.4]
Observations	73	67	73	63	73	67	73	63
R-squared	0.193	0.34	0.196	0.209	0.246	0.254	0.244	0.211

*Note: Beta coefficients. Standard errors in brackets. *: 0.10: significance level. **: 0.05 significance level. ***: 0.01 significance level*

Localized school closures and restaurant closures do not appear to exhibit a correlation with COVID-19 deaths, neither contemporaneous nor with a lag (tables 4 and 6). The only coefficients that can be distinguished from zero are those associated with domestic lockdowns on lagged deaths (Table 5, second panel). The percentage of cumulated domestic lockdowns that are local is associated with lower deaths with a three-month lag, suggesting that this might be the type of restrictive measure that is correlated with a reduction in the adverse effects of the virus. The indicators for the restrictive measures of all three types are never statistically distinguishable from zero.[4]

5.2 The role of country size

Country size may also be an important determinant in explaining differences in the number of deaths across countries. Large countries in a geographic sense may suffer from logistical problems in relation to the supply and delivery of equipment, medicines and vaccines, hinting towards benefits from centralization. On the other hand, size in terms of population and its distribution might instead be such that decentralized solutions are more effective. From an empirical viewpoint, however, both population and square area are highly correlated with subnational autonomy measures, not allowing the inclusion of the three variables simultaneously. In the previous models, a solution has been to consider density to account for these aspects (*density*). In this Section, an indicator variable for large countries (*large*) has been added to the model (table 7).[5] Results are shown only for data related to deaths up to July 2020, as this effect probably decreased in importance over time, as countries moved from an emergency situation to an unforeseen shock.[6]

Overall, the main results are unchanged. Two aspects are worth highlighting though. First, larger countries, in terms of population and area, tend to experience higher deaths, *ceteris paribus*. Second, there is a correlation between size and subnational autonomy (but not so strong as to hamper the statistical significance of the empirical model),[7] with unitary countries being generally smaller. However, this correlation does not undermine the importance of subnational autonomy *per se*, with, overall, the same results as before: more centralized countries seem to have, on average, fared better than decentralized countries in curbing deaths from COVID-19.

[4] Further investigations concerning the effects of nation-wide containment measures, while outside the scope of this paper, would be interesting and should include the population's perception of the risk of contagion (Huynh, 2020)

5 Following Crowards 2002, the indicator variable large is created by combining size in terms of area and population (and excluding the GDP dimension as GDP pc is already one of the regressors), defining a country as large if population is more than 2.7 million inhabitants and area is above 40.000 square km.

6 Additional results for later periods are available upon request.

7 The correlation coefficient between the large indicator and the measures of subnational autonomy, always statistically different from zero, ranges between 0.1942 and 0.3714, thus not posing significant problems for the inclusion of the dummy in the empirical specifications.

Table 7: The effect of country size

	Dep. Var. COVID-19 Deaths per 1000 inhabitants (July 30 2020)			
	(1)	(2)	(3)	(4)
GDP p.c.	0.234*	0,143	0.252*	0.327**
	[0.001]	[0.001]	[0.001]	[0.002]
Population >70 yrs	0.571***	0.372**	0.511***	0.484**
	[8.080]	[7.398]	[7.952]	[8.989]
Hospital beds	-0.440***	-0.448***	-0.442***	-0.463***
	[10.79]	[9.277]	[10.33]	[10.35]
Institutional quality	-0.222*	-0.139	-0.230*	-0.222
	[50.09]	[59.09]	[47.53]	[55.18]
Large coountry dummy	0.129*	0.003	0.146*	0.142***
	[47.24]	[47.36]	[54.40]	[50.58]
Federalism	0.199			
	[59.01]			
Regional authority Index		0.472***		
		[2.933]		
Political decentralization index			0.091	
			[96.78]	
Territorial self-governance				0.219*
				[18.60]
Observations	76	69	76	65
R-squared	0.241	0.366	0.21	0.27

*Note: Beta coefficients. Standard errors in brackets. *: 0.10: significance level. **: 0.05 significance level. ***: 0.01 significance level.*

6. Discussion and conclusions

The estimation results allow drawing a series of preliminary evidence on the role of subnational autonomy and non-unitary organization of countries worldwide and on the relation between economic, institutional and demographic and fatal consequences of the COVID-19 pandemic. As stressed throughout the paper, the estimated coefficients reflect association between variables and more research is needed to explore the issue of causation. However, given that the pandemic is still ongoing and that the available treatment and inoculation options are still at rather initial stages, a more in depth examination is left for the future, when hopefully the adverse effects will have been tamed and a better understanding of the epidemiological and clinical behavior and impact of COVID-19 will be available.

Regional authority, political decentralization, territorial self-governance and, to a minor extent, federalism, are all associated with higher COVID-19 deaths, suggesting that in countries where the policy-making process is fragmented at the subnational level, the negative consequences of the coronavirus infection are more severe, and this effect holds also when accounting for country size and density. This association can be explained by considering how the diffusion of a respiratory virus is not directly constrained by borders, most notably those within a country, suggesting that the effectiveness of containment measures is probably higher if these are centrally decided and enforced equally at the territorial level. Further, in non-unitary countries, there might be differences in terms of the organization and funding of the health system across the different subnational divisions (Saltman et al., 2006), implying a fragmented response of local hospitals and physicians. If further analysis, possibly conducted across different countries with spatially disaggregated data, should confirm and strengthen this result, a clear policy implication is that, notwithstanding the organization in federal or unitary systems, countries should centralize policy decision making in phenomena that are not confined by intra-national borders, such as pandemics or possibly nation-wide natural disasters, in order to curb the adverse effects and not be burdened by the problems related to a fractionalized policy-making system.

Another implication of the empirical results is related to the importance, in facing adverse events, of the organization of national health systems, with a specific focus on the availability of hospital beds. If pandemics will indeed be recurrent in the coming future (Dobson et al., 2020), it is crucial that each country is well equipped to contain damages. To the extent that this is also related to the unitary or federalist structure of the country, this might point to the need for central coordination and the definition of minimum standards to be achieved by subnational health systems, notwithstanding the possibility of maintaining a decentralized structure for other issues.

Results on the local dimension of restrictive measures suggest that an associated reduction in deaths is detected only when considering the percentage of localized domestic lockdowns and when allowing for a three-month lag. This result does not alter the fact that countries with higher degrees of subnational autonomy are still associated with higher death rates, even when controlling for the local dimension of restrictions. While more research is needed to understand the causal links, this finding suggests that even in non-unitary states, government responses aimed at containing the adverse effects of the virus might exploit the spatial variation of diffusion and make use of local knowledge possessed by lower tiers of government to design and put in place local measures.

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Appendix

Table A.1: Subnational autonomy indicators and sample

Country	Federalism	Regional authority index	Territorial self governance	Political decentralization index
Albania	x	x	x	x
Argentina	x	x	x	x
Australia	x	x	x	x
Austria	x	x	x	x
Bahamas	x	x		x
Barbados	x	x		x
Belgium	x	x	x	x
Belize	x	x		x
Bolivia	x	x	x	x
Bosnia and Herzegovina	x	x		x
Brazil	x	x	x	x
Brunei	x	x		x
Bulgaria	x	x	x	x
Canada	x	x	x	x
Chile	x	x	x	x
Colombia	x	x		x
Costa Rica	x	x	x	x
Croatia	x	x	x	x
Cuba	x	x	x	x
Cyprus	x	x	x	x
Czech Republic	x	x	x	x
Denmark	x	x	x	x
Dominican Republic	x	x	x	x
East Timor	x	x		x
Ecuador	x	x	x	x
Egypt	x			x
El Salvador	x	x	x	x
Estonia	x	x	x	x
Finland	x	x	x	x
France	x	x	x	x
Germany	x	x	x	x
Greece	x	x	x	x
Guatemala	x	x	x	x
Guyana	x	x	x	x
Haiti	x	x	x	x
Honduras	x	x	x	x
Hungary	x	x	x	x
Iceland	x	x		x
India	x		x	x

Indonesia	x	x	x	x
Iran	x			x
Iraq	x			x
Ireland	x	x	x	x
Israel	x	x	x	x
Italy	x	x	x	x
Jamaica	x	x	x	x
Japan	x	x	x	x
Korea	x	x	x	x
Kosovo	x	x		x
Latvia	x	x	x	x
Lithuania	x	x	x	x
Luxembourg	x	x	x	x
Macedonia (FYR)	x	x	x	x
Malaysia	x	x	x	x
Malta	x	x		x
Mexico	x	x	x	x
Montenegro	x	x	x	x
Nepal	x			x
Netherlands	x	x	x	x
New Zealand	x	x	x	x
Nicaragua	x	x	x	x
Nigeria	x		x	x
Norway	x	x	x	x
Pakistan	x		x	x
Panama	x	x	x	x
Paraguay	x	x	x	x
Peru	x	x	x	x
Philippines	x	x	x	x
Poland	x	x	x	x
Portugal	x	x	x	x
Romania	x	x	x	x
Russian Federation	x	x	x	x
Serbia	x	x	x	x
Singapore	x	x		x
Slovak Republic	x	x	x	x
Slovenia	x	x	x	x
South Africa	x		x	x
Spain	x	x	x	x
Suriname	x	x		x
Sweden	x	x	x	x
Switzerland	x	x	x	x
Thailand	x	x	x	x
Trinidad and Tobago	x	x	x	x
Turkey	x	x	x	x

United Kingdom	x	x	x	x
United States	x	x	x	x
Uruguay	x	x	x	x
Venezuela	x	x	x	x
Zambia	x			x