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Multi-level Governance and policy uncertainty during the first wave of COVID-19

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Abstract

We compare health system responses to the first wave of COVID-19 pandemic in Italy and Spain. Although in both countries, healthcare is managed at the regional level, the central government behaved differently in the uncertainty surrounding the first wave, leaving more autonomy to regional governments in Italy than in Spain. Upon documenting evidence of national and regional health system responses, we show important differences in the number of infected cases, alongside regular and emergency hospital admissions, and mortality in the two countries, both at the national and at the regional level. We then discuss several potential mechanisms, such as policy stringency, the localization of the pandemic and mobility restrictions, measurement error, and especially the regional autonomy, enjoyed by Italian regions but not by Spanish regional governments amidst a state of alarm in both countries. We conclude that, given the strong localized effect of the pandemic, allowing more autonomy, and fostering experimentation and local solutions explains the gap between Italy and Spain in the first wave of the pandemic.

Keywords: regional health systems, decentralization, policy stringency, health care, COVID-19, Italy, Spain.

JEL Codes: H75, I18

1. Introduction

Although pandemics such as COVID-19 are a 'global public bad', that requires further intergovernmental coordination at the highest possible level, crucial local knowledge about how best to address the needs imposed by a pandemic might not be used when decision making is completely centralized. This issue is of particular relevance in a number of healthcare systems in the European Union where the health policy expertise is at different levels of government.

The territorial governance has been at the center of every policy reaction to new viruses before, (see for instance reactions to SARS-CoV in 2002, MERS-CoV in 2012 or the spread of known lethal viruses like EBOV in 2014); and the *balance of power* between a highly centralized governance and a more decentralized solution has played a central role. Proponents of centralized governance argue for a *uniform* response to counteract adverse effects of territorial self-interest (e.g., not sharing timely information, or circulating essential protective equipment). In contrast, advocates of decentralization put forward the role of innovation and low-cost experimentation when the optimal policy reaction is unknown, and the new virus is surrounded by uncertainty. Decentralized governance can still allow for some degree of coordination, for instance via Pandemic Plans, within and even between countries. Cross country and cross regional coordination via Pandemic Plans allow for a swift exchange of information on the characteristics of the pathogen, alongside the set-up of common standards to track its evolution and collect comparable data, regulations to manage the actions of infected patients and prevent the spread of the disease further (including border closures and quarantines). Whilst coordination across borders is required at a European-wide level to face a global pandemic, regional reactions are more flexible to respond to idiosyncratic needs;

hence, a 'one-size-fits-all' approach might be a less efficient governance design when the impact of policies are highly uncertain as it is the case in the presence of a completely new virus.

This paper examines the effects of national (central) and sub-national (regional) reactions to COVID-19 in Italy and Spain by exploiting the first wave of the pandemic, when the new virus was largely unknown and governments (both at the central and at the local level) had to decide what to do rapidly to protect the health of citizens with almost no information on the potential impact of specific policies. We contribute to a growing multidisciplinary literature (e.g., Casula and Vidal, 2021, Bailey et al., 2020, and Dodds et al., 2020), by examining how decentralized health systems have managed the pandemic expansion. More specifically, we study the effect of multilevel governance of COVID-19 on several outcomes across Italy and Spain after the declaration of the state of emergency[2]. It is unclear whether regional autonomy provides an advantage to face a pandemic; when there is a large uncertainty in the effect of policies, as it had been the case during the first wave of COVID-19. More specifically, are there any cross-country differences in *new* health care emergencies on health outcomes? Are regional governments better suited to face the coordination of health care needs in a *new* pandemic (for instance, by adapting mobility restrictions to their local circumstances)?

Italy and Spain share common institutional backgrounds (e.g., decentralized health care systems), but differed in the governance of the first wave of COVID-19 pandemic (as discussed also qualitatively by Casula and Vidal, 2021). Both countries were hit hardly by the pandemic, approximately around the same time: Spain was only few weeks behind Italy in the spread of the virus. In May 2020, when the 'first wave' was reaching an end and countries gradually re-opened their economies, reported cases in Italy (230,000) compared to those reported in Spain (240,000), and the same applies to deaths (33,000 and 29,000, in Italy and Spain respectively).

[2] Table A.1 included in the Appendix details the policies and the interventions taken in the two countries.

However, despite sharing a heavily decentralized health system and hence an important regional level expertise, their central governments responded differently during the crisis. Whilst the Spanish government centralized the purchase of health care equipment and imposed a central level coordination in all policy domains related to pandemic management, the Italian government did not enforce a full coordination among the regional governments. In addition, even before calling a national lockdown in Italy, regional governments were allowed to differ in their policy priorities: Lombardy relied mostly on hospitals, while Veneto pushed on contact-tracing. This was not possible during the first wave of the pandemic in Spain, given the centralization of power in the hand of the central government. Hence, the latter offers an opportunity to study the effects of this choice on relevant outcomes.

Given their different governance responses to the first wave of the COVID-19 outbreak, comparing evidence from Italy and Spain can be informative of the *balance of territorial power* allocation, and specifically, the welfare effects of health care (de-)centralization. Indeed, reliance on central level coordination runs the risk of amplifying the effect of a policy when it succeeds, but especially when it fails. A uniform response across the entire national territory is still possible when effective cooperation takes place as it has been the case of the countries of the United Kingdom. In contrast, decentralized designs allow for experimentation in identifying a regional specific policy solution to face the spread of the virus. When the latter proves effective, then other regions can learn from such effects and adjust their own response.

In this paper, besides studying national aggregate data, we also consider four regional case studies, Lombardy and Veneto in Italy and Madrid and Catalonia in Spain, and we argue that an effective policy solution was found by the Veneto Region in Italy. Despite bordering the Lombardy Region, Veneto experienced less than 20,000 cases as compared to about 80,000 in Lombardy during the first wave emergency. In contrast, Madrid and Catalonia replied in the

same manner, given the limited role for local policies allowed by the central government in Spain.

Policy reactions to COVID-19 in Italy

The first COVID-19 case in Italy was officially identified on 20 February 2020, at a public hospital in Codogno, a small town close to Milan, in Lombardy, thanks to the intuition of an anesthesiologist, who tested a 38-years old patient *against* the national advice for COVID-19 testing. In fact, the Italian Prime Minister has declared a national emergency via an 'emergency decree' since 31 January 2020, for a period of six months; but before detecting this first case, people to be checked and tested were only those returning directly from China.

Another similar town was Vo' Euganeo, an even smaller jurisdiction in the surroundings of Padua, in Veneto, where an outbreak was early discovered. Yet, both Codogno and Vo' Euganeo were locked-down into a *red-zon*e by the Central government after 23 February 2020, which entailed temporary closures of all economic activities but for essential services, and stay-at-home orders for all the people residing in the area. On 8 March 2020, the entire Lombardy, as well as few provinces in the bordering regions of Veneto, Piedmont and Emilia Romagna were locked into *red-zones too*. Finally, the whole country has been locked down in a national *red-zone* few days later, starting from 11 March 2020. After months of lockdown, a de-escalation of measures was started at the beginning of May, marking the end of the first wave of COVID-19 pandemic in Italy.

Despite a national lockdown was enacted, the evolution of the epidemic in Italy was regionally heterogeneous. Northern Italy was more exposed to COVID-19 infection compared to both the Center and South, where the spread of the new coronavirus did not follow a similar growth. In Northern Italy, Lombardy was by far the most affected region, and one of the most affected in

the world during the first wave. Conversely, in Veneto the evolution of contagion had been more mitigated. These are the two Italian regions that we consider as case studies below.

The Italian National Healthcare System (NHS), provides universal healthcare coverage since 1978, and it is financed with taxes, mostly collected at the central level. During the Nineties, several policy reforms transferred administrative and organizational responsibilities from the central government to the regional administrations, so that Italian regions have significant autonomy in organizing their own healthcare system (Turati, 2013). This autonomy was enjoyed also during the pandemic despite the declaration of the national emergency, and it helps explain the different policy patterns followed by Lombardy and Veneto.

Among the regions, Lombardy has a population of 10 million residents, and it ranks among the most competitive areas in Europe. Public expenditure for healthcare services reached 19 billion euro in the last year. The healthcare system comprises approximately 150 hospitals generating 1.5 million discharges annually. A regional reform in 1997 radically transformed the healthcare system in Lombardy into a quasi-market in which citizens are free to choose the provider, regardless of its ownership (private or public). Unlike other Italian regions, the healthcare system in Lombardy is entirely built on a clear separation between insurers (the Local Health Authorities, LHA) and providers, on resources allocated based on a prospective payment system based on DRGs, and on the reimbursement for all the (public and private) providers within the regional accreditation system (Brenna, 2011). The unfolding of the COVID-19 pandemics led to a rise of hospitalization, allowing the virus to spread into the hospitals which forced authorities in the provinces of Bergamo and Brescia to convert entire hospitals into COVID-19 wards, increasing beds capacity in ICU, moving physicians and nurses from their usual activity to care patients affected by the coronavirus. This policy of increasing ICU beds capacity was later adopted across the country.

In contrast to Lombardy, Veneto presented a more centralized healthcare model, with the regional government capable to better coordinate with a top-down approach the choices of hospitals. As for the pandemic, this model appeared more ready to deal with the epidemic outside the hospital. Veneto addressed COVID-19 epidemic by extensive testing of symptomatic and asymptomatic citizens, broad contact tracing around positive cases, quarantine for cases and suspected with daily telephone monitoring, detailed practical guidelines on home isolation, minimization of contacts with physicians and nurses, and limited hospital admissions to patients with major healthcare needs (Binkin et al., 2020).

Policy reactions to COVID-19 in Spain

During the first wave, Spain had one of the highest numbers of COVID-19 cases in the world, after the United States. The first positive case was detected on 31 January 2020, but it was only from March when the diagnoses began to increase exponentially. As of 25 February 2020, cases in Spain skyrocketed because people with pneumonia of unknown origin were tested for COVID-19. On the same day, four new cases related to the Italian cluster were confirmed in Spain. By 13 March 2020, cases had been confirmed in all 50 provinces of the country. A state of alarm and national lockdown was imposed on 14 March, and the central government was allocated full responsibility to coordinate and implement interventions to deal with the COVID-19 crisis. On 29 March 2020 it was announced that, beginning the following day, all non-essential workers were to stay home for the next 14 days. On 28 April, the government announced a plan for easing lockdown restrictions, but people were allowed out of their homes for short walks and individual sports only from 2 May, marking the end of the first wave also in Spain.

Unlike in Italy, Spain adopted a 'command-and-control' approach in stark contrast to its healthcare decentralization in normal times. Indeed, the health system in Spain compares to

the Italian one in all of its relevant design features: it is organized along the lines of a National Health System, the governance of the system is decentralized at the regional level. Seventeen regions (called autonomous communities) have health care responsibilities with regards to providers' organization and funding, and the system is funded by unadjusted block grants and, to a lesser extent, by regionally devolved and own taxes. So far, evidence documents that decentralized governance plays a role in lowering regional inequalities in health care use and in stimulating innovation (Costa-Font and Turati, 2018). However, strikingly, a newly appointed Minister of Health coordinated the commandment of the health system amidst the state of alarm, which was declared on 14 March 2020. The decree centralized the purchase of medical equipment, and the suspension of flights from Italy.

At the time of the first wave, health care policies were already highly heterogeneous across regions, since regional governments were run by different political coalitions. At the time of the first outbreak, the region of Madrid, was run by a conservative coalition government which has engaged in a plan of significant health care privatization, and during the pandemic pushed ahead outsourcing health care services to private for-profit providers. In contrast, Catalonia was run by a regional coalition whilst the central government was supported by a left -wing coalition with different regional supports. Madrid was the focal point of the pandemic in Spain, followed by Catalonia, which we consider as the two case studies in Spain below. Yet, although exposure to the pandemic differed by region considerably (e.g., besides Madrid and Catalonia, other heavily affected regions were the two Castile's, Basque Country, Navarra and Andalusia), as the speed of the pandemic differed by regions, the state of emergency and a central level coordination was imposed. In contrast, in the second and third wave, regional governments kept their own responsibilities. This provides with some levels of policy variation where to examine the effects of decentralization on relevant health outcomes.

2. Materials and methods

2.1. Data

The aim of this research is to compare the reaction to the first wave of COVID-19 pandemic in Spain and Italy to learn about the effect of a different governance in terms of centralization/decentralization in the management of the pandemic. We focus on the first wave, from the start to about its exhaustion: this period is characterized by the novelty of COVID-19, hence by the uncertainty surrounding policies aimed at containing the spread of the virus. Spanish data are gathered from the website of Instituto de Salud Carlos III (https://COVID19.isciii.es), while Italian Civil Protection provides daily updated data in a Github repository (https://github.com/pcm-dpc/ COVID-19).

Data reliability is clearly an issue for the comparison of performance in the first wave, and, more generally, for research related to COVID-19 (e.g., Odone et al., 2020). There are three main issues that affect data quality, missing a common framework at both supra-national and national level guaranteeing comparability, especially for the first wave. First, information on the number of affected people are influenced by the number of people that have developed the symptoms, have been treated by healthcare systems and have been tested by swab (the only method that produce reliable information). However, the use of swabs as a test procedure to identify Covid-19 infected has been very different across countries, and across regions within countries. In addition, testing policies have also changed during the pandemic for different reasons, including the fact that swabs or reagents were unavailable, again particularly in the first wave. Second, the number of hospitalizations, especially in ICU, have been influenced by the policies adopted by different regions and countries, and by the availability at the local level

of beds, which were adapted according to needs to be able to treat all patients (see, e.g., Fagiuoli et al., 2020, on the dramatic situation experienced at the Hospital Giovanni XXIII in Bergamo, Lombardy). Third, similar problems related to the number of infected applies to the number of deaths, which overlap with in-hospital mortality also for other causes. The absence of accepted standard for counting patients dying only for COVID-19 and patients affected by a number of other pathologies struck down by COVID-19 will produce noisy statistics in this respect. Considering these issues, ICU admissions and hospitalizations seems to be the most reliable information, at least for two reasons: these data reflect the strategy in contrasting the COVID-19 epidemic (Nacoti et al., 2020) and beds capacity has been increased in order to admit all possible patients, so that capacity constraints do not represent a crucial issue. In our analysis below, we then consider also these two outcomes (ICU admissions, hospitalizations) besides the number of cases and the number of deaths.

In addition to data on COVID-19 outcomes, we collect data on the Stringency index produced by the Blavatnik School of Government at the University of Oxford (available at https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker) with the aim to compare the restrictions applied in our countries of analysis. The index provides a better representation of the lockdown imposed in the two countries, detailing information on the policy response by governments like, e.g., school closures and stay-at-home orders (Hale et al., 2020).

Table A.2 in the Appendix provides descriptive statistics for all the variables included in our two datasets, one considering aggregate national data for both Spain and Italy, and one pooling information related to our four regional case studies.

2.2. Methods

Our discussion will be based on a descriptive analysis of COVID-19 outcomes measured at the national level in Italy and Spain, and at the regional level considering four selected case studies in the two countries. In particular, we examine the total number of infected cases, hospitalized patients, patients admitted in ICU together with evidence on regional and country specific mortality. To better interpret the evolution of the pandemic in the two countries during the first wave, we paired the time series for each country following the timeframe resulting from the day when Italy and Spain exhibited the same number of hospitalized patients, namely 7 March 2020 in Spain and 25 February 2020 in Italy (t_0). Furthermore, we considered the same length in days of the time series (75) and truncated for Italy on 9 May and for Spain on 20 May (t_{75}), corresponding to the end of the first wave emergency.

Given that trends across spatial units might be affected by factors like differences in population age groups, we also consider a simple regression model to complement our descriptive analysis. First, considering national data, we estimate the following model:

$$y_{i,t} = \alpha + \beta_1 SI_{i,t} + \sum \beta_{2,t} d\_Month_t + \beta_3 d\_ITA_i + \varepsilon_{i,t} \quad [1]$$

where y is one of the four COVID-19 outcomes (cases, hospitalizations, ICU admissions, and deaths), observed in country i (i=*Italy, Spain*) in day t, SI is the overall Stringency Index (summarizing a number of restrictive measures), d_Month are time dummies (February as a reference category, March, April, May), and ε represents the error term. The coefficient of interest is β_3 for the dummy d_ITA, which is equal to 1 for Italy and 0 for Spain. This coefficient estimates the differences between Italy and Spain in each Covid-19 outcome.

In order to explore regional differences, we select four regional case studies (Veneto and Lombardy in Italy, Catalonia and Madrid in Spain). Pooling data referring to these four regions, we then estimate the following model:

$$y_{i,t} = \alpha + \beta_1 SI_{i,t} + \sum \boldsymbol{\beta_{2,t} d\_Month_t} + \sum \boldsymbol{\beta_{3,i} d\_Reg_i} + \varepsilon_{i,t} \quad [2]$$

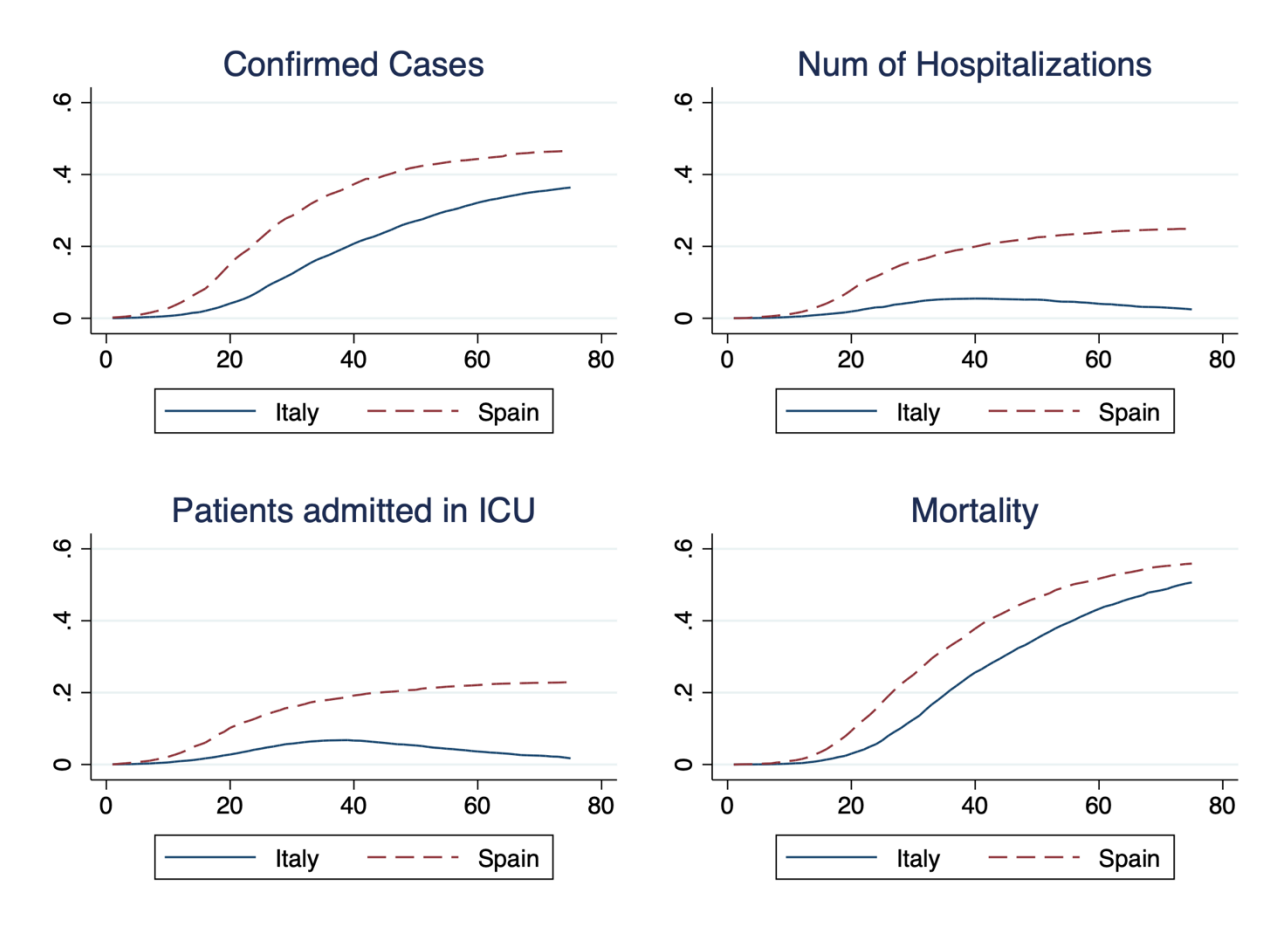
where all the variables are defined as before, except for the regional dummies, included to control for differences in the management of the COVID-19. Vector of coefficients $\boldsymbol{\beta}_3$is associated with the dummies ***d_Reg***, a vector of four regions: Veneto, Lombardy, Madrid and Catalonia (excluded as a reference category).

3. Results

3.1 Descriptive Evidence at the National Level

Figure 1 displays the cross-country comparisons in terms of the four COVID-19 related measures: number of infected cases, hospitalizations, admissions in ICU, and deaths. Data consider aggregate figures at the national level and all the measures are standardized rates in terms of population. To obtain a comparable scale for all plots, number of cases and hospitalizations rates are multiplied by 100, whereas admissions in ICU and deaths by 1,000. The values on x-axis refer to days t_0-t_{75}, as defined above. All figures reveal a consistent path: despite Spain has a population of about 47 million people compared to about 60 million people in Italy, Spain recorded a higher number of confirmed cases, hospitalized patients, patients admitted in ICUs and deaths. More strikingly, whilst hospitalizations and admissions to ICU tail-off after 30 days in Italy, they continue growing in Spain. This descriptive evidence points

toward a better performance of a governance model allowing for regional differentiation of policies.



One potential explanation of the differences between Italy and Spain lies in the stringency of measures implemented in Italy. Let us consider the Stringency index produced by the Blavatnik School of Government. The index details the lockdown policies adopted by the countries, summarizing several information about containment efforts, including the following measures: school and workplace closures, cancelling public events, limits on private gatherings, closing of public transport, and restrictions on internal movement between cities/regions. The index is computed at the national level, and it goes from 0 to 100: a higher value of the Stringency index suggests that the overall government response has become stronger. The comparison between Italy and Spain (see Table A.2) in terms of the Stringency index suggests that - although in the

early days of the pandemic the two countries differed in the stringency of measures implemented to fight the pandemic - both countries ended up exhibiting similar values of the index. In the following analysis, we consider the overall index provided by Blavatnik School of Government, instead of single specific policy domains included in the index. In fact, most of the measures (relative to school closures, international travel controls, or cancelling public events) have been early implemented in both countries. Differently, restrictions about workplaces or public transportations have been applied later in Spain as compared to Italy. The t_0 in the two countries is different: 7th March in Spain and 25th February for Italy. Hence, the few days of delay with which central government in Madrid adopted harsh measures as compared to Italy might explain part of the difference in outcomes between the two countries (on this, e.g., Montesò-Curto et al., 2020).

The slight delay in response by the Spanish government with respect to the actions taken in Italy can be gauged also by looking at excess mortality in 2020 compared to mortality estimates in 2019. Information about overall mortality in Spain are gathered from the Spanish Mortality Monitor (MoMo, available at https://www.isciii.es). Spanish data are daily collected and include all-causes mortality obtained from the General Register of Civil Registers and Notaries of the Ministry of Justice, distributed among all the Autonomous Communities and including the 52 provincial capitals. During 2020, MoMo in Spain includes deaths from all causes from 3,929 computerized civil registries, representing 92% of the Spanish population. Daily data are available from 5 April 2018 up to 22 April 2020. The Italian Institute of Statistics (ISTAT) provides data about overall mortality in Italy. ISTAT focused on the municipalities with reliable data that show at least ten deaths in the period 1 January - 31 May 2020 and that recorded a 20% increase in mortality in the period 1 March - 4 April 2020 compared to the average mortality for the same period in the years 2015-2019. ISTAT made available the data of 7,357 municipalities (out of a total of 7,904, 93.1%), for which a consolidation was possible until 31

May 2020, and covering 95% of the population resident in Italy. In Figure 2, the comparison between Spain and Italy is performed analyzing the first four months (January-April) of 2019 and 2020, and mortality rate is computed by considering population in the two countries. It is clear that excess mortality is higher in Italy than in Spain. However, it is also evident that excess mortality in Spain was positive sharply after t_0, while t_0 in Italy is about ten days before excess mortality becomes positive. Once again, this supports the view that the Spanish government was some days late in adopting the same measures of the Italian government. In addition, notice that mortality is higher in Italy also in 2019 with respect to Spain, suggesting that differences in the age structure of the population might affect the level of mortality, and the outcome of Covid-19. For instance, Islam et al. (2021) show that - accounting for the different age structures of European countries - excess mortality in Italy in 2020 is actually lower than that recorded in other European countries, including Spain, Belgium and the United Kingdom.

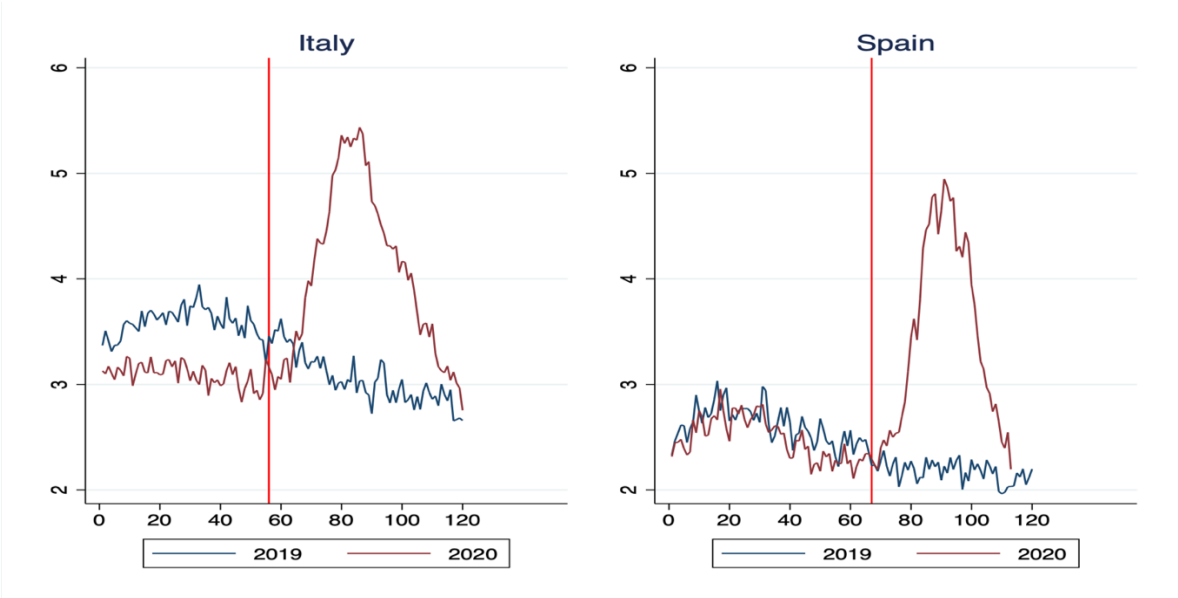


Figure 2: Excess Mortality 2019-2020 (January-April)

A further and connected explanation of the differences observed in the number of cases and the number of excessive deaths, calling into question the role of governance, is that the pandemic was strongly concentrated in very few regions in Italy because of the adoption of severe

measures early from the start of the pandemic, while in Spain the region of Madrid remained open and contributed to spread the pandemic to other regions. To better understand the concentration and the evolution of the pandemic, we compute the Gini index on the number of deaths in each region and each week from t_0 to t_{75}. Results (not reported here for brevity) confirm a higher concentration of the COVID-19 pandemic in Italy than in Spain, which implies that a centralized governance allows for more homogeneous outcomes across regions, while a decentralized solution allows to separate and identify best practices from those regions that have adopted unsuccessful choices. The concentration index also shows a decreasing trend for Spain, suggesting even more homogeneous outcomes as the pandemic makes progress also in regions that were not hit at the beginning by the virus.

3.2. Regional Level Evidence

To better understand the role of regional patterns, we examine the regional trends of COVID-19 outcomes selecting as case studies two of the most affected regions in the two countries under analysis, namely Lombardy and Veneto in Italy, and Catalonia and Madrid in Spain. As for Italy, the importance of focusing on Veneto and Lombardy is well described by Binkin et al. (2020) in terms of the different approach to COVID-19 epidemic in the two Italian regions. The authors showed that the community-based approach adopted in Veneto seems to be correlated with a limited rate of cases, hospitalizations, and deaths, whereas the approach based on a strong hospitalization of positive cases adopted in Lombardy overwhelmed the healthcare system with major consequences on the whole regional population. Similar arguments are discussed also by Costa-Font et al. (2020), who focus their attention on the different model of managed competition adopted by the two regions, with the one adopted by Lombardy more decentralized than the one adopted by Veneto. As for Spain, the importance of focusing on

Madrid and Catalonia is supported by, e.g., Legido-Quigley et al. (2020). The Madrid region was the epicenter of the crisis in Spain. Catalonia requested a complete shutdown of the region together with a full range of social distancing measures, but the royal decree declaring national emergency contained new controversial measures attributing to the central government more and new powers over health services. Panels in figure 3 are defined following t_0-t_{75} at the national level. They compare the four regions in the two countries, standardizing all measures by the population in each region. Panel representing confirmed cases shows evidence that the two regions that were the focus of the pandemic in both countries (Lombardy and Madrid) reveal increasing trends in terms of confirmed cases, but Catalonia in Spain follows Madrid closely while Veneto in Italy presents a very different pattern with respect to Lombardy.

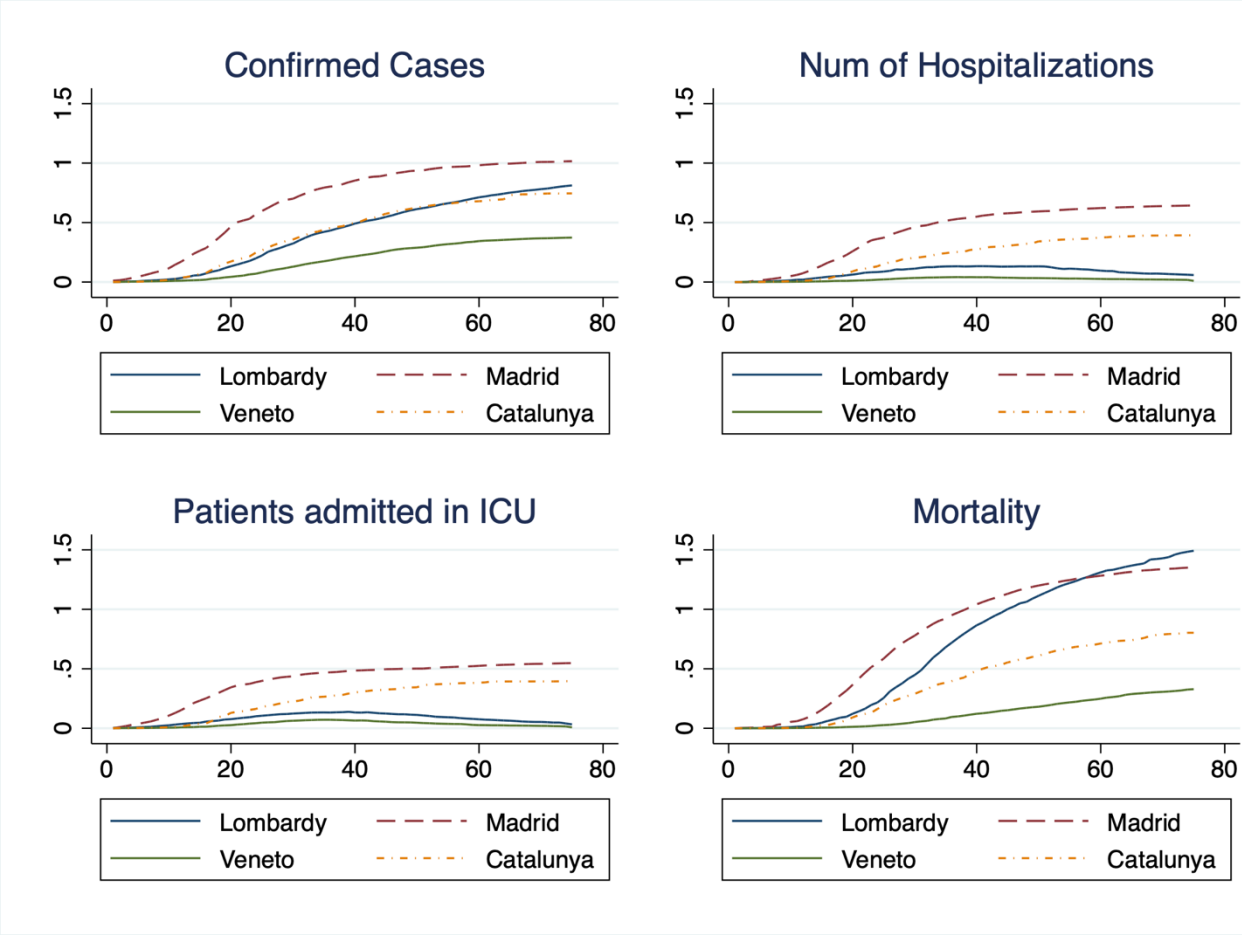


Figure 3: evolution of COVID-19 first wave in four regions in Italy and Spain

Panels relative to the number of hospitalizations and patients admitted in ICU describe the trends in the two variables in each of the four regions. The two Spanish regions clearly stand above Lombardy and Veneto following very similar patterns, while Lombardy performs differently from Veneto. As for mortality, Lombardy exhibits much higher numbers than all the other regions; trend in Madrid is very similar to trend in Catalonia, while Veneto clearly follow a very different pattern with respect to Lombardy. This is consistent with the differential role of regional autonomy in Veneto and Lombardy, compared to a much more centralized management of the crisis in Spain.

3.3. Regression analysis

Estimates of Equation [1] based on aggregate national data are reported in Table 1, Panel A. We use robust standard errors in all specifications. Coefficient for the Stringency Index is consistently positive and significant for all the outcomes: when cases are increasing, severe measures are positively associated with the number of cases. Monthly dummies are also significant and positive, picking up the increasing trend in the outcomes during the severe phase of the pandemic. The country dummy (negative and statistically significant) emphasizes that all the outcomes are lower in Italy than in Spain, suggesting a different approach to the management of the pandemic between the two countries.

We estimate Equation [1] also first differencing the four outcome variables.[3] Results are reported in Table 1, Panel B. Coefficient for the Stringency Index is still positive and statistically significant: an increase in the measures adopted by the two countries to contain the spread of

[3] First differences have been computed simply as $\Delta=y_t-y_{t-1}$.

the COVID-19 is positively associated with the growth in outcomes. Interestingly, monthly dummies are not all significant and increasing with respect to February when the epidemic started, in particular for hospitalizations and ICU admissions. As for the country dummy, all the outcomes show that Italy is characterized by lower values with respect to Spain. This result is in line with the descriptive analysis presented above, and can be explained by the delay in the adoption of restrictive measures and the multilevel governance implemented in Italy. Before moving to the regional analysis, we also tested two further specifications of Eq. [1]. In particular, we consider the number of hospitalized patients and ICU patients (standardized by the number of infected cases) as additional outcomes in Eq. [1]. Results are reported in Table A.3 in the Appendix. The country dummy for Italy still shows a negative coefficient for both hospitalizations and ICU admissions, but for the model in first differences for ICU patients. Interestingly, the Stringency Index coefficient is now positive and significant only for the number of patients, suggesting that more stringent measures were associated to the rise in the number of patients needing to be hospitalized.

Estimates of Equation [2] based on pooled data referred to the four case studies (Lombardy, Veneto, Madrid, and Catalonia) are in Table 2, Panel A (levels) and Panel B (first differences). All the previous findings on the Stringency Index and the time dummies are largely confirmed. More interesting, dummies for regional governments are almost all statistically significant; however, only the dummy for Veneto is consistently negative, both for the model in levels and in first differences, across all the outcomes. In addition, the dummy for Lombardy is positive for cases and deaths but negative for hospitalizations and ICU admissions, in both the models. These results suggest that regional differences are much larger in Italy than they are in Spain, where the management of COVID-19 has been largely centralized in the hand of the central government in Madrid.

Table 1. Estimates of Equation [1] – Countries

Panel A – Levels				
	(1)	(2)	(3)	(4)
VARIABLES	Cases	Hospitalizations	ICU	Death
Stringency Index	0.0560***	0.0822***	0.0737***	0.0890***
	0.005	0.004	0.006	0.010
Mar vs Feb	3.0026***	2.3452***	2.1305***	3.4229***
	0.259	0.240	0.209	0.266
Apr vs Feb	4.2420***	2.8315***	2.2997***	5.0149***
	0.263	0.248	0.236	0.315
May vs Feb	4.8592***	3.4397***	2.7216***	6.0028***
	0.304	0.282	0.243	0.365
Italy vs Spain	-0.6462***	-1.7064***	-1.6730***	-0.5912***
	0.136	0.104	0.093	0.192
Constant	3.1447***	1.5801***	0.5327	-2.7606***
	0.336	0.315	0.419	0.625
Observations	150	150	150	150
R-squared	0.874	0.920	0.908	0.880
Panel B- First Differences				
	(1)	(2)	(3)	(4)
VARIABLES	Cases	Hospitalizations	ICU	Death
Stringency Index	0.0314***	0.0676***	0.0356***	0.0600***
	0.005	0.006	0.006	0.010
Mar vs Feb	2.4601***	1.5118***	1.9445***	3.3527***
	0.284	0.483	0.726	0.327
Apr vs Feb	2.1052***	-0.1188	0.3261	3.4327***
	0.294	0.524	0.754	0.369
May vs Feb	0.9887***	-1.2617**	-0.9632	2.7753***
	0.332	0.528	0.755	0.401
Italy vs Spain	-0.3137**	-2.1667***	-1.6059***	-0.4175**
	0.140	0.167	0.151	0.183
Constant	3.3230***	1.6410***	1.3129*	-2.3372***
	0.332	0.575	0.787	0.639
Observations	147	113	112	148
R-squared	0.597	0.756	0.710	0.666

Table 2. Estimates of Equation [2] – Regions

Panel A – Levels				
	(1)	(2)	(3)	(4)
VARIABLES	Cases	Hospitalizations	ICU	Death
Stringency Index	0.0620***	0.1123***	0.0822***	0.0837***
	0.005	0.008	0.006	0.006
Mar vs Feb	2.4765***	1.4755***	1.3427***	2.6567***
	0.184	0.168	0.142	0.208
Apr vs Feb	3.5791***	1.6521***	1.3650***	4.3147***
	0.203	0.226	0.185	0.229
May vs Feb	4.2732***	2.5046***	1.8715***	5.2897***
	0.222	0.236	0.177	0.267
MAD vs CAT	0.7458***	0.6914***	0.7587***	0.9587***
	0.096	0.109	0.101	0.118
LOM vs CAT	0.2161*	-1.0247***	-0.9755***	0.7159***
	0.118	0.133	0.116	0.157
VEN vs CAT	-1.3314***	-3.1002***	-2.6209***	-1.8051***
	0.122	0.135	0.120	0.162
Constant	1.5017***	-1.5067***	-0.9712**	-3.4621***
	0.364	0.503	0.420	0.376
Observations	300	300	300	300
R-squared	0.883	0.915	0.890	0.894
Panel B- First Differences				
	(1)	(2)	(3)	(4)
VARIABLES	Cases	Hospitalizations	ICU	Death
Stringency Index	0.0382***	0.0661***	0.0331***	0.0540***
	0.007	0.007	0.009	0.007
Mar vs Feb	1.9206***	1.0620***	0.8959***	2.4405***
	0.296	0.273	0.332	0.251
Apr vs Feb	1.4275***	-0.4776	-0.5055	2.5846***
	0.325	0.365	0.420	0.277
May vs Feb	0.3644	-1.6224***	-1.7700***	1.9934***
	0.330	0.359	0.431	0.299
MAD vs CAT	0.1380	0.3985***	0.3908**	0.4714***
	0.135	0.128	0.182	0.142
LOM vs CAT	0.1468	-1.4359***	-0.7753***	0.5370***
	0.135	0.201	0.224	0.169
VEN vs CAT	-1.4245***	-3.5264***	-2.3468***	-1.6130***
	0.137	0.257	0.253	0.170
Constant	1.9120***	0.5995	0.7073	-2.6512***
	0.538	0.474	0.620	0.496
Observations	294	227	217	287
R-squared	0.611	0.694	0.449	0.623

To further discuss this issue, in Figure 4 we report the predictive margins for regional dummies obtained from estimates of Equation [2], both in levels and first differences. Several insights emerge. First, Lombardy and Madrid seem to be largely comparable for most outcomes. The fact that they serve as hubs for their countries, they share connections with the rest of the world and of the country, they have a lively and strong economy, are all factors to account for in the spread of the pandemic and in the definition of containment policies. Second, and much more important for our purpose here, Catalonia and Madrid appear to be much more similar than Veneto and Lombardy. This supports the view that a centralized solution in the management of a pandemic crisis homogenizes the outcomes across the regions, not allowing for experimentation, which – on the contrary - might offer useful insights when government are facing an unknown challenge like the COVID-19 in the first wave.

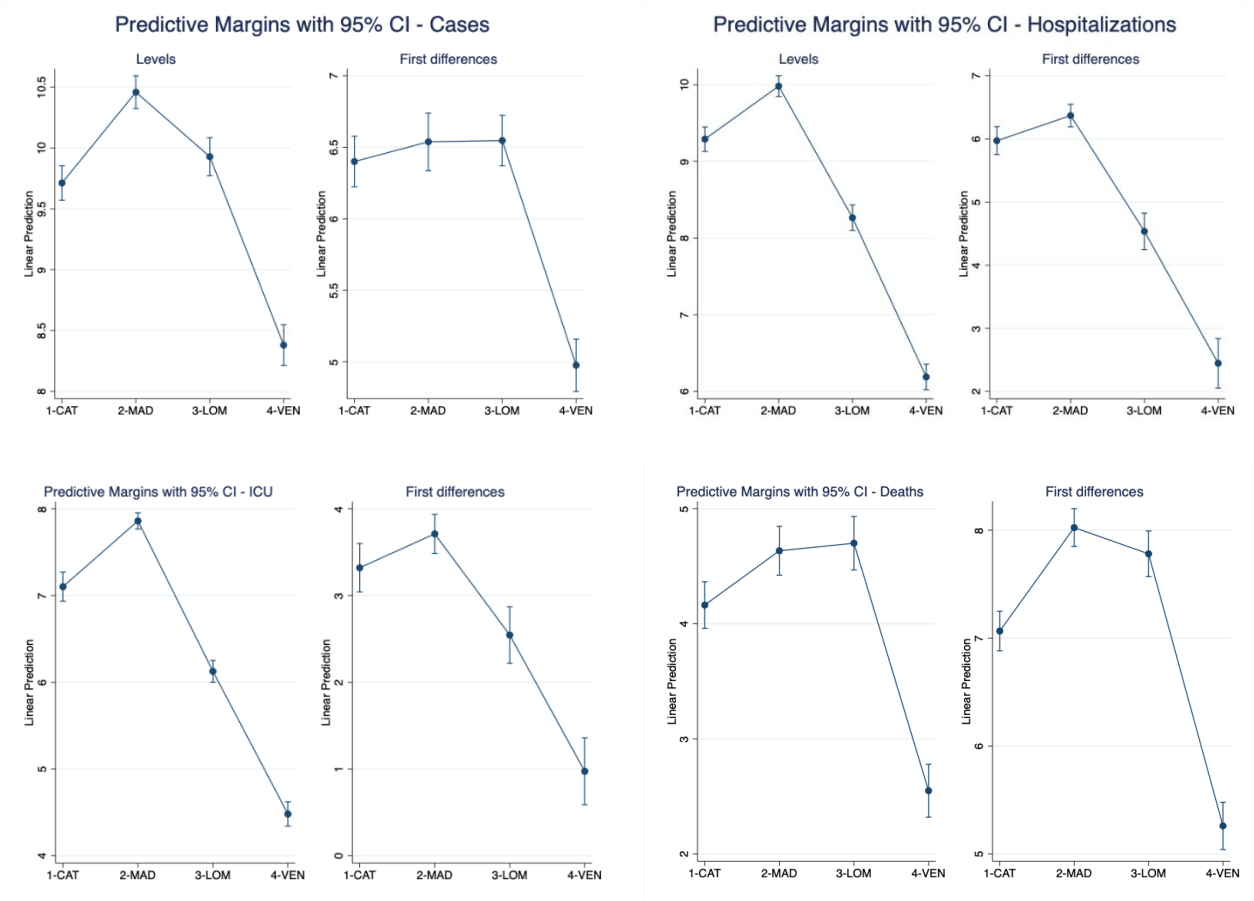


Figure 4: Predictive margins from Eq. 2

4. Discussion

We compare reactions to the pandemic in two countries (Italy and Spain) that, despite similar financing and territorial organization, reveal clear differences in their multilevel governance. Such analysis offers an opportunity to understand how best governments should adjust to the needs of a pandemic. Namely, whether to centralize or decentralize health care responsibilities, even when international health is coordinated at a central or even supranational level. Our findings suggest that decentralized governance offers an advantage during a pandemic. More specifically, we document a significant gap in the number of COVID-19 cases, hospitalizations ICU admissions, and of deaths in Italy and Spain, both at the national and at the regional level. Our analysis indicates evidence of a strong localization of the pandemic in Italy, and it suggests that regional autonomy, by fostering experimentation and local solutions to local COVID-19 outbreaks, can explain the cross-country differences in such trends.

Our findings suggest that, in a setting where the optimal reaction to a pandemic is unknown, even though coordination does play a role in solving potential collective actions problems (e.g., border closures), regional autonomy can make a difference in the number of fatalities (lives saved), as well as in avoiding unnecessary hospitalizations. More specifically, evidence suggests that encouraging regional cooperation but relying on regional autonomy such as in Italy might provide an advantage in facing the challenges of pandemics, allowing the emergence of good practices to manage the pandemic, compared to more centralized approaches, especially when regional needs and knowledge are largely heterogeneous. Yet, whether these good practices are then extended to the whole country during later phases of the pandemic is an interesting issue to be discussed in future work.

5. Conclusion

This paper examines the influence of territorial healthcare system governance on COVID-19 outcomes in two countries that, despite similar financing and territorial organization, have shown clear differences in how the government addressed the challenges of the first wave of the COVID-19 pandemic. Our findings suggest that the Italian decentralized reaction to the pandemic was advantageous at a time when policy uncertainty was high, as it combined coordination and local experimentation and targeting of health policies that allowed the emergency of "best practices" from the comparison of outcomes in different regions adopting different strategies to cope with the virus. Interestingly, in the second wave of the pandemic, Spain followed Italian footsteps in keeping the governance of the pandemic decentralized, and in line with the regional expertise. In contrast, in Italy attempts were made to turn to a more centralized governance in later waves, without recognizing comparative evidence suggesting that a more homogeneous outcome across regions might come at the cost of a higher number of fatalities.

References

Bailey D., Clark J., Colombelli A., Corradini C., De Propris L., Derudder B., Fratesi U., Fritsch M., Harrison J., Hatfield M., Kemeny T., Kogler D. F., Lagendijk A., Lawton P., Ortega-Argilés R., Otero C. I., Usai S. (2020), Regions in a time of pandemic, *Regional Studies*, 54(9), 1163-1174.

Binkin, N., S. Salmaso, F. Michieletto, and F. Russo (2020). Protecting our health care workers while protecting our communities during the COVID-19 pandemic: a comparison of approaches and early outcomes in two Italian regions, *medRxiv*.

Brenna E. (2011). Quasi-market and cost-containment in Beveridge systems: The Lombardy model of Italy, *Health Policy* 103 (2011): 209 – 218.

Casula, M., & Pazos-Vidal, S. (2021). Assessing the Multi-level Government Response to the COVID-19 Crisis: Italy and Spain Compared*. International Journal of Public Administration, 1–12.*

Costa-Font J., Levaggi R., Turati G. (2020). Resilient Managed Competition during Pandemics: Lessons from the Italian experience during COVID-19, *Health Economics, Policy and Law*, forthcoming.

Costa-Font, J., Turati, G. (2018). Regional healthcare decentralization in unitary states: equal spending, equal satisfaction? *Regional Studies*, 52(7), 974-985.

Dodds, K., Castan Broto, V., Detterbeck, K., Jones, M., Mamadouh, V., Ramutsindela, M., Varsanyi, M., Wachsmuth, D., & Yuan Woon, C. (2020). The COVID-19 pandemic: Territorial, political and governance dimensions of the crisis. *Territory, Politics, Governance*, 8(3), 289–298.

Fagiuoli, S., Lorini, F. L., Remuzzi, G. (2020), Adaptations and Lessons in the Province of Bergamo, *New England Journal of Medicine*, 382, 21, e71, doi 10.1056/NEJMc2011599

Hale, T., A. Noam, K. Beatriz, P. Anna, P. Toby, and W. Samuel (2020). Variation in government responses to COVID-19. *Blavatnik School of Government Working Paper,* University of Oxford.

Islam, N. Shkolnikov, V. M., Acosta, R. J., Klimkin, I., Kawachi, I., Irizarry, R. A., Alicandro, G., Khunti, K., Yates, T., & Jdanov, D. A. (2021). Excess deaths associated with covid-19 pandemic in 2020: Age and sex disaggregated time series analysis in 29 high income countries. British Medical Journal, 373,

Legido-Quigley, H., Mateos-García, J. T., Regulez Campos, V., Gea-Sánchez, M., Muntaner, C., McKee, M. (2020), The resilience of the Spanish health system against the COVID-19 pandemic, *The Lancet*, 5(5), e251-e252.

Montesò-Curto, P., Sanchez-Montesò, L., Maramao, F. S., Toussaint, L. (2020), Coping with the COVID-19 pandemic in Italy and Spain: Lessons in response urgency, *Journal of Global Health,* 10(2), 020326.

Nacoti, M., A. Ciocca, A. Giupponi, P. Brambillasca, F. Lussana, M. Pisano, G. Goisis, D. Bonacina, F. Fazzi, R. Naspro, et al. (2020). At the epicenter of the COVID-19 pandemic and humanitarian

crises in italy: changing perspectives on preparation and mitigation. *NEJM Catalyst Innovations in Care Delivery* 1(2).

Odone A., D. Delmonte, T. Scognamiglio, C. Signorelli (2020), COVID-19 deaths in Lombardy, Italy: data in context, *The Lancet Public Health*, 5(6), e310.

Turati G. (2013). The Italian *Servizio Sanitario Nazionale*: A Renewing Tale of Lost Promises. In: Costa-Font J., Greer S.L. (eds.) Federalism and Decentralization in European Health and Social Care. Palgrave Macmillan, London.

Appendix

Table A.1. Policies adopted in Italy and Spain to manage Covid-19 pandemic relative to different domains

Italy	Spain
Health communication	
On 5 March 2020, the Ministry of Health (MOH) specified essential behavior concerning hand hygiene. Face masks are suggested only if there is suspicion of being sick or if assisting somebody who is. Department of Civil Protection provides daily updates on the epidemiological situation. Specific information for each area is further detailed on Regional Government and local health authorities' websites.	On 23 January 2020, the Task Force for the design and development of a COVID-19 rapid response published the first protocol establishing measures for early detection, surveillance, prevention. Since the initiation of a curfew (called the State of Alarm) on 14 March 2020, all Ministries involved in these operations (Ministries of Health, Economy, Internal Affairs and Defence) are responsible for releasing the latest news on the implementation of the specific measures. The different regional governments, usually through the heads of their departments of health, debrief local media about the local progression of the outbreak.
Physical distancing	
Italy was the first country in Europe to adopt restrictive physical and social distancing measures, defining "red zones". Within a "red zone", people were imposed to stay-at-home and not to leave the area, and all non-essential economic activities were temporarily closed. The first "red zone" was imposed to isolate two outbreaks in small villages in Lombardy and Veneto on 23 February 2020. On 8 March, the "red zone" regime was extended to the entire Lombardy and some neighboring provinces. The entire country was locked down on March 11, about one month and a half after declaring a "state of emergency for sanitary reasons" on 31 January 2020.	The first community outbreak was declared on 3 March 2020, prompting progressive physical distancing measures. The Interterritorial Council of the National Health System (a body composed by the Ministry of Health, MOH, with Autonomous Communities representatives) agreed on 9 March 2020 on new measures to slow down the spread of the new coronavirus. The state of Alarm was declared on 14 March. People over six years old have to wear face masks in transports. Similarly, masks should be wear outdoors or in closed public spaces where a minimum distance of 1.5 meters cannot be assured.
Isolation and quarantine	
Isolation was imposed upon those who have tested positive to COVID-19 but did not require hospitalization and to those who have had contact with somebody who has tested positive, to inhibit the transmission of SARS-CoV-2 and avoid overloading the hospital system. Considering the different timing of the COVID19 epidemic across the Italian Regions, regional presidents issued special decrees imposing quarantine on people coming from Regions or Provinces considered at higher risk. A crucial issue is that – at the beginning of the first wave, in February 2020 – testing policy was limited to people returning from China and developing flu-like symptoms, according to national regulations (see below). The first patient identified in Lombardy on 20 February 2020 is the result of a test outside national rules.	Surveillance and monitoring mechanisms to detect cases coming from China were activated on 23 January 2020. All suspicious cases were isolated upon arrival to Spain and potential contacts investigated. Starting from 25 February 2020, people with mild symptoms that would have been visiting high risk areas or in contact with people infected from those areas (China, South Korea, Singapore, Japan, Iran and Italy) were confined for 2 weeks and potential contacts further investigated. Few days later, from 28 February, cases (possible or confirmed COVID-19) with mild symptoms are requested to stay at home in self-isolation and are followed up by a home care team, via telephone but with home visits or immediate hospitalization if needed.
Monitoring and surveillance	
Contact tracing has been recognized as a sustainable Public Health tool for the prevention and containment of COVID-19. However, the government was unable to use this strategy, especially during the first wave. The central government also tried to develop a contact tracing software (an app called "Immuni"). But, waiting for this app, Italian Regions autonomously developed several different digital solutions for the control and containment of infected citizens which, in most cases, are based on analyses of movements and gatherings on the basis of anonymous	Case definition has evolved in response to the evolution of the outbreak but has always followed protocols proposed by WHO, which was updated by the ECDC on 24 February 2020. A nationwide seroprevalence study has been launched with the aims to estimate the population's level of exposure to the virus, and whether the population has developed protective antibody titers. Regional health authorities have taken responsibility for the deployment of the study. Primary care professionals, specifically nursing staff, have been in charge

data. These digital solutions were never really taken seriously in any of the regions.

Lombardy has launched a Remote Training course in order to train interns and healthcare professionals specifically in contact tracing, to monitor the infected, keep contacts under surveillance and solicit testing in case of risk exposure. However, this solution was made ineffective by the mounting of cases during the first wave.

of the epidemiological survey and sample extractions (carried out either at home or in the primary care centers).

Planning services

On 1 March 2020, the MOH issued a regulation requiring all regions to take action according to following recommendations/rules:

- Increase by 50% the number of intensive care beds
- Increase by 100% the number of beds in pneumology and infectious diseases wards (these beds should be equipped with adequate assisted pulmonary ventilation systems)
- Mainly use private contractors (private hospitals accredited with the NHS) for non COVID-19 patients; however, in Lazio and **Lombardy**, private contracted hospitals increased their capacity also for COVID- 19 patients
- Re-allocate health professionals according to the internal re-organizations and provide a short training program if required.

Since the second week of March 2020, as a response to the increasing toll of cases, elective surgery and non-urgent consultations have been postponed. In turn, primary care centers have also called off non-urgent consultations, cancelled emergency care except for patients with respiratory symptoms, and implemented an e-prescription mechanism for chronic patients so they can get their prescriptions renewed automatically, and thus avoid a visit to primary care premises.

Since 14 March, after the declaration of the "state of alarm", the MOH was temporarily entitled to determine the best distribution of technical resources, including those from the military forces, private health sector, and even private business as hotels.

Managing cases

This is a crucial domain to understand the differences in the outcomes across regions. According to national guidelines, patients having symptoms but not in a critical situation were asked to stay at home and contact their GPs. The GP was asked to make the diagnosis either physically or virtually and, depending on the symptoms, s/he can request a nasopharyngeal swab that is generally taken at the patient's home. Only patients who suffer from severe failure of the respiratory systems were told to go to the hospital; likely too late to be saved. The decentralization of the Italian healthcare system and the quasi-market models developed by regions has led to different behaviors among regions with regard to the choice of care settings.

Lombardy has primarily managed cases by resorting to inpatient care (49% of positive cases are hospitalized – as of 8 April 2020). **Veneto**, with a very low hospitalization rate of 21% (as of 8th April), has been resorting mainly to outpatient care. Hospitalization has been almost entirely restricted to those requiring intensive care.

The first contact point measures have changed with the evolution of the outbreak and are somewhat different across Spain's regions (Autonomous Communities). At the very beginning of the crisis, the usual pathways of care, that is, primary care centers and hospital emergency departments, were the reception point for cases. Shortly afterwards, mild cases were advised to stay at home and call the regular 24/7 emergency call centers from which they could obtain advice and/or the activation of a mobile unit to their home. Most Autonomous Communities have created a dedicated phone helpline that is different from the regular 24/7 call center number, keeping the latter for emergencies not related to COVID-19. Some Autonomous Communities have also developed an on-line self-administered survey to help citizens figure out how likely it is for them to be infected.

Maintaining essential services

During the first wave, most regions defined their own plan for the re-organization of hospital care. In fact, in almost all Italian regions, ICU bed capacity was increased by over 50%, exceeding the amount suggested by the MOH and stopping almost entirely elective care. By 26 May 2020, the organization of hospital care was showing very heterogeneous behaviors among regions, and none of them had issued specific resolutions or acts relating to the reorganization of hospital care after the emergency. Only 9 regions defined Covid-19 hospital networks, albeit with different levels of detail and, by 11 June, the number rose to 10 out of 20. **Lombardy**, Liguria, **Veneto** and Tuscany have preferred not to set up covid hospitals.

On 17 May 2020, when the first wave was ending, the MOH published guidance on how to program elective surgery during the transition period. So, elective surgery could start if admitted COVID-19 patients were less than 5% of the total hospital capacity and hospitals had separate areas for COVID and non-COVID patients. Prior surgery consultations were recommended to be telematic, admissions should be done the same day of the intervention and early discharge assessment has been encouraged. In addition, patients should have been interviewed on clinical symptoms compatible with COVID-19 and tested with a PCR genetic test in the 72 hours prior to the surgery; they had to wear face masks during their stay as well as their companions, and visits have been severely restricted.

Testing

The first two confirmed cases of Covid-19 were represented by two Chinese tourists travelling to Rome on 31 January 2020, and the first cases among Italian residents were registered on 21 February 2020 in **Lombardy** and **Veneto**. Since the beginning of the mitigation phase (26 February),

Laboratory testing for the diagnosis of the SARS-CoV-2 has been mandatory in two situations:

- a patient presenting clinical signs of acute respiratory infection who was hospitalized or who met criteria for hospital admission;

Italian national guidelines on testing followed WHO and ECDC guidelines stating that patients with symptoms could be tested if (i) they had contacts with a confirmed case; (ii) they came from areas where local transmission was ongoing; (iii) they were hospitalized. However, it has been challenging to ensure full consistency with this policy throughout the Italian territory. This was due to the fact that the regions, which are responsible for health services' delivery, organized the tracing and testing in different manners. During the first days of March 2020, as recommended by the Scientific Committee advising the national government, **Lombardy** tested only symptomatic patients. Going beyond national guidelines aligned with WHO and ECDC recommendations, **Veneto** adopted a different approach to testing aiming towards mass population screening. The regional government approved on 16 March a plan for large-scale population testing.	● a patient presenting clinical signs of acute respiratory infections of any severity who belongs to the health and social care workforce or to any other essential service. Tests could only be requested by any medical doctor, and were approved once public health authorities check whether the patient fulfils the testing criteria described.
Governance	
Notwithstanding the availability, on paper, of an (old) National Pandemic Plan, the national government has decided not to follow its prescriptions and to the use the Plan as a coordination device during the first months of the COVID-19 crisis. On 5 February 2020, after the declaration of the "state of emergency" attributing special powers to the Department of Civil Protection and to the national government, a Scientific and Technical Committee was instituted. Its purpose was (and still is) to provide guidance based on scientific evidence to the national government. Notwithstanding the increased role of the central government, regions still retain decision-making autonomy regarding the delivery and organization of health services, such as whether to conduct COVID-19 tests on the regional entire population. Different approaches have been taken by the **Lombardy** and **Veneto** regions. Aside from being the two regions most affected by the crisis, these two neighboring regions also share a similar socioeconomic profile. They have both imposed social distancing measures and retail closures. **Veneto** has applied a more proactive strategy aimed at containment. It performed tests on asymptomatic cases at a very early stage and then traced potential positives. Once someone was found to be infected, their families and neighbors were tested in turn or, if testing kits were not available, they were quarantined. Home care and diagnoses have been also strongly emphasized (for example, when possible, samples are collected at home) and healthcare and essential workers were specifically monitored. **Lombardy**, proportionally to its population, has conducted half the number of tests performed in the Veneto region and has focused only on symptomatic cases. The regional government relied less on tracing, home care and on monitoring healthcare workers. Another example are the regional measures on face masks adopted in Lombardy. National guidelines follow WHO recommendations and impose their utilization only on health professionals and Covid-19 positive patients. However, Lombardy's president has issued an ordinance that made wearing protection over mouth and face mandatory, starting from 5 April 2020.	Since 7 January, 2020, when COVID-19 was identified as the pathogen that caused the outbreak in Wuhan, the MOH, throughout the Centre for the Coordination of Health Alerts and Emergencies (CCAES, in Spanish), activated the COVID-19 protocol in coordination with the Departments of Health in Spain's 17 Autonomous Communities. The Royal Decree declaring the "state of alarm" on 14 March 2020, conferred full responsibility to the Spanish government to implement measures to deal with the COVID-19 crisis. The Prime Minister has delegated competences to the Ministers of Defence, Internal Affairs, Transport, Mobility and Urban Matters, as well as to the MOH, in their respective areas of responsibility, led by the latter. In order to enhance coordination in the collection of epidemiological information, each regional Health Authority had to report a core set of indicators to the CCAES, since March 15, which includes: epidemiological indicators (e.g. new confirmed cases, differentiating those diagnosed with PCR and those with rapid tests and those with and without symptoms, cured cases, deaths), utilization indicators (number of admitted and discharged patients differentiating the type of care provider), and supply indicators (number and occupation of beds in ICUs, reanimation units, and workforce available for service, specially ICU doctors and anesthesiology and reanimation professionals, including 4th and 5th year residency physicians, as well as any other healthcare professional that could be summoned if required, including retired professionals and physician and nurses in their first years of training).

Note: Authors' elaboration starting from information published by the WHO Covid-19 Health System Response monitor.

Table A.2. Descriptive statistics

National level dataset	Spain			
	Min	Mean	StdDev	Max
Cases	1,100.00	99,935.06	73,008.05	204,027.00
Hospitalizations	150.00	53,565.89	40,104.35	108,932.00
ICU Admissions	10.00	5,582.47	3,658.87	10,187.00
Deaths	0.00	8,976.21	7,866.11	22,156.00
Stringency Index	11.11	76.48	15.86	85.19
	Italy			
	Min	Mean	StdDev	Max
Cases	322.00	78,546.00	65,588.20	187,327.00
Hospitalizations	150.00	19,548.78	12,592.69	33,004.00
ICU Admissions	35.00	2,332.00	1,417.18	4,068.00
Deaths	10.00	9,418.88	8,817.17	25,085.00
Stringency Index	68.52	85.64	9.50	93.52
Pooled regional level dataset	Catalonia			
	Min	Mean	StdDev	Max
Cases	49.00	31360.71	20187.03	55921.00
Hospitalizations	0.00	16896.64	10955.54	29497.00
ICU Admissions	0.00	1800.92	1096.02	2969.00
Deaths	0.00	3010.33	2215.99	6021.00
Stringency Index	11.11	76.48	15.86	85.19
	Madrid			
	Min	Mean	StdDev	Max
Cases	738.00	45027.55	22598.21	67049.00
Hospitalizations	0.00	28253.52	14978.29	42497.00
ICU Admissions	0.00	2615.75	1121.17	3617.00
Deaths	0.00	5388.11	3257.72	8931.00
Stringency Index	11.11	76.48	15.86	85.19
	Lombardy			
	Min	Mean	StdDev	Max
Cases	240.00	41583.95	28346.66	81225.00
Hospitalizations	104.00	8258.83	4357.17	13328.00
ICU Admissions	25.00	798.07	411.85	1381.00
Deaths	9.00	7182.80	5487.85	14924.00
Stringency Index	68.52	85.64	9.50	93.52
	Veneto			
	Min	Mean	StdDev	Max
Cases	43.00	9445.96	6918.81	18671.00
Hospitalizations	19.00	1114.23	667.68	2068.00
ICU Admissions	7.00	169.99	111.59	356.00
Deaths	1.00	630.03	569.47	1643.00
Stringency Index	68.52	85.64	9.50	93.52

Table A.3: Estimates at the national level: outcomes standardized by the number of detected cases

	(1)	(2)	(3)	(4)
	Levels		First differences	
VARIABLES	Hospitalizations	ICU	Hospitalizations	ICU
Stringency Index	0.0067***	0.0003	-0.0005	-0.0003*
	0.001	0.000	0.000	0.000
Mar vs Feb	-0.1731***	-0.0351***	0.0094	0.0057
	0.025	0.007	0.022	0.008
Apr vs Feb	-0.3628***	-0.0723***	0.0077	0.0089
	0.024	0.007	0.023	0.009
May vs Feb	-0.3301***	-0.0744***	0.0046	0.0073
	0.025	0.007	0.022	0.008
Italy vs Spain	-0.2962***	-0.0253***	-0.0063**	0.0009
	0.019	0.003	0.003	0.001
Constant	0.2809***	0.0947***	0.0400	0.0143
	0.044	0.014	0.038	0.013
Observations	150	150	148	148
R-squared	0.642	0.684	0.122	0.262