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Role of professionalism in response to the COVID-19 pandemic: Does a public health or medical background help?

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\textbf{ABSTRACT}

In response to the outbreak of coronavirus disease 2019 (COVID-19), there have been substantial variations in policy response and performance for disease control and prevention within and across nations. It remains unclear to what extent these variations may be explained by bureaucrats' professionalism, as measured by their educational background or work experience in public health or medicine. To investigate the effects of officials' professionalism on their response to and performance in fighting the COVID-19 pandemic, we collect information from the résumés of government and Party officials in 294 Chinese cities, and integrate this information with other data sources, including weather conditions, city characteristics, COVID-19-related policy measures, and health outcomes. We show that, on average, cities whose top officials had public health or medical backgrounds (PHMBGs) had a significantly lower infection rate than cities whose top officials lacked such backgrounds. We test the mechanisms of these effects and find that cities whose officials had a PHMBG implemented community closure more rapidly than those lacked such backgrounds. Our findings highlight the importance of professionalism in combating the pandemic.

1. Introduction

Coronavirus disease 2019 (COVID-19) was first reported in the city of Wuhan in Hubei province, China, in early December 2019. It then spread rapidly within China and worldwide, becoming a pandemic and bringing about devastating consequences (Ramteke and Sabu, 2020). To contain the transmission of the novel coronavirus, countries around the world have adopted a wide range of stringent measures to reduce human interactions, such as family outdoor restrictions, closed community management, and large-scale quarantines and isolations.

The exponential viral transmission highlights the importance of a swift response. However, COVID-19 countermeasures vary substantially in the timing of their implementation and their efficacy. For instance, most East Asian countries, with their existing contact-tracing systems and experience of viral outbreaks, could contain COVID-19 in a relatively short time. Western governments, on the other hand, often began with loose regulations and delayed responses, which were followed by blanket lockdown. Countries that
responded more quickly, such as Italy, Germany, Austria, and Switzerland, contained the spread of the virus more effectively than countries with a delayed response, including the United Kingdom, Sweden, and the United States (Flaxman et al., 2020; The Economist, 2020). The effectiveness of the pandemic response varied across countries and regions. For instance, in the initial phase of the pandemic, the case fatality rate (CFR) in Italy was 13.98% (number of deaths per 100 confirmed cases), in contrast to only 5.40% in China (Chauhan, 2020). Response effectiveness also varied within countries. In China, Hubei province had a CFR of 6.62%, which was much higher than the average value of 0.82% for other Chinese provinces (Peng, Xu, Sun, Han, & Zhou, 2020). In the early stage of COVID-19 transmission, quarantine was often the most effective approach, especially in combination with other prevention and control measures (Nussbaumer-Streit, 2020). China's early implementation of family outdoor restrictions and closed community management might have avoided a large number of infections and casualties (Qiu, Chen, & Shi, 2020).

There is no doubt that combating the pandemic requires collaboration of the public, scientists, and government officials. The characteristics of officials may be particularly important, as they oversee policy formulation and enforcement to contain the spread of the virus. Their scientific knowledge may affect their perceptions of the underlying risks and corresponding responses. Numerous studies have suggested that a more diverse leadership team tends to be more productive and creative in problem solving, and leads to higher quality decision-making (Nowak, 2020; Shi, Teplitisky, Duede, & Evans, 2019). Moreover, leaders' educational backgrounds may shape their ideas and beliefs about policymaking (Li, Xi, & Yao, 2020). Leaders' experience may also be a good predictor of their behavior (Avery, Tonidandel, Griffith, & Quinones, 2003). The ongoing COVID-19 pandemic offers the opportunity to better understand the role of officials' professionalism in emergency responses in a high-stakes context.

Do more professional officials strengthen the efforts to fight COVID-19? To test this hypothesis, we collect data on officials in 294 Chinese cities, and examine the effect of the officials' professionalism, as measured by having a public health or medical background (PHMBG), on epidemic control. A PHMBG is broadly defined as having received education or worked in public health or medicine. Senior officials are central to social management and development in China. Professional leaders with a PHMBG may leverage their unique experience during a public health crisis to demonstrate urgently needed skills in monitoring infectious diseases and organizing an effective policy response. However, only a small proportion of Chinese officials have a PHMBG. We collect the official résumés of principal and deputy Communist Party secretaries (secretaries hereafter) and mayors, the officials responsible for managing a city, from which we extract information on their experiences relevant to a PHMBG. We merge this information with data from other sources, including COVID-19 infection and fatality data, a rich set of socioeconomic characteristics, and meteorological and environmental information at city level that may influence virus transmission. We estimate the effects of officials' PHMBG on the COVID-19 infection rates, death rates, and public health measures taken. Our linear regression model at the city level controls for city-level covariates associated with both the officials' profiles and outcome measures, including population density, GDP per capita, the number of doctors per 10,000 population, and the average air quality index (AQI). We also include weather controls, such as the average daily maximum temperature, average wind speed, and average precipitation. Our results indicate that a city leadership with a PHMBG was significantly associated with a lower infection rate, which seemed to be driven by the Party secretary's PHMBG. The backgrounds of the Party secretaries seemed to play a much bigger role in reducing infections than those of the mayors. We also show that having a PHMBG was important for timely implementation of local public health measures, such as community closure and outdoor restrictions, to curb human-to-human virus transmission.

This analysis represents, to the best of our knowledge, the first attempt to empirically test the impact of officials' professionalism on their policy response and performance in combating the COVID-19 pandemic. We contribute to the literature in the following respects. First, we offer novel evidence on how officials' characteristics influence policies, in the context of responding to a major public health crisis. Existing studies have mostly focused on the roles of officials' gender, age, and educational attainment (Beaman et al., 2009; Braun, Peus, & Frey, 2018; Elgar, 2016; Li et al., 2020; Lahoti and Sahoo, 2020). Second, we add to the literature on the determinants of virus transmission. In addition to socioeconomic factors, environmental conditions, the political system, and compliance with disease control norms (Farseev, Chu-Farseeva, Qi, & Loo, 2020; Ogen, 2020), the PHMBG of a political leadership has an important effect on transmission, though this factor has received less attention in the literature.

This paper is organized as follows. The next section introduces the data sources of this paper. Section 3 lays out our empirical strategy. Section 4 reports the findings. The final section presents concluding remarks and discusses future research directions in this field.

2. Data

This section discusses several data sources this paper exploits. Section 2.1 presents how we construct our sample and define key variables. Some relevant issues or concerns are also discussed. Section 2.2 reports some descriptive features of the sample.

1 The public's scolding the lack of a timely and appropriate response and the consequent outbreaks nationwide led the government to discipline local officials for mishandling the epidemic, partly due to their lack of relevant experience. We offer two anecdotal examples below. First, the top officials in the epicenter Wuhan had no PHMBG. Second, the principal public health official of the city of Huanggang, which had the second largest number of infections in China, was dismissed for incompetence in handling the epidemic. This official in charge had received a law education but had no prior experience of managing public health.
2.1. Our sample

We use the city as the unit of analysis, including prefectural cities and direct-administered municipalities (i.e., Beijing, Shanghai, Chongqing, and Tianjin). We exclude Wuhan from our analysis as it was the initial epicenter where the virus was first identified. Given its limited knowledge and capacity in the face of this novel virus, infections and deaths data may not be of adequate quality. Some small cities, primarily located in Tibet, Xinjiang, Inner Mongolia, and Hainan, are also excluded due to lack of socioeconomic data. Hong Kong, Macau, and Taiwan are not included due to their different political systems from mainland China. We are left with 294 cities in our sample.

To identify city officials’ backgrounds, we collect from posts on official websites and digitize résumés of city leaders – secretaries, deputy secretaries, mayors, and deputy mayors – who were in office before March 2020. These résumés provide comprehensive information on officials’ age, gender, education background, and work experience. In particular, we focus on characteristics of a city’s two most powerful officials, i.e., the secretary and the mayor. We define an official as having a PHMBG if they completed college/graduate school education in the fields of medicine or public health and/or had experiences working in hospitals, centers of disease control, public health departments, etc. A PHMBG is defined as a binary variable.

Panel A. Outcomes

Infections per million 73 89.438 183.034 1 1009 221 108.783 365.420 1 3452
Deaths per million 73 0.875 2.218 0.095 13.993 221 1.281 4.621 0.083 54.054
Days to community closure 61 13.803 3.341 5 26 179 14.464 3.420 6 28
Days to outdoor restriction 27 14.667 4.288 10 24 95 14.568 3.844 9 28

Panel B. City covariates

GDP per capita 73 63,070.277 43,986.919 2.389 189,568 221 54,235.110 32,204.516 1.141 10,938
Doctors per 10k 73 1.283 1.326 0.017 7.636 221 1.037 1.038 0.138 10.938
Population density 73 432.981 361.147 9.049 1777.670 221 433.423 374.635 10.250 3444.092
Population flow from Wuhan 73 0.247 0.998 0 6.433 221 0.353 1.878 0 19.786

Panel C. Weather variables

Temperature (◦C) 73 11.836 6.879 2.389 189,568 221 68.509 18.669 28.589 113.108
Precipitation (mm) 73 0.286 0.615 0 4.197 221 0.200 0.336 0 4.197

Panel D. Leader covariates

Female mayor 73 0.041 0.200 0 1 221 0.072 0.260 0 1
Male mayor 73 0.055 0.229 0 1 221 0.032 0.176 0 1
Secretary’s age 73 53.288 3.541 44 61 221 56.005 2.645 45 65
Secretary’s tenure 73 2.425 1.674 0 7 221 2.679 1.719 0 9
Secretary’s education (1–4) 73 2.795 0.440 1 3 221 2.760 0.469 1 4
Mayor’s education (1–4) 73 2.781 0.479 1 3 221 2.783 0.455 1 3

2 We do not further distinguish the length of such experiences, because in some cities resume data released are not detailed enough to accurately measure the lengths of related experiences. In addition, given the small number of officials in China with PHMBG, non-binary coding would not offer us more variations over the intensive margin.

3 Air pollution is harmful to individuals’ respiratory system (e.g., Guaita, Pichiule, Maté, Linares, & Díaz, 2011), making people more vulnerable to COVID-19 infection. Karen et al. (2020) find many countries seriously hit by COVID-19 have very poor air quality.
We utilize data on the timing of community closure and family outdoor restrictions collected from Qiu, Chen, and Shi (2020a) and Fang, Wang, and Yang (2020), which aimed at keeping social distance and containing both within-city and between-city viral transmission. Qiu, Chen, and Shi (2020a)’s sample provides data on the timing of restrictive policies that aimed at reducing face-to-face contacts within a city, based on official announcements and media reports.

A community closure order limits residents’ visits between communities. From January 28 to February 20, 2020, more than 250 prefecture-level cities in China implemented community closure. Under this policy, each community leaves only one entrance/exit open, and only residents of that community can enter or exit. Meanwhile, body temperature is checked for each entrant. Testing and quarantining cases are implemented immediately for those who exhibit fever, and whose close contacts are traced and quarantined. Moreover, residents who have symptoms of fever or dry cough are required to report to the community and are quarantined and treated in special medical facilities.

The community closure essentially still allows residents to go out freely, whereas the outdoor restriction is a more stringent policy that largely limits outdoor activities. Governments of 127 Chinese cities imposed family outdoor restrictions. Under such order, residents are required to stay at home and can only go out for necessary needs. For example, in most cities only one household member can go out for groceries every two days, but it may vary from 1 to 5 days across cities in very occasional cases. In some cases, all

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A Chinese community usually has walls and gates to separate it from the outside. Under the community closure order, personnel check visitors’ identity to make sure only residents of that community in and out. For communities that are open or semi-open to the outside (there are no walls), roadblock is set to enforce the closure order.

Here outdoor restrictions mean restricting outdoor activities and travels within a city, rather than travels between cities. This is different from orders such as Wuhan lockdown on January 23, 2020, which prohibited people from entering or leaving Wuhan, while people within the city could still go out.
Residents should stay at home with no exception, and the government is responsible for delivering living resources (e.g., food) to them. Exit permits are usually distributed to each family in advance and recollected when residents re-enter the community. Contacts of those infected are also traced and quarantined.

Dummy variables for the presence of community closure and family outdoor restrictions are created. Both policies were announced in city-level government documents and were uniform across areas within each city. As also acknowledged in Qiu, Chen, and Shi (2020a) and Fang et al. (2020), there were a few cities in which only part of their counties declared to start with implementing these policies. However, other counties in the same city quickly learned from them. Thus, as long as one county in a city has implemented a community closure order or a family outdoor restriction, we treat the whole city as having the policy in place.

Based on information on policy timing, we measure policy adoption speed by the number of days between Wuhan’s lockdown (January 23, 2020) and the implementation of a city’s community closure or outdoor restriction orders. We use Wuhan lockdown date as a reference point because locking down Wuhan, one of the largest and most populous cities in China, offered a salient signal to city officials in other parts of China that similar restrictive policies could be a key option in their toolkit. Without the experience of Wuhan, officials might not have good justification and resolve to adopt such a stringent policy, especially when the virus outbreak overlapped with the Chinese New Year 2020. Peaceful atmosphere is important during major festivals, but stringent public health measures greatly hinder family and friend union. Nonetheless, the lockdown of Wuhan signaled that these measures were unavoidable, and that the stance in the top leadership team was clear and supportive. Alternatively, other dates that represent important events may also be used as a reference point, such as the date when COVID-19 became known to the public. However, to the extent that a reference date is constant across all cities, the estimates would not change with the reference point. Finally, for city-specific reference points, we use the date of each city’s first identified case, and results are qualitatively identical (see Section 4.3).
2.2. Descriptive analysis

The final sample consists of 294 cities. Table 1 displays summary statistics of main variables. We divide cities into two groups based on whether anyone in the leadership has a PHMBG. There are 73 cities with a leadership having at least one PHMBG official, and 221 cities without. Panel A contains outcomes of interest. Comparing city leaderships with and without a PHMBG, the former witnessed less infections, a lower death rate, and quicker adoption of community closure, all of which motivates us to more rigorously investigate the role of a PHMBG in combating COVID-19. However, no such pattern is found on the speed of implementing outdoor restrictions. We discuss this issue in Section 4.3.

Panels B and C display city covariates and weather conditions in the early stage of the pandemic that can be associated with the pandemic and its control measures. There were large differences in GDP per capita, population flow from Wuhan, AQI, maximum temperature, and precipitation between cities of which the leadership team had versus had no PHMBG.

Lastly, Panel D of Table 1 reports characteristics of principal leaders, i.e., secretary and mayor. It is apparent that there were very few female leaders. The average age of the secretaries was around 55; on average, they were 3 years older than the mayors. When the pandemic began, the principal officials on average started their third year in office. Educational attainment is coded in a 1–4 scale: 1 denotes junior college, 2 Bachelor, 3 Master, and 4 Doctorate. An average secretary or mayor received graduate education (note all means are well above 2). Notably, there were no large differences in these characteristics between city leaderships with a PHMBG and those without.

Figs. 1–5 visualize patterns in our data. Fig. 1 shows spatial distribution of city leaderships’ PHMBG. We categorize the sampled

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*Qiu et al. (2020a)*'s sample includes 304 cities. Ten cities are excluded from our analysis due to missing information on their officials’ profiles.
cities into four categories, based on the composition of leaders: (1) none has a PHMBG, (2) only deputy officials have a PHMBG, (3) only principal officials have a PHMBG, and (4) both principal and deputy officials have a PHMBG. There seems to be some spatial clustering of PHMBG in southeast and southern China. To address confounding spatial correlations, we control for province fixed effects and explore spatial standard errors in the econometric investigation (see Section 3). Figs. 2 and 3 display COVID-19 infections and deaths (per million population) across cities, where darker colors denote more infections or deaths. Infections vary largely across cities. Overall, infections decline as a city is further away from Wuhan. However, this pattern is nuanced, as Fig. 2 shows that cities were differentially affected within the same geographical cluster, which encourages us to study the association between leadership PHMBG and infections. By contrast, there are fewer variations in deaths, and the death rate is very low beyond Hubei Province. For this reason, the focus of this paper is on COVID-19 infections.

Figs. 4 and 5 show the adoption speed of community closure and outdoor restriction orders. Darker colors represent more rapid action relative to Wuhan lockdown date, January 23, 2020. In our sample, 240 out of 294 cities eventually implemented a community closure order, whereas for the more stringent policy, outdoor restrictions, only 122 cities implemented. All cities having an outdoor restriction order also had a community closure order. It is evident that cities differ substantially in terms of whether and how quickly they implemented these policies. It is worth noting that while Wuhan and other cities in Hubei Province were most severely hit by the pandemic and took the most rapid action in locking down, they were not the first ones implementing more restrictive measures like community closure or outdoor restriction. In fact, many cities away from Wuhan (e.g., some cities in southwest China, southern China, or northern China) took these measures more quickly, whose leadership team also seemed to have a PHMBG.

Though from these visualizations it is hard to draw conclusive relationships between a PHMBG and COVID-19 outcomes and policy responses, the large variations across cities merit further investigation. In the next section, we discuss our empirical strategy to examine the role of a PHMBG in the pandemic.
3. Empirical strategy

In this section, we describe empirical strategies that we implement to study the effects of officials’ PHMBG on different outcomes, including infections, deaths from COVID-19, and policy responses.

3.1. Effects of PHMBG on COVID-19 pandemic consequences

We rely on the following linear regression models to explore the effects of officials’ PHMBG on pandemic outcomes:

$$y_{ip} = \alpha + \beta Z_{L} + \gamma X_{ip} + \delta W_{ip} + \lambda_{p} + \epsilon_{ip}$$

(1)

$$y_{ip} = \alpha + \sum_{O \in \{S, M, D\}} \beta_{O} Z_{O} + \gamma X_{ip} + \delta W_{ip} + \lambda_{p} + \epsilon_{ip}$$

(2)

In two equations, $i$ indexes city, and $p$ indexes province where the city locates. For the outcome variable $y_{ip}$, we use two measures of COVID-19 pandemic consequences, i.e., logged infection rate and death rate as of February 29, 2020.

In Eq. (1) $Z_{L}$ is a dummy variable that equals one if any official in a city’s leadership has a PHMBG. In Eq. (2), $Z_{S}$ and $Z_{M}$ are dummy variables coding whether city $i$’s secretary and mayor have a PHMBG, respectively, whereas the dummy variable $Z_{D}$ denotes if any deputy officials have a PHMBG. $X$ refers to a set of city-level covariates that could also affect the outcomes, as displayed in Panels B and C of Table 1. $W$ refers to other characteristics of principal officials of a city, i.e., the secretary and mayor, which includes their gender, age, tenure, and educational attainment (i.e., variables in Panel D of Table 1). $\lambda_{p}$ accounts for province fixed effects, which removes unobserved heterogeneity across provinces, such as actions taken by the provincial government. $\epsilon_{ip}$ is an error term, clustered at the province level. We also explore other error term structures to account for arbitrary spatial correlations. First, we assume cities’ error terms are subject to distance-based correlations unless they are 300 km away from each other. Second, error terms in different
provinces can be correlated based on their network-based adjacency relationships, which may correspond to the mode of virus transmission. For example, neighboring provinces of Hubei were more seriously hit by the pandemic.

Clearly, $\beta$'s are the parameters of interest, capturing how officials’ PHMBG is associated with pandemic outcomes. In terms of causality, one may concern that officials with a PHMBG could be sent during the pandemic to less developed regions to lead health systems improvement, or promoted to more developed regions due to their good public health performance. However, these concerns can be addressed with the following evidence. The appointments of Chinese municipal leaders are often centralized in higher level governments, and the primary determinants are their ability in boosting economic growth and political ties (e.g., Jia, Kudamatsu, & Seim, 2015). Moreover, these leadership positions require general skills, rather than specific skills in a certain field. Therefore, it is unlikely that a PHMBG per se would be particularly emphasized in appointments prior to the pandemic. In addition, to the best of our knowledge, during the pandemic political turnovers that replaced incompetent officials with competent ones to help with epidemic control were largely absent. Most political turnovers before March 2020 (the point at which our sample period ends) were during January 2020, which were routine turnovers approved by local people's congress prior to the pandemic. The mere exceptions include Jinan’s secretary Wang Zhonglin being sent to Wuhan as the secretary; and Shanghai’s mayor Ying Yong being appointed as Hubei provincial secretary. However, none of them or their successors in Jinan and Shanghai held PHMBG. Therefore, they should not threaten our identification.

Table 2  
Effects of PHMBG on COVID-19 infections and deaths, Wuhan city excluded.

|                   | Log infections per million | Log deaths per million |
|-------------------|---------------------------|------------------------|
|                   | (1)                       | (2)                    | (3)                     | (4)                     |
| Leadership PHMBG  | -0.181                    | (0.105)*               | 0.048                   | (0.101)                 |
|                   | [0.103]*                  | [0.091]                |                         | (0.065)                 |
| Secretary PHMBG   | -0.823                    | (0.420)*               | -0.153                  | (0.297)                 |
|                   | [0.202]**                  | [0.225]                |                         | (0.220)                 |
|                   | (0.281)**                 |                       |                         |                        |
| Mayor PHMBG       | 0.316                     | (0.391)                | 0.549                   | (0.303)                 |
|                   | [0.332]                   | [0.291]**             |                         | (0.276)**              |
|                   | (0.390)                   |                        | [0.291]***             |                         |
| Deputy PHMBG      | -0.177                    | (0.112)                | -0.010                  | (0.102)                 |
|                   | [0.103]*                  | [0.098]                |                         | (0.060)                 |
|                   | (0.106)**                 |                       |                         |                        |

Note: This table reports coefficients on key independent variables. All regressions control for province fixed effects. Robust standard errors clustered at province level are reported in the parentheses. For key independent variables, official PHMBG, two additional types of standard errors are reported. Distance-based spatial standard errors are reported in brackets, where cities at a distance over 300 km are assumed independent. Network-based spatial standard errors are reported in braces, where province adjacency is modeled to account for spatial correlation.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Fig. 6. Effects of leadership PHMBG on COVID-19 infections and deaths, Wuhan city excluded.
Note: Estimates correspond to Table 2. Both 90 (short caps) and 95% (long lines) confidence intervals are displayed.
3.2. PHMBG and policy responses

We also examine how the officials’ PHMBG affects the decision of policy responses to the COVID-19 outbreak using Eqs. (1) and (2), where the dependent variable $y$ is replaced with a dummy variable that equals one if city $i$ implemented certain policy, i.e., community closure or outdoor restriction orders, to restrict face-to-face contact. The link between the two sets of outcomes, i.e., policy responses (i.e., days to implement community closure or outdoor restrictions) and public health outcomes (i.e., COVID-19 infections and deaths)

### Table 3
Effects of PHMBG on COVID-19 infections and deaths, Wuhan city excluded.

|                          | Log infections per million | Log deaths per million |
|--------------------------|---------------------------|------------------------|
|                          | (1)           | (2)          | (3)           | (4)          |
| **City covariates**      |               |              |               |              |
| Log GDP per capita       | 0.045         | 0.042        | 0.029         | 0.025        |
| (0.032)                  | (0.031)       | (0.022)      | (0.022)       |              |
| Doctors per 10 k         | 0.276***      | 0.277***     | -0.346***     | -0.330***    |
| (0.077)                  | (0.076)       | (0.099)      | (0.098)       |              |
| Population density       | 4.934**       | 5.311**      | -0.197        | -0.021       |
| (2.358)                  | (2.506)       | (1.437)      | (1.304)       |              |
| % population flow from Wuhan | 0.008       | 0.008       | 0.036***      | 0.036***     |
| (0.023)                  | (0.024)       | (0.012)      | (0.012)       |              |
| AverageAQI               | -0.008        | -0.009       | -0.004        | -0.006       |
| (0.006)                  | (0.006)       | (0.005)      | (0.005)       |              |
| **Weather**              |               |              |               |              |
| Wind speed               | 0.200         | 0.211        | 0.151*        | 0.156*       |
| (0.124)                  | (0.126)       | (0.081)      | (0.082)       |              |
| Temperature              | 0.029         | 0.032        | 0.017         | 0.020        |
| (0.031)                  | (0.031)       | (0.021)      | (0.021)       |              |
| Precipitation            | -0.051        | -0.069       | -0.018        | -0.030       |
| (0.048)                  | (0.042)       | (0.060)      | (0.052)       |              |
| **Leader covariates**    |               |              |               |              |
| Female secretary         | -0.048        | -0.056       | -0.155        | -0.137       |
| (0.246)                  | (0.245)       | (0.191)      | (0.191)       |              |
| Female mayor             | -0.074        | -0.068       | 0.136         | 0.113        |
| (0.193)                  | (0.195)       | (0.107)      | (0.115)       |              |
| Secretary age (50, 55)   | 0.092         | 0.104        | 0.197         | 0.181        |
| (0.264)                  | (0.272)       | (0.162)      | (0.163)       |              |
| Secretary age ≥ 55       | 0.032         | 0.047        | 0.100         | 0.074        |
| (0.358)                  | (0.370)       | (0.187)      | (0.196)       |              |
| Mayor age (50, 55)       | 0.140         | 0.127        | 0.085         | 0.084        |
| (0.150)                  | (0.148)       | (0.091)      | (0.091)       |              |
| Mayor age ≥ 55           | 0.141         | 0.112        | 0.077         | 0.057        |
| (0.171)                  | (0.173)       | (0.102)      | (0.106)       |              |
| Secretary tenure (4, 5)  | -0.077        | -0.067       | -0.079        | -0.073       |
| (0.130)                  | (0.130)       | (0.086)      | (0.085)       |              |
| Secretary tenure ≥6      | -0.114        | -0.114       | -0.239        | -0.219       |
| (0.185)                  | (0.185)       | (0.216)      | (0.206)       |              |
| Mayor tenure (4, 5)      | 0.052         | 0.042        | 0.104         | 0.114        |
| (0.135)                  | (0.139)       | (0.098)      | (0.098)       |              |
| Mayor tenure ≥6          | -0.665***     | -0.713***    | -0.185        | -0.183       |
| (0.210)                  | (0.209)       | (0.114)      | (0.117)       |              |
| Secretary bachelor       | 0.261         | 0.227        | 0.131         | 0.094        |
| (0.233)                  | (0.211)       | (0.339)      | (0.319)       |              |
| Secretary master         | 0.198         | 0.178        | 0.027         | 0.013        |
| (0.169)                  | (0.155)       | (0.326)      | (0.308)       |              |
| Secretary doctorate      | -0.102        | -0.128       | 0.461         | 0.422        |
| (0.307)                  | (0.311)       | (0.465)      | (0.451)       |              |
| Mayor bachelor           | 0.131         | 0.126        | -0.283*       | -0.283*      |
| (0.392)                  | (0.395)       | (0.152)      | (0.151)       |              |
| Mayor master             | 0.165         | 0.156        | -0.210        | -0.218       |
| (0.338)                  | (0.341)       | (0.157)      | (0.155)       |              |
| Observations             | 294           | 294          | 294           | 294          |
| R squared                | 0.719         | 0.724        | 0.756         | 0.760        |

Note: This table continues Table 2 and reports coefficients on other independent variables. All regressions control for province fixed effects. Robust standard errors clustered at province level are reported in the parentheses. Official age is binned into three groups, below 50, between 50 and 55, and above 55 (reference group). Official tenure is binned into three groups, below 3 years, between 4 and 5 years, and above 5 years (reference group). Dummy variables for junior college, bachelor, master, and doctorate education are included for both secretaries and mayors, where junior college is the omitted group. There is no mayor having a doctorate.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. 

3.2. PHMBG and policy responses

We also examine how the officials’ PHMBG affects the decision of policy responses to the COVID-19 outbreak using Eqs. (1) and (2), where the dependent variable $y$ is replaced with a dummy variable that equals one if city $i$ implemented certain policy, i.e., community closure or outdoor restriction orders, to restrict face-to-face contact. The link between the two sets of outcomes, i.e., policy responses (i.e., days to implement community closure or outdoor restrictions) and public health outcomes (i.e., COVID-19 infections and deaths)
has been established.\footnote{Qiu et al. (2020a) use city level data and counterfactual analyses to quantify the effects of community closure and family outdoor restrictions on avoided number of infections by the end of February 2020.}

In addition to the PHMBG’s effect on whether to implement a restrictive policy, we also examine how the PHMBG influences the speed of implementation among cities that adopted such policies. To answer this question, we replace the dependent variable of Eqs. (1) and (2) with the number of days between Wuhan’s lockdown (January 23) and the implementation of a city’s outdoor restrictions or community closure.

Simply running Eqs. (1) and (2) would give incorrect estimates of PHMBG’s impact on days to policy implementation, because cities self-selected into policy implementation based on their social and economic conditions, pressures of pandemic control, and importantly, leadership characteristics, which result in the sample selection problem. To correct for this bias, we apply the Heckman two-stage method\footnote{Before January 28, 2020, no cities had implemented either a community closure or an outdoor restriction order.} (Heckman, 1979). In the first stage, we run a Probit regression of the policy adoption indicator for either outdoor restriction or community closure on average weather conditions (unreported), principal officials’ characteristics, and the infection rate as of January 28, 2020.\footnote{Therefore, the model predicts a city’s necessity and likelihood of adopting a policy based on its epidemic condition and governance style. In the second stage, the inverse Mills ratio, which is derived from the Probit model and explicitly accounts for the probability of policy response, is included in the linear regression as an extra regressor to correct for the sample selection bias.}

4. Results

4.1. Effects of PHMBG on infections and deaths

By estimating Eqs. (1) and (2), Table 2 reports the effects of PHMBG on infection and death rates, and Fig. 6 visualizes key estimates. As discussed in Section 3, we report three different standard errors: standard errors clustered at the province level in parentheses, distance-based standard errors in brackets, and network-based standard errors in braces. Clustering at province level appears to offer most conservative inferences. Columns (1) and (2) use logged infections per million as the dependent variable. Column (1) is based on Eq. (1), a parsimonious specification that bundles up all officials’ PHMBG as the leadership variable. The estimate suggests that if anyone in a city leadership has a PHMBG, then infections per million are reduced by about 18%. By estimating Eq. (2), Column (2) separates the effects of different officials’ PHMBG. The leadership’s PHMBG effects are mainly driven by secretary and deputy officials, while the mayor’s PHMBG demonstrates no significant effects. Having a secretary with PHMBG reduces infections per million by 82%, and any PHMBG of deputy officials leads to 17.7% lower infections per million. The coefficient for deputy officials is less precisely estimated, therefore, we interpret it only as qualitative evidence. Columns (3) and (4) report the effects of a PHMBG on deaths per million. There are no detectable effects of the leadership’s, secretary’s, or deputy officials’ PHMBG. One potential explanation is that lack of variations in death data across cities (see Fig. 3) results in random correlations due to over-fitting. However, we also admit the possibility that the results might reflect certain features of the decision-making process within the leadership, which is an open question for future research.

Table 3 displays coefficients on other variables, which also provides some interesting insights for understanding factors that influence the pandemic outcomes. Officials’ characteristics are of particular interest. Some earlier anecdotal cross-country comparisons
suggest that female politicians appeared to perform better than male politicians in handling the COVID-19 crisis (Taub, 2020). However, this pattern is less pronounced in our within-country study. We do not find female secretaries or mayors with PHMBG significantly correlated with fewer infections or deaths. We also find no supporting evidence linking educational attainment to health outcomes. Moreover, officials’ age did not have significant influences, though previous literature suggests age matters to Chinese officials’ incentives and performance, as it indicates opportunities for promotion (e.g., Chen, Li, & Zhou, 2005; Li, 1998; Li & Zhou, 2005). One possible explanation is that, faced with the devastating COVID-19 crisis, pandemic control was the vital obligation of officials, which overwhelmed career concerns and left no room for slackness. Work experience in the mayor position shows a salient effect that mayors who had worked in the city for more than six years prior to the pandemic were associated with a lower infection rate.

4.2. Robustness checks

Our results support that the PHMBG of the leadership team, especially that of the secretary, plays an important role in mitigating damages resulting from the pandemic. In this subsection, we provide a set of robustness checks to alleviate potential concerns.

4.2.1. Outliers

One concern is that regression results can be driven by hotspots whose leadership by chance did not have PHMBG. Instead of only excluding the initial largest hotspot city Wuhan from the analysis, now we exclude all cities in Hubei Province and re-do the analysis in Table 2 to minimize influences of outliers, because all cities in Hubei were early hotspots and their leadership mostly did not hold...
PHMBG. Full estimates are reported by Table A1 in the Appendix. Fig. 7 displays coefficients on officials’ PHMBG. Comparing Figs. 6 and 7 shows that results are robust after excluding all cities in Hubei: the leadership’s PHMBG now reduces the infection rate by 20%, slightly higher than the previous estimate (18%), and the effect remains driven by the secretary’s and deputy officials’ PHMBG. Therefore, our results should not be affected by potential outliers. For remaining tests in this paper, we primarily report results after excluding Wuhan, though they are also robust to excluding all cities in Hubei province (see Appendix).

4.2.2. Alternative explanations

We interpret the association between PHMBG and lower infection rates as showing that officials’ professionalism served as a beneficial input into combating the pandemic. However, one might argue that PHMBG may also pick up a general impact of governing style given their technocratic or scientific background. To address this issue, we run Eqs. (1) and (2), adding indicators for the secretary’s, mayor’s, and deputy officials’ STEM (science, technology, engineering, and mathematics) education experience, based on their highest degree received. Fig. 8 displays the estimates. Fig. 8(A) compares effects of the leadership’s PHMBG and officials’ STEM background. The effect of the leadership’s PHMBG is virtually unchanged compared to the baseline estimate in Column (1) of Table 2 (18.4 versus 18.1%). Reassuringly, the effects of STEM background are all statistically insignificant and have very small magnitude. Fig. 8(B) shows similar patterns for the effects of officials’ PHMBG and STEM background. Results are similar if we repeat this exercise on the sample that excludes all cities in Hubei province (see Fig. A1 in Appendix). Therefore, it is most plausible that our identified effects of officials’ PHMBG represent the unique importance of professionalism, rather than general scientific thinking.

Fig. 9. Permutation tests of leadership and secretary PHMBG’s effects on infections, Wuhan city excluded. 
Note: Counterfactual PHMBG effects are generated by 20,000 simulations. The vertical dashed lines denote true effects reported in Table 2.

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4.2.3. Coincidence

One may also worry that our findings are just by coincidence. We conduct placebo tests, allowing for a more flexible way to test for our findings. Given that our main findings are on the role of leadership's PHMBG on epidemic control, which is driven by the secretary's PHMBG, we simulate the distributions of the leadership's and the secretary's PHMBG across cities by randomly assigning PHMBG (holding constant the fractions of different types of officials who have a PHMBG). For each simulated sample, we re-estimate Eqs. (1) and (2) and obtain counterfactual effects of a PHMBG. We run simulations for 20,000 times. In Fig. 9(A), we report the permutation test result for the effect of the leadership's PHMBG. It plots the distribution of counterfactual estimates, while the vertical dashed line denotes the true estimate shown in Tables 2 and 3. The true estimate lies in the left tail of the distribution, and a $t$-test does not reject that the mean of counterfactual estimates is zero ($p$-value $= 0.301$), indicating that our findings are not just by coincidence. Fig. 9(B) tests for the effect of the secretary's PHMBG. According to these placebo test results, it is unlikely that our findings are merely by chance.

4.3. Implementation of community closure and outdoor restrictions

In this subsection, we probe into explanations for the association between the PHMBG and lower infections rates. Using a sample of cities almost the same to ours, Qiu, Chen, and Shi (2020a) find that community closure and outdoor restriction orders effectively...
contained viral transmission within Chinese cities. Cross-country evidence also supports the importance of timely measures to enforce social distancing. Countries that responded more quickly, such as Italy, Germany, Austria, and Switzerland, contained the spread of the virus more effectively than countries with a delayed response, including the United Kingdom, Sweden, and the United States (Flaxman et al., 2020; The Economist, 2020). Along this line, we explore if a PHMBG contributed to better policy responses in the first place, which then manifested itself in fewer infections.

Firstly, we look at how a PHMBG affected the probability of community closure and outdoor restriction orders being implemented. Fig. 10 shows the estimates from linear probability models specified as Eqs. (1) and (2) using policy adoption dummies as dependent variables. A secretary with a PHMBG made the city 13.5% more likely to enact community closure, while other officials did not have significant contributions. However, for the more stringent outdoor restriction, mayor's PHMBG made more difference.

We then investigate PHMBG's effects on the speed of policy adoption. We estimate Eqs. (1) and (2) with the days between policy implementation date and Wuhan lockdown date (January 23), augmented by Heckman two-step method. Fig. 11 visualizes the results for cities excluding Wuhan. The left panel shows that a leadership team with a PHMBG implemented a community closure order nearly one day earlier, but the PHMBG's effects differ dramatically across officials. The secretary's PHMBG significantly accelerated a community closure order by about three days, but the mayor's PHMBG seems to cause a delay though insignificant, and deputy officials' PHMBG had no effect. The right panel turns to investigate the speed of implementing outdoor restriction, none of officials' PHMBG had any salient influences. We also look at results using each city's first case date as the reference point (Fig. 12). In general, results are similar to Fig. 11: secretary's PHMBG drives the entire leadership to speed up launching community closure, but a distinction is that the mayor's PHMBG now appears to facilitate more rapid outdoor restrictions.

In sum, the results deliver a clear message that secretary's PHMBG increases the chance and rapidity of a community closure order. This provides an explanation for earlier finding that secretary's PHMBG reduced infections: quicker community closure effectively reduced face-to-face contacts, thus cut off many channels through which the virus might transmit. Admittedly, the results are mixed in the role of mayor's PHMBG. If anything, on the extensive margin, mayor's PHMBG insignificantly increased the probability of adopting outdoor restriction, but on the intensive margin, it had no impact on the speed of implementing an outdoor restriction if using Wuhan lockdown date as the reference point, but accelerated the policy adoption if using the city's first case date as the reference point. A further question is why PHMBG's effects vary dramatically by position. One conjecture is political hierarchy and differential power attached to each position. This study documents this pattern and leaves the exact interpretations for future research.

5. Concluding remarks

This study examines the potential influence of city officials' educational or work experience in public health or medicine on their epidemic control and prevention efforts and outcomes. Our results show that the presence of city officials with a PHMBG was significantly associated with lower infection rates. Second, cities whose officials had a PHMBG implemented a community closure order in a timelier manner.

Our findings may have implications that training background and work experience of the leadership team may play a role in response to epidemics. Given that only 3.27% of top-ranked officials in our sampled cities have a PHMBG, enhancing professionalism in leadership team may generate high return in disease control and prevention. For example, the appointment of officials in public

\[\text{Calculated among over 3000 officials in the sample.}\]
health departments may stress on professional skills. Under the Chinese bureaucratic rotation system, a department's leader usually does not have relevant experience in issues that the department oversees. Some training can be helpful. In addition, certain institutional reforms are necessary to empower professionalism in the policy making process in the face of emergencies. For instance, establishing an advisory board that consists of public health or medical scientists can provide professional suggestions to policy makers.\(^\text{10}\) This implication for professionalism not only applies to public health emergencies, but is relevant for other public sectors in which the government plays an important role.

In times of crises, people with a public health background may respond differently from those with a medical background, as the former often emphasize preventive measures to protect population-level health, while the latter treat specific patients. However, as only a small proportion of top city officials in China have such background, even when both types of background are combined, future studies will have to wait for a larger number of cities to join this group to obtain the statistical power needed to identify potentially heterogeneous effects. Future studies could also conduct randomized control trials to examine whether providing local officials with training in public health, medicine or other fields could improve professionalism in their duties. Finally, studying the significance of officials’ PHMBG during epidemics from a global perspective would be another meaningful extension of this study.

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Appendix A. Results after excluding Hubei province.

In the main text, we present results excluding Wuhan. In this appendix section, we replicate all analyses excluding all cities in Hubie Province, which leaves us 278 cities.

### Table A1

**Effects of PHMBG on COVID-19 infections and deaths, Hubei province excluded.**

|                         | Log infections per million | Log deaths per million |
|-------------------------|-----------------------------|------------------------|
|                         | (1)                         | (2)                    |
| Leadership PHMBG        | 0.103                       | 0.103                  |
| (0.129)**               | (0.085)                     |                        |
| Secretary PHMBG         | 0.805                       | 0.110                  |
| (0.407) *               | (0.316)                     |                        |
| [0.187]**               | [0.202]                     |                        |
| [0.254]**               | [0.204]                     |                        |
| Mayor PHMBG             | 0.317                       | 0.526                  |
| (0.422)                 | (0.294) *                   |                        |
| [0.364]                 | [0.293] *                   |                        |
| [0.399]                 | [0.250]**                   |                        |
| Deputy PHMBG            | 0.195*                      | 0.042                  |
| (0.111)                 | (0.076)                     |                        |
| [0.101]**               | [0.091]                     |                        |
| [0.116]**               | [0.077]                     |                        |

Note: This table reports coefficients on key independent variables. All regressions control for province fixed effects. Robust standard errors clustered at province level are reported in the parentheses. For key independent variables, official PHMBG, two additional types of standard errors are reported. Distance-based spatial standard errors are reported in brackets, where cities at a distance over 300 km are assumed independent. Network-based spatial standard errors are reported in braces, where province adjacency is modeled to account for spatial correlation.

\(*\ p < 0.1, \ **\ p < 0.05, \ ***\ p < 0.01.

Table A1-Continued: Effects of PHMBG on COVID-19 infections and deaths, Hubei province excluded.

|                         | Log infections per million | Log deaths per million |
|-------------------------|-----------------------------|------------------------|
|                         | (1)                         | (2)                    |
| City covariates         |                             |                        |
| Log GDP per capita      | 0.042                       | 0.037                  |
|                         |                             | 0.023                  |
|                         |                             | 0.018                  |

\(^{10}\) Recently, the Chinese government has started some of these efforts. For example, Hubei is set to create a “Chief Public Health Specialist” position in its public health department. [https://ctdsbepaper.hubeidaily.net/pc/content/202007/07/content_38466.html](https://ctdsbepaper.hubeidaily.net/pc/content/202007/07/content_38466.html)
|                          | Log infections per million | Log deaths per million |
|--------------------------|----------------------------|------------------------|
|                          | (1)                        | (2)                    |
| Doctors per 10 k         | 0.040                      | (0.039)                |
|                          | (0.056)                    | (0.055)                |
| Population density       | 4.039                      | 4.425                  |
|                          | (2.640)                    | (2.829)                |
| % Population flow from Wuhan | 3.574***                    | 3.556***               |
|                          | (0.902)                    | (0.889)                |
| Average AQI              | −0.005                     | −0.006                 |
|                          | (0.006)                    | (0.006)                |
| Weather                  |                            |                        |
| Wind speed               | 0.158                      | 0.169                  |
|                          | (0.114)                    | (0.116)                |
| Temperature              | 0.020                      | 0.023                  |
|                          | (0.028)                    | (0.028)                |
| Precipitation            | −0.047                     | −0.067                 |
|                          | (0.041)                    | (0.048)                |
| Leader covariates        |                            |                        |
| Female secretary         | −0.114                     | −0.117                 |
|                          | (0.224)                    | (0.225)                |
| Female mayor             | −0.152                     | −0.148                 |
|                          | (0.173)                    | (0.179)                |
| Secretary age (50, 55)   | 0.154                      | 0.162                  |
|                          | (0.294)                    | (0.305)                |
| Secretary age ≥ 55       | 0.097                      | 0.109                  |
|                          | (0.357)                    | (0.375)                |
| Mayor age (50, 55)       | 0.122                      | 0.109                  |
|                          | (0.162)                    | (0.161)                |
| Mayor age ≥ 55           | 0.135                      | 0.107                  |
|                          | (0.171)                    | (0.176)                |
| Secretary tenure (4, 5)  | −0.037                     | −0.026                 |
|                          | (0.138)                    | (0.137)                |
| Secretary tenure ≥ 6     | −0.171                     | −0.170                 |
|                          | (0.190)                    | (0.193)                |
| Mayor tenure (4, 5)      | 0.037                      | 0.026                  |
|                          | (0.140)                    | (0.143)                |
| Mayor tenure ≥ 6         | −0.695***                  | −0.724***              |
|                          | (0.221)                    | (0.224)                |
| Secretary bachelor       | −0.006                     | −0.035                 |
|                          | (0.253)                    | (0.223)                |
| Secretary master         | −0.022                     | −0.036                 |
|                          | (0.202)                    | (0.198)                |
| Secretary doctorate      | −0.315                     | −0.337                 |
|                          | (0.323)                    | (0.327)                |
| Mayor bachelor           | 0.529                      | 0.534                  |
|                          | (0.638)                    | (0.633)                |
| Mayor master             | 0.457                      | 0.458                  |
|                          | (0.625)                    | (0.623)                |
| Observations             | 278                        | 278                    |
| R squared                | 0.537                      | 0.546                  |

Note: This table continues Table A1 and reports coefficients on other independent variables. All regressions control for province fixed effects. Robust standard errors clustered at province level are reported in the parentheses. Official age is binned into three groups, below 50, between 50 and 55, and above 55 (reference group). Official tenure is binned into three groups, below 3 years, between 4 and 5 years, and above 5 years (reference group). Dummy variables for junior college, bachelor, master, and doctorate education are included for both secretaries and mayors, where junior college is the omitted group. There is no mayor having a doctorate.

* p < 0.1, ** p < 0.05, *** p < 0.01.
Fig. A1. The role of PHMBG and STEM backgrounds in containing infections, Hubei province excluded.
Note: Both 90 (short caps) and 95% (long lines) confidence intervals are displayed.
Fig. A2. Permutation tests of leadership and secretary PHMBG’s effects on infections, Hubei province excluded. Note: Counterfactual PHMBG effects are generated by 20,000 simulations. The vertical dashed lines denote true effects reported in Table A1.

Fig. A3. Effects of PHMBG on policy adoption, Hubei province excluded. Note: Both 90 (short caps) and 95% (long lines) confidence intervals are displayed. Policy adoption is a binary choice variable.
Fig. A4. Effects of PHMBG on policy speed (relative to January 23, 2020), Hubei province excluded. Note: Both 90 (short caps) and 95% (long lines) confidence intervals are displayed.

Fig. A5. Effects of PHMBG on policy speed (relative to first case date), Hubei province excluded. Note: Both 90 (short caps) and 95% (long lines) confidence intervals are displayed.

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