Front. Econ. China 2021, 16(4): 589–606
https://doi.org/10.54605/fec20210401

RESEARCH ARTICLE

Chen Cheng[a], Jiasheng Li[b], Chuanchuan Zhang[c]

Variations in Governmental Responses to and the Diffusion of COVID-19: The Role of Political Decentralization

Abstract Policymakers have implemented a wide range of non-pharmaceutical interventions to fight the spread of COVID-19. Such policies vary substantially across regions or countries and, therefore, lead to variations in the diffusion patterns and fatality rates associated with this virus. We show that political decentralization is closely related to both the spread of COVID-19 and government responses to this spread. Specifically, we find that the disease tends to spread at higher speeds and result in more confirmed cases and deaths in countries that are more decentralized. We further show that it takes longer for more decentralized countries to implement any non-pharmaceutical interventions against COVID-19 and that more decentralized countries tend to adopt policies that are more targeted as opposed to being more generalized.

Keywords COVID-19, political decentralization, non-pharmaceutical interventions
JEL Classification F50, H11, H12, I18

1 Introduction

As of July 29, 2020, there were 16,523,815 confirmed cases of the corona virus and 655,112 deaths worldwide due to the COVID-19 pandemic.[1] Amidst this global crisis, countries differ in their responses and performance in tackling the

[1] Source: WHO Coronavirus Disease (COVID-19) Dashboard.

Received April 20, 2021
[a] Carey Business School, Johns Hopkins University, Baltimore, MD 21202, USA
[b] School of Economics and Management, Tsinghua University, Beijing 100084, China
[c] School of Economics, Zhejiang University, Hangzhou 310058, China
E-mail: chen_cheng@jhu.edu (Chen Cheng), jansonleeljs@126.com (Jiasheng Li), ccz.zhang @gmail.com (Chuanchuan Zhang, corresponding author)

disease. Most existing studies focus on the most effective policies in fighting the virus and the economic impact of the disease (e.g., Acemoglu et al., 2020; Baker et al., 2020; Coibion et al., 2020; Fajgelbaum et al., 2020; Gormsen and Koijen, 2020; Jones et al., 2020). However, there is a lack of a more in-depth understanding of the fundamental causes of the variations in country responses, for example, why did some countries respond more quickly? What determined whether a country undertook more targeted policies that were carried out only at certain areas, whereas other countries chose more general ones that applied broadly?[2]

Political regimes matter. While a centralized system may be better at coordination, a decentralized system adapts more to local conditions and information. As with every crisis, COVID-19 requires timely responses that cope with local conditions. In this sense, one might imagine that a decentralized system would fare better than a centralized one. However, as with every epidemic, COVID-19 also presents problems related to a number of externalities that require both coordination and concerted responses.[3] In this sense, a centralized system has its advantages. It is, therefore, not clear which system would do better in fighting COVID-19 ex-ante.

This paper examines whether political centralization/decentralization is associated with the severity of the pandemic and its spread and impact and governmental responses to COVID-19. The results show that a higher level of decentralization is associated with the disease’s higher speed of spread (as measured by how many times the number of daily confirmed cases increased one week after the global spread of COVID-19 constituted a pandemic in each country), more total confirmed cases and more deaths. That is, the pandemic is more severe in countries that are more decentralized.

We further examine why this is the case. Theories of decentralization usually associate this political structure with miscoordination and a lack of internalizing externalities, compared to the case of centralization. We, therefore, explore whether decentralization is associated with slower responses to the pandemic

[2] More details on targeted or general policies are provided in the Data and Measurement section.

[3] “Coordinated Response Needed to Fight Coronavirus Pandemic.” Stanford News, 26 Mar. 2020, news.stanford.edu/2020/03/26/coordinated-response-needed-fight-coronavirus-pandemic. See Chandrasekhar et al. (2020) for a theoretical foundation.

(possibly due to miscoordination) and the adoption of policies that are more targeted rather than general (possibly due to the lack of internalizing externalities). We find that it takes longer for more decentralized countries to implement any non-pharmaceutical interventions against COVID-19 and, also, that more decentralized countries tend to adopt policies that are more targeted rather than general.

The rest of this paper is organized as follows. Section 2 provides the conceptual framework. Section 3 describes the data and measurements. Section 4 presents the key results. Section 5 concludes.

2 Conceptual Framework

Theories of decentralization usually associate this type of political structure with better local information (e.g., Oates, 1999), more policy diversity across regions (Cheng and Li, 2019), easier adaptation (Alonso, Dessein, and Matouschek, 2008), among others. By comparison, a more centralized state will tend to internalize externalities more often than decentralized states do (Cai and Treisman, 2009), facilitate coordinated change (Alonso, Dessein, and Matouschek, 2015), and hold its agents to account more often (Cheng and Li, 2019). Jackson and López-Pintado (2013) examine how heterogeneity in a population can affect the spread of disease, and they find that homophily can facilitate diffusion from a small initial seed of adopters. We focus on the political regime level of heterogeneity.

Building on the previous literature on decentralization, and combining this with the features of the COVID-19 pandemic (which poses a great deal of externalities), we generate the following testable hypotheses:

- H1: Since the pandemic requires timely and coordinated responses, COVID-19 would be more severe in more decentralized states.
- H2 (a): Responses are slower in more decentralized states.
- H2 (b): Policies are more targeted rather than general in more decentralized states.

And to complete our theory, we establish the link between the type of policies (e.g., targeted vs. general) and the severity of COVID-19:

- H3: More general and more timely policies contribute to better control of the pandemic.

3 Data and Measurement

3.1 Data on Political Decentralization

We use the regional autonomy index (RAI) of Hooghe et al. (2016) to measure political decentralization. This index covers 81 democracies or quasi-democracies over the period 1950 to 2010. The RAI is first measured at the regional-government level along ten dimensions and then aggregated to the country level. To make the index more reliable, primary dimensions, like constitutions, legislation and statutes, are triangulated with secondary literature and consultations of country experts. The RAI ranges from 0 (e.g., Singapore and Luxemburg) to 30 (e.g., Germany and Spain), in which a higher score represents a higher level of decentralization. In this paper, the RAI variable, *n_RAI*, for the year 2010 is utilized to represent each country's decentralization level.[4] The mean and the median of the sample are 9.645 and 7.670, respectively. Other statistics related to the data are presented in Panel A of Table A1.

3.2 Data on Government Responses

The Oxford COVID-19 Government Response Tracker (OxCGRT) has persistently recorded the responses against COVID-19 of more than 160 countries, at a daily frequency. It classifies these responses into four categories; i.e., containment and closure policies, economic policies, health-system policies, and miscellaneous policies. Our study focuses on the containment and closure part of these responses, which OxCGRT decomposes into seven specific policies (school closures, workplace closures, cancelling public events, closing public transport, public information campaigns, restrictions on internal movement, and international travel controls). When recording each policy, the dataset reports whether a country took the policy at time t and whether the policy was carried out at a targeted level (meaning the policy is applied only in a geographically concentrated area) or a general level (meaning policy is applied throughout the

[4] Political regimes of the countries covered in the RAI data have barely changed over the past decade. Therefore, we believe that the RAI calculated for 2010 is still a proper measure for a country's decentralization level in 2020.

entire jurisdiction).[5] Panel B of Table A1 summarizes the ratio of countries ever enacting non-pharmaceutical interventions against the pandemic. Most countries in our sample took some actions. Amongst the seven listed interventions, closing public transport is the least-used option, and only 48.7% of these countries have carried it out at least once. Panel B also summarizes the ratio grouped by whether *n_RAI* is above its sample median. The ratios that countries take related to these interventions are about 30% higher for more decentralized authorities. Within countries taking some actions, Panel C presents how many countries applied general interventions and shows that countries for which *n_RAI* is below the median are at least 5% more likely to apply these actions.

3.3 COVID-19 Outbreak Data

Our daily confirmed COVID-19 cases and death counts are obtained from the WHO Coronavirus Disease (COVID-19) Dashboard. In our main analysis, we define the time at which COVID-19 broke out in country *i* as the date when the total number of deaths reaches five, since at the beginning period of the pandemic the number of confirmed cases is more likely to have a measurement error. By the end of our project's event window, which is from January 1, 2020, to April 20, 2020, the data covers 2,667,439 confirmed cases of COVID-19 and 190,229 confirmed deaths worldwide. Equation (1) offers a formal definition of spread speed of country *i*. The denominator of (1) is just the total confirmed cases on outbreak date. And the numerator measures the total confirmed cases 1 week after the outbreak date (the paper also employs total confirmed cases 2 weeks after outbreak as numerator in robust checks).

$$Spread\ speed_i = \frac{Country\ i's\ total\ confirmed\ cases\ 1\left(or\ 2\right) week\left(s\right) after\ outbreak}{Country\ i's\ total\ confirmed\ cases\ when\ COVID-19\ broke\ out} \tag{1}$$

Panel C of Table A1 summarizes the sample. More decentralized countries experience faster spreads of the pandemic. For countries with a regional authority index above the median value, the speed of the spread in the first week is about 66% higher than those below the median and even triples in the first two weeks.

[5] The full codebook and definition for each variable of OxCGRT can be found by referring to their official website on Github: https://github.com/OxCGRT/covid-policy-tracker/blob/master/documentation/codebook.md

Countries with a higher regional authority index also have more total confirmed cases and more total deaths.

3.4 Control Variables

Although our analysis on the relationship between political decentralization, the speed of spread of COVID-19 and governmental responses to the pandemic is essentially descriptive, we partial out the effects of the socioeconomic factors that are potentially related to our outcome variables. Specifically, we control for the population size, life expectancy, population age structure, disability-adjusted life years (DALY), health-care access and quality (HAQ) index, GDP per capita, urbanization rate, and population flow, in our regressions. These control variables are collected from *Our World in Data*, a data-sharing project operated by the Oxford Martin School.[6] Panel D in Table A1 reports the sample means of these control variables.

4 Results

4.1 Political Decentralization and the Severity of the COVID-19 Pandemic

We first estimate the relationship between political decentralization and the severity of the COVID-19 pandemic, which is measured by both the speed of spread and the number of people infected or deceased. To measure the speed of spread, it is necessary to define a time window. We set the outbreak time for each country affected by COVID-19 as the time at which the country's total deaths reached five.[7] The number of deaths is more reliable than the confirmed number of cases, since many patients have not been testified or recorded due to the limitations in testing capacity. We then calculate the total number of confirmed cases during the first week and the first two weeks to measure the speed of spread of COVID-19. Table 1 presents the results on the relationship between political decentralization and the speed of spread of COVID-19. The results in

[6] Our World in Data is an open-access and open-source project. Research organizations such as *Science*, *Nature*, and *PNAS* trust the data provided by this project.

[7] We test whether our findings are robust to the definition of the outbreak time. Specifically, we set the beginning time as when the total number of deaths reached 20 or 50. We obtained consistent conclusions. Table A2 in the appendix presents the results.

Columns (1) and (3) of Table 1 show that a one-unit increase in the regional authority index, our measure for political decentralization, is associated with a 22.7% and a 169.8% increase in the number of total confirmed cases during the first week and the first two weeks that follow the outbreak of COVID-19, respectively. We include a set of control variables, such as the population size, life expectancy, population age structure, disability-adjusted life years (DALY), health-care access and quality (HAQ) index, GDP per capita, urbanization rate, and population flow. The results in Columns (2) and (4) show that a one-unit increase in the RAI is associated with a 16.5% and 149.7% increase in the first week and first two weeks, respectively, conditional on the above control variables. Surprisingly, we find no significant relationship between these control variables and the speed of spread of COVID-19, suggesting that the early severity of COVID-19 is more closely related to the level of political decentralization than to other factors.

Table 1 More Decentralized Countries Witnessed Faster Spreads after the Outbreak of the Pandemic

Variables	Speed of spread (1 week) (1)	Speed of spread (1 week) (2)	Speed of spread (2 weeks) (3)	Speed of spread (2 weeks) (4)
n_RAI	0.227***	0.165**	1.698***	1.497***
	(0.000)	(0.025)	(0.000)	(0.006)
Population (log)		0.440		0.899
		(0.429)		(0.845)
Life expectancy (log)		0.250		1.325
		(0.675)		(0.790)
Dependency ratio: Young		0.021		0.402
		(0.832)		(0.598)
Dependency ratio: Old		0.038		0.576
		(0.735)		(0.494)
DALY (log)		2.335		–19.056
		(0.813)		(0.807)

(*To be continued*)

(*Continued*)

Variables	Speed of spread (1 week) (1)	Speed of spread (1 week) (2)	Speed of spread (2 weeks) (3)	Speed of spread (2 weeks) (4)
HAQ index		0.013		–0.029
		(0.933)		(0.982)
GDP per capita (log)		0.053		–4.302
		(0.975)		(0.738)
Urbanization ratio		–0.011		–0.082
		(0.805)		(0.817)
Airline passengers (log)		–0.038		–0.172
		(0.908)		(0.954)
Constant	2.317***	–50.407	0.671	94.117
	(0.001)	(0.713)	(0.895)	(0.931)
Observations	70	66	64	60
R-squared	0.278	0.307	0.295	0.352

Note: (1) A definition of the speed of spread is shown in equation 1.

(2) Data for calculating the speed of spread are from WHO dashboard, *n_RAI* from Hooghe et al. (2016), and control variables from Our World in Data.

(3) The *p* values are in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 2 Countries with Higher RAIs Encountered More Total Confirmed Cases and Deaths

Variables	Total confirmed cases (log) (1)	Total confirmed cases (log) (2)	Total deaths (log) (3)	Total deaths (log) (4)
n_RAI	0.058***	0.009	0.070***	0.039*
	(0.005)	(0.596)	(0.000)	(0.055)
Days since outbreak	0.121***	0.048***	0.127***	0.087***
	(0.000)	(0.004)	(0.000)	(0.000)
Population (log)		0.684***		0.448***
		(0.000)		(0.008)
Life expectancy (log)		0.113		0.107
		(0.363)		(0.454)

(*To be continued*)

(*Continued*)

Variables	Total confirmed cases (log) (1)	Total confirmed cases (log) (2)	Total deaths (log) (3)	Total deaths (log) (4)
Dependency ratio: Young		0.008		0.023
		(0.657)		(0.238)
Dependency ratio: Old		–0.021		0.018
		(0.426)		(0.547)
DALY (log)		3.551		3.257
		(0.103)		(0.192)
HAQ index		0.082**		0.045
		(0.025)		(0.280)
GDP per capita (log)		0.610*		0.242
		(0.074)		(0.533)
Urbanization ratio		0.003		–0.002
		(0.722)		(0.852)
Airline passengers (log)		0.019		0.019
		(0.804)		(0.829)
Constant	4.625***	–61.143**	1.129***	–52.696
	(0.000)	(0.044)	(0.000)	(0.129)
Observations	79	75	79	75
R-squared	0.728	0.868	0.803	0.840

Note: (1) Total confirmed cases and number of deaths were up to date as of April 20, 2020.

(2) Data of total confirmed cases and total deaths are from WHO COID-19 dashboard, *n_RAI* from Hooghe et al. (2016), and control variables from Our World in Data.

(3) The *p* values are in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 2 presents the results on the relationships between political decentralization and the total number of confirmed cases and fatalities. The results in Column (1) of Table 2 show that a one-unit increase in the regional authority index is associated with a 5.8% increase in the total number of confirmed cases, conditional on the duration of the pandemic since the outbreak. We then include the same control variables that we included in Columns (2) and (4) of Table 1. Here, the relationship between the level of political decentralization and the number of confirmed cases becomes nonsignificant. Columns (3) and (4) of Table 2 present the results on the number of deaths. Consistently, we find a significantly positive relationship between political decentralization and the number of deaths. A one-unit increase in the regional authority index is associated with a 7% and 3.9% increase in the total number of death cases without and with control variables, respectively. It is not surprising that the longer the duration since the outbreak of the pandemic, the larger the number of confirmed cases and deaths. For other socioeconomic indicators, we find a positive relationship between the population size and the number of confirmed cases and deaths. The HAQ index and the GDP per capita are also positively associated with the number of confirmed cases. One possible explanation is that the HAQ index and the GDP per capita are closely related to countries' testing capacities, which partly determines their number of reported COVID-19 cases. It is worth noting that the number of confirmed cases is more likely to suffer from a measurement error than that of the number of deaths, again due to the limited testing capacity in many countries. If politically decentralized countries have higher testing capacities, then the relationship between the level of political decentralization and the number of confirmed cases would be overestimated.

4.2 Political Decentralization and the Response to COVID-19

Our next question concerns why COVID-19 is more severe in those countries that are more decentralized. Theories of decentralization usually associate decentralization with miscoordination and a lack of internalizing externalities, compared to the case of centralization. We, therefore, explore whether decentralization is indeed associated with slower responses to the pandemic (possibly due to miscoordination) and the adoption of policies that are more targeted rather than general.[8]

Based on data from OxCGRT, we focus on seven policy measures: school closures, workplace closures, cancelling public events, closing public transport, public information campaigns, restrictions on internal movement, and international travel controls. We first examine whether decentralized countries that take any of these actions take longer to respond to the pandemic. Table 3

[8] It is reasonable to presume that late responses and targeted policies, instead of general policies, would lead to more severe spreads of COVID-19. Table A3 in the appendix presents the results on the relationship between policy responses and the slope of the curve of daily confirmed cases. The results suggest that general policies in school closures, workplace closures, cancelling public events, and closing public transport significantly flatten the curve.

Table 3 Durations between the Outbreak of COVID-19 and the Time It Takes to Respond

Variables	School closures	Workplace closures	Cancelling public events	Closing public transport	Public info campaigns	Restrictions on internal movement	International travel controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
n_RAI	0.122	0.268*	0.337*	0.022	0.013	0.201	0.772*
	(0.416)	(0.078)	(0.067)	(0.927)	(0.974)	(0.182)	(0.072)
Observations	61	59	63	38	62	60	61
R-squared	0.489	0.422	0.368	0.433	0.246	0.531	0.221

Note: (1) All regressions include a constant term and control variables, such as population size, life expectancy, population age structure, DALY, HAQ, GDP per capita, urbanization rate, and population flow.

(2) Non-pharmaceutical interventions data are from OxCGRT.

(3) The *p* values are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4 More Decentralized Countries Were More Likely to Undertake Targeted Policies against COVID-19 at the Outset of the Outbreak

Variables	General interventions from the beginning (=1, yes)					
	School closures	Workplace closures	Cancelling public events	Closing public transport	Public info campaigns	Restrictions on internal movement
	(1)	(2)	(3)	(4)	(5)	(6)
n_RAI	–0.022**	–0.004	–0.009	–0.030**	0.002	0.001
	(0.010)	(0.679)	(0.325)	(0.041)	(0.859)	(0.939)
Observations	56	54	58	35	57	55
R-squared	0.413	0.168	0.366	0.538	0.222	0.288

Note: Dependent variables are dummies that equal 1 if a country carried out a certain general response from the beginning of the pandemic. There are six kinds of responses: school closures, workplace closures, cancelling public events, closing public transport, public information campaigns, restrictions on internal movement, and international travel controls. All of the regressions include a constant term and control variables, such as population size, life expectancy, population age structure, DALY, HAQ, GDP per capita, urbanization rate and population flow. Specifically, data for non-pharmaceutical interventions are from OxCGRT, n_RAI from Hooghe et al. (2016), and control variables from Our World in Data. The time when COVID-19 broke out in country *i* is pinned down as the date when the total number of deaths reaches five. The *p* values are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

presents results show that more decentralized countries generally undertake non-pharmaceutical interventions later than centralized countries do. Specifically, more decentralized countries take significantly longer to close workplaces, cancel public events, and restrict international travel.

We then explore whether more decentralized countries tend to adopt policies that are more targeted rather than general. Table 4 finds that countries with a one-unit higher regional authority index are 2.2% and 3% more likely to take such actions that as school closures and closing public transport, at the targeted level, after the outbreak of the pandemic. Table 5 observes that a one-unit increase in the RAI would delay countries' school closures and workplace closures, at the general level, by 0.277 days and 0.581 days, respectively.[9]

Table 5 More Decentralized Countries Took Longer to Take General Interventions against COVID-19.

Variables	Durations from the outbreak to taking general interventions					
	School closures	Workplace closures	Cancelling public events	Closing public transport	Public info campaigns	Restrictions on internal movement
	(1)	(2)	(3)	(4)	(5)	(6)
n_RAI	0.277***	0.581***	0.304	–0.157	–0.064	0.164
	(0.004)	(0.003)	(0.118)	(0.584)	(0.866)	(0.290)
Observations	58	51	58	27	58	53
R-squared	0.756	0.488	0.507	0.669	0.345	0.641

Note: The dependent variables are the duration of time from the outbreak of the pandemic to taking general interventions against COVID-19. There are six kinds of responses: school closures, workplace closures, cancelling public events, closing public transport, public information campaigns, restrictions on internal movement, and international travel controls. All of the regressions include a constant term and control variables, such as population size, life expectancy, population age structure, DALY, HAQ, GDP per capita, urbanization rate, and population flow. Specifically, data for non-pharmaceutical interventions are from OxCGRT, n_RAI from Hooghe et al. (2016), and control variables from Our World in Data. The time when COVID-19 broke out in country *i* is pinned down as the date when the total number of deaths reaches five. The *p* values are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[9] International-travel controls were imposed at the country level, by definition. Because of this, Tables 5 to 8 do not include columns on the effects of the regional authority index on international travel controls.

Moreover, it also caused those countries to spend 0.239 more days transiting from targeted to general workplace closures, which is shown in Table 6.

Table 6 More Decentralized Countries Spent Longer Transiting from Targeted Policies to General Policies

Variables	Time spent in transit from targeted policies to general policies					
	School closures	Workplace closures	Cancelling public events	Closing public transport	Public info campaigns	Restrictions on internal movement
	(1)	(2)	(3)	(4)	(5)	(6)
n_RAI	0.178	0.239**	–0.108	0.059	–0.119	–0.043
	(0.132)	(0.026)	(0.439)	(0.337)	(0.373)	(0.839)
Observations	58	51	58	27	58	53
R-squared	0.317	0.209	0.345	0.444	0.143	0.121

Note: The dependent variables are time spent in transit from targeted policies to general policies. There are six kinds of responses: school closures, workplace closures, cancelling public events, closing public transport, public information campaigns, restrictions on internal movement, and international travel controls. All of the regressions include a constant term and control variables, such as population size, life expectancy, population age structure, DALY, HAQ, GDP per capita, urbanization rate, and population flow. Specifically, data for non-pharmaceutical interventions are from OxCGRT, n_RAI from Hooghe et al. (2016), and control variables from Our World in Data. The time when COVID-19 broke out in country i is pinned down as the date when the total number of deaths reaches five. The p values are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

4.3 Comparison of the Effects of Targeted versus General Policies

We estimate the relationship between specific policy responses and the evolution of the pandemic. The results in Table A3 show that general policies in school closures, workplace closures, cancelling public events, and closing public transport are associated with more flattened curves of daily confirmed cases. Countries that introduce these policies observe the growth rate of daily confirmed cases declining by 5.4%, 1.9%, 2.9%, and 2.9%, respectively. In contrast, targeted policies fail to flatten the curve. We then examine whether timeliness prevents the spread of COVID-19. Specifically, we regress the log total confirmed cases and the log total number of deaths on the time interval between the outbreak and the time at which certain responses are undertaken. Table 7 shows that a one-day delay in closing public transport is associated with a 2% increase in the total number of confirmed cases. Untimely responses also predict more deaths: A one-day delay in cancelling public events would result in a 6% increase in the number of total deaths; in closing public transport, a 1.6% increase; in delaying public info campaigns, a 1.2% increase; and 1.6% more people would die from a one-day delay in controlling international travel.

Table 7 Longer Days between Outbreak and Taking Actions Worsened the Severity of COVID-19

Days from outbreak to taking the action of dependent variable	School closures (1)	Workplace closures (2)	Cancelling public events (3)	Closing public transport (4)	Public info campaigns (5)	Restrictions on internal movement (6)	International travel controls (7)
Total confirmed cases (log)	0.023 (0.196)	–0.006 (0.381)	0.025 (0.145)	0.020** (0.028)	0.003 (0.619)	0.006 (0.537)	0.005 (0.398)
Observations	61	59	63	38	62	60	61
R-squared	0.839	0.832	0.842	0.903	0.830	0.835	0.829

Days from outbreak to taking the action of dependent variable	School closures (8)	Workplace closures (9)	Cancelling public events (10)	Closing public transport (11)	Public info campaigns (12)	Restrictions on internal movement (13)	International travel controls (14)
Total deaths (log)	0.041 (0.104)	–0.002 (0.782)	0.060*** (0.001)	0.016* (0.055)	0.012* (0.071)	0.016 (0.254)	0.016** (0.034)
Observations	61	59	63	38	62	60	61
R-squared	0.790	0.765	0.825	0.929	0.784	0.774	0.796

Note: Delay of actions and responses, such as cancelling public events, closing public transport, public information campaigns, and international travel controls are associated with more total deaths. Control variables include days since the outbreak of COVID-19, population size, life expectancy, population age structure, DALY, HAQ, GDP per capita, urbanization rate, and population flow. Data for non-pharmaceutical interventions are from OxCGRT, n_RAI from Hooghe et al. (2016), and control variables from Our World in Data. The time when COVID-19 broke out in country *i* is pinned down as the date when the total number of deaths reaches five. The *p* values are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

5 Conclusion

In this paper, we examine how centralization/decentralization affects governmental responses to COVID-19. We find that the disease spreads at higher speeds and that there are more total confirmed cases and deaths in those countries that are more decentralized. When exploring the underlying mechanisms, we find that more decentralized countries take longer to undertake any non-pharmaceutical interventions against COVID-19 and more decentralized countries tend to adopt policies that are more targeted rather than general. The study suggests that fighting COVID-19 requires coordination and concerted responses and those countries that have more centralized systems might have institutional advantages in containing the spread of this virus and reducing the number of new cases and deaths. In short, centralized systems are more conducive to flattening the curve.

Acknowledgments Chuanchuan Zhang acknowledges the financial support from the Zhejiang Philosophy and Social Science Planning Project (21WZQH01Z) and the Fundamental Research Funds for the Central Universities.

References

Acemoglu D, Chernozhukov V, Werning I, Whinston M D (2020). Optimal targeted lockdowns in a multi-group SIR model. NBER Working Paper, No. 27102.

Alonso R, Dessein W, Matouschek N (2008). When does coordination require centralization? American Economic Review, 98(1): 145–179.

Alonso R, Dessein, W, Matouschek N (2015). Organizing to adapt and compete. American Economic Journal: Microeconomics, 7(2): 158–187.

Baker S R, Farrokhnia R A, Meyer S, Pagel M, Yannelis C (2020). How does household spending respond to an epidemic? Consumption during the 2020 COVID-19 pandemic. The Review of Asset Pricing Studies, 10(4): 834–862.

Cai H, Treisman D (2009). Political decentralization and policy experimentation. Quarterly Journal of Political Science, 4(1): 35–58.

Chandrasekhar A G, Goldsmith-Pinkham P, Jackson M O, Thau S (2021). Interacting regional policies in containing a disease. Proceedings of the National Academy of Sciences, 118(19): 1–7.

Cheng C, Li C (2019). Laboratories of democracy: Policy experimentation under decentralization. American Economic Journal: Microeconomics, 11(3): 125–154.

Coibion O, Gorodnichenko Y, Weber M (2020). The cost of the covid-19 crisis: Lockdowns, macroeconomic expectations, and consumer spending. NBER Working Papers, No. 27141.

Fajgelbaum P, Khandelwal A, Kim W, Mantovani C, Schaal E (2020). Optimal lockdown in a commuting network. NBER Working Papers, No. 27441.

Gormsen N J, Koijen R S (2020). Coronavirus: Impact on stock prices and growth expectations. The Review of Asset Pricing Studies, 10(4): 574–597.

Hooghe L, Marks G, Schakel A H, Osterkatz S C, Niedzwiecki S, Shair-Rosenfield S (2016).

Measuring regional authority: A postfunctionalist theory of governance, Volume I. Oxford, OXF: Oxford University Press.

Jackson M O, López-Pintado D (2013). Diffusion and contagion in networks with heterogeneous agents and homophily. Network Science, 1(1): 49–67.

Jones C J, Philippon T, Venkateswaran V (2020). Optimal mitigation policies in a pandemic: Social distancing and working from home. NBER Working Papers, No. 26984.

Oates W E (1999). An essay on fiscal federalism. Journal of economic literature, 37(3): 1120–1149.

Witte M D (2020). Coordinated response needed to fight coronavirus pandemic. *Stanford News*.https://news.stanford.edu/2020/03/26/coordinated-response-needed-fight-coronavirus-pandemic, visited on June 2, 2021.

Appendix

Table A1 Summary Statistics

Panel A						
Variable	Obs.	Min	Max	Mean	Median	SD
Regional authority index	80	0	30	9.645	7.670	9.753

Panel B						
Take action or not?	Full sample		*n_RAI* above median		*n_RAI* below median	
	Obs.	Mean	Obs	Mean	Obs	Mean
School closures	80	0.800	40	0.950	40	0.650
Workplace closures	80	0.775	40	0.950	40	0.600
Cancelling public events	80	0.825	40	0.975	40	0.675
Closing public transport	80	0.487	40	0.550	40	0.425
Public info campaigns	80	0.813	40	0.975	40	0.650
Restrictions on internal movement	80	0.787	40	0.950	40	0.625
International travel controls	80	0.800	40	0.950	40	0.650

Panel C						
Within countries taking action,	Full sample		n_RAI above median		n_RAI below median	
whether general action is applied?	Obs.	Mean	Obs.	Mean	Obs.	Mean
School closures	66	0.697	38	0.553	28	0.893
Workplace closures	63	0.667	38	0.632	25	0.720

(*To be continued*)

(*Continued*)

Panel C

Within countries taking action, whether general action is applied?	Full sample		n_RAI above median		n_RAI below median	
	Obs.	Mean	Obs	Mean	Obs	Mean
Cancelling public events	68	0.647	39	0.564	29	0.759
Closing public transport	39	0.564	22	0.364	17	0.824
Public info campaigns	68	0.794	39	0.718	29	0.897
Restrictions on internal movement	64	0.547	38	0.526	26	0.577

Panel D

The severity of COVID-19	Full sample		n_RAI above median		n_RAI below median	
	Obs.	Mean	Obs.	Mean	Obs.	Mean
Total confirmed cases (log)	79	7.947	40	9.365	39	6.494
Total deaths (log)	78	4.714	40	6.233	38	3.115
Speed of spread in the first week	70	4.791	40	5.867	30	3.355
Speed of spread in the first two weeks	64	20.269	38	28.331	26	8.486

Panel E

Economic and demographic variables	Full sample		n_RAI above median		n_RAI below median	
	Obs.	Mean	Obs.	Mean	Obs.	Mean
Population size (log)	78	16.028	40	17.129	38	14.870
Life expectancy (years)	78	77.934	40	78.926	38	76.889
Age dependency ratio - young	78	31.662	40	29.306	38	34.142
Age dependency ratio - old	78	20.394	40	22.412	38	18.271
DALY (log)	78	10.056	40	10.006	38	10.108
HAQ index	77	74.939	40	77.793	37	71.854
GDP per capita (log)	77	9.978	40	10.147	37	9.796
Urbanization ratio	78	70.832	40	74.141	38	67.349
Passengers carried by airline (log)	67	15.667	36	16.932	31	14.198

Note: The sample consists of democracies or quasi-democracies from the regional authority index data. Statistics of subsamples, which are classified by whether *n_RAI* is above or below median level, are reported in Panels B to E as well.

Table A2 More Decentralized Countries Witnessed Faster Spread after the Outbreak of the COVID-19 Pandemic

Variable	20 deaths		50 deaths	
	Spread speed (1 week)	Spread speed (2 weeks)	Spread speed (1 week)	Spread speed (2 weeks)
	(3)	(4)	(5)	(6)
n_RAI	0.075*	0.674**	0.088**	0.486**
	(0.091)	(0.016)	(0.021)	(0.030)
Observations	52	50	42	40
R-squared	0.353	0.424	0.481	0.507

Note: All regressions include a constant term and control variables such as population size, life expectancy, population age structure, DALY, HAQ, GDP per capita, urbanization rate, and population flow. The *p* values are in parentheses. *** *p*<0.01, ** *p*<0.05, * *p*<0.1.

Table A3 Relationship between Specific Policy Response and the Evolution of the COVID-19 Pandemic

Dependent variable: Curve slope of daily confirmed cases	School closures	Workplace closures	Cancelling public events	Closing public transport	Public info campaigns	Restrictions on internal movement
	(1)	(2)	(3)	(4)	(5)	(6)
Independent variable	0.021	–0.017	0.011	0.002	–0.011	–0.014
	(0.204)	(0.140)	(0.343)	(0.843)	(0.230)	(0.283)
Independent variable*General policies	–0.054***	–0.019*	–0.029**	–0.029***	0.006	–0.009
	(0.004)	(0.064)	(0.030)	(0.007)	(0.491)	(0.404)
Observations	13,725	13,725	13,725	13,725	13,725	13,725
R-squared	0.457	0.454	0.452	0.452	0.449	0.451

Note: All regressions include country fixed effects, day fixed effects, and cohort fixed effects. The standard errors are clustered at the country-daily level. The *p* values are in parentheses. *** *p*<0.01, ** *p*<0.05, * *p*<0.1.