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Study on the patterns of COVID-19 prevention and control in China: An empirical analysis on prefecture-level governments

By

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Abstract

In order to deal with the ongoing threat of the COVID-19 pandemic, China has adopted the “Normalized Epidemic Prevention and Control Requirements” measures in the last two years. This study investigates the effect of smart city projects on the patterns of COVID-19 prevention and control in China’s prefecture-level governments. Using an original prefecture-level data between 2020 and 2021, I show that, after the initial outbreak of the COVID-19 pandemic in Wuhan, prefecture-level governments with a higher level of smart city construction adopt more targeted measures towards the COVID-19 pandemic under mild outbreaks, but show no significant difference under severe outbreaks.

Keywords: COVID-19; Targeted Contorl; Smart City.

1 Introduction

China has entered the second phase of COVID-19 prevention and control since May 2020, namely as the “Normalized Epidemic Prevention and Control Requirements” measures. It points to the resolution made by the central government to completely eliminate the transmission of the virus, namely as the “dynamic zero-COVID policy.” In most of the areas in mainland China, the prefecture-level governments are the main administrative bodies responsible for the implementation of concrete prevention and control measures, such as lockdown and nucleic acid testing.

Over the last two years, several waves of COVID-19 pandemics struck China, with the ”dynamic zero-COVID policy” remaining the same. However, under the same national goal, prefecture-level governments respond to COVID-19 outbreaks in drastically different ways. [1] While some governments prefer targeted measures that balance the economic activities and pandemic control, others would rather adopt the strictest lockdown policy to cope with COVID-19. To figure out what determines their different responses to

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[1] According to my data, 90% COVID-19 outbreaks in Heilongjiang Province were at least handled with partial lockdown while only a half COVID-19 outbreaks in Jiangsu Province were handled in the same way.

COVID-19 pandemics is worthy of exploration, as it points to key factors affecting regional variation in governance styles and patterns in China.

Smart city refers to an idea first raised by China's Ministry of Housing and Urban-Rural Development in 2012, to promote the intelligence of urban planning, construction, management and service by using a new generation of information technologies such as the Internet of Things, cloud computing, big data, and spatial geographic information integration. The central government lays great emphasis on this project as it not only involves huge amounts of infrastructural investment but also pertains to the improvement of governance capacity. The construction of smart cities was initiated in 2012, and altogether three batches of pilot cities have been batched until now (Yang and Chong, 2021). During the COVID-19 pandemic, the significance of smart city in pandemic prevention and control was brought up again by governments, news reports and academic research. Its role in promptly tracking the infected, integrating information and determining the control area by employing multiple information technologies is the basis of targeted measures of pandemic control and prevention. However, after ten years since the first batch of pilot smart city programs was initiated, it remains unclear whether in public health emergency events like the COVID-19 pandemic, smart city construction will improve local governments' performance against COVID-19. Furthermore, the discussion points to a broader question on whether smart city projects can help reach the goal of "Modernizing the National Governance System and Capacity". Up to now, although there are several individual studies suggesting that local governments with higher level of smart city investment are more likely to adopt targeted measures like Shanghai, no quantitative evidence is available on a national scale to prove this claim. Therefore, this study aims to find out whether the level of smart city will affect how governments respond to COVID-19 pandemics.

2 Literature Review

Research on Chinese governments' response to the COVID-19 pandemic can be generally divided into two categories. One perspective focuses on the Chinese bureaucratic system. Interestingly enough, scholars attribute both failed and successful responses made by governments to this institutional perspective. During the initial outbreak of COVID-19 in Wuhan, Wuhan government's attempt to conceal the spread of virus from the public and the central government is viewed as a typical central-local tension in China (Yang, 2020; Zhou, 2020). Yang argues that when the threat of instability led to the central-local interests divergence, it produced feigned compliance, distortion and subterfuge of local governments. Zhou argues that the Wuhan case fitted a pattern of familiar Chinese bureaucratic behaviors in which the principle of political stability took precedence over professional judgment in organizational response. In contrast, after China managed to keep the initial outbreak in control efficiently, the institutional perspective was brought up again to glorify China's temporal superiority over other countries in pandemic prevention and control. Scholars use the term campaign-style governance to describe how local officials can enjoy more power than usual and break routine rules as long as they meet the goals the central leaders assign to them, in particular the "dynamic zero-COVID policy" (Zhou, 2012). Besides, official propaganda uses the jargon *Juguo Tizhi* or the "whole nation" system to summarise how the entire country could concentrate and mobilize tremendous resources and efforts to realize the zero-infection goal (Hu, 2015; Hu and Henry, 2017; Wei et al., 2010). However, this generalized institutional perspective overlooked the significant variation among local officials in their responses to COVID-19 pandemics. Under the same “dynamic zero-COVID policy”, some prefecture-level governments are more willing to implement targeted measures while others only resort to harsh measures, including full-scale lockdown. Apparently, other explanations are needed to account for the difference in local officials’ decision-making when facing COVID-19 pandemics.

Other than looking for institutional explanation, the second perspective pays more attention to concrete measures taken by local governments, revealing how information and digital technologies can improve governance capacity and thus, help local governments perform better in pandemic prevention and control. Studies show that in China, smart city policies significantly increase urban innovation (Xu et al., 2020). During the initial outbreak of COVID-19, cities with higher amount of smart city investment per capita proves to have a lower rate of COVID-19 confirmed cases (Yang and Chong, 2021), with all else being equal. Moreover, Chu et al. (2021) and Chen et al. (2021) both show that higher urban governance capacity, of which the level of smart city construction is an important indicator, can improve the city’s resilience against pandemic. Apart from quantitative evidence, multiple case studies on Shanghai, the city among the top of smart city ranking in China, presents how smart city projects help build one of the most precise and targeted systems of pandemic prevention and control in China. Dong and Ye (2020) argues about applying new technology into pandemic control , while Gao (2021) summarizes Shanghai’s experience as quick response, accurate control, and standardized operation.

Different from most quantitative studies that focus on the effect of smart city construction on how well prefecture-level governments can control the initial outbreak of pandemic, this study extends the discussion to the second phase of COVID-19 pandemics in China. Instead of focusing on the direct effect of smart city projects on pandemic prevention and control, this study attempts to understand the influence of smart city projects on whether prefecture-level officials will take more targeted measures against COVID-19 pandemics or not. It may also serve as the alternative explanation to the institutional factor, illustrating why under similar central-local tensions, the extent to which prefecture-level governments take targeted measures towards COVID-19 varies a lot. In a more general sense, it explores whether infrastructure investment like smart city can lead to the improvement of governance capacity and decision-making in prefecture-level governments. Therefore, the study tries to study how smart city projects will affect the choice of patterns of pandemic prevention and control for prefecture-level governments in the second phase of COVID-19 pandemic. Since there are only a few case studies with a limited focus on top-ranking cities in China, more comprehensive and quantitative evidence is needed.

3 Empirical Design

3.1 *Theory*

Entering the phase of implementing “Normalized Epidemic Prevention and Control Requirements” since May 2020, China has adopted a decentralized fashion that prefecture-level governments are the principal agents to take responsibility for pandemic prevention and control. In most COVID-19 outbreaks, it is the prefecture-level governments that analyze severity, make decisions and take concrete measures. Typically, within 24 hours after the first case is detected, the prefectural center for disease control and prevention (CDC) gets a preliminary result of epidemiological investigation and then, heads of the government and the health commission gather together to firm up how much area and population should be under control, followed by medical staff, the press conference and the official statement released in multiple platforms. Given that prefecture-level governments are the major policy maker and implementer as well, it leaves them little opportunity for delegating or diffusing blame to other levels of administrative bodies (Ran, 2017). For instance, in a severe COVID-19 pandemic outbreak in Jiangsu Province in July, 2021, provincial leaders remained intact while prefecture-level leaders like the deputy mayor of Yangzhou and the deputy director of the CDC in Nanjing were imposed severe penalty. Therefore, the same time prefecture-level governments enjoy huge discretion over measures against COVID-19, they also become the principal blame taker for it.

When facing emergency management like handling COVID-19, government heads usually face two sources of blame. On the one hand, failure to cease the spread of virus in time can cost their entire political careers. On the other hand, however, the one-size-fits-all approach (*yidaoqie*) like full-scale lockdown may exert significantly negative impact on socio-economic activities, generating the blame from both the public and the central government. Unlike ”credit-claiming” economic performance, this is a negative-sum game for policy makers as all possible alternatives have strong negative consequences (Weaver, 1986). Under this circumstance, most policy makers tend to avoid blame by minimizing political losses. Over the last two years, the central government sees the failure to control the pandemic as the “one-item veto” (Zhou and Lian, 2020) for prefecture-level governments, while the blame for overreaction is more tolerable. Therefore, when a COVID-19 pandemic strikes, all prefecture-level governments have the similar prioritized incentive to control the spread of virus. This explains why many government heads resort to full-scale lockdown and nucleic acid testing in spite of enormous economic costs when the danger of the pandemic remains unknown.

However, for those cities with a higher level of smart city construction, it can reduce the risk of virus spread even with a more targeted measures and thus mitigate the prioritized incentive to implement harsh measures against COVID-19 pandemics. Smart city construction provides prefecture-level governments with a wider combination of policy options and in turn, harsh measures are not necessarily the only way to minimize political losses. The essence of smart city is the intelligent processing of data. By investing more in smart city projects, including the Internet of Things, cloud computing, big data, and GIS, governments are able to collect systematic and timely information and then conduct analysis. With the help of big data analysis, the bureaucratic system can coordinate different departments and conduct timely and accurate measures towards all sorts of public affairs. For instance, when a COVID-19 case is detected in a city, the communication department will accurately depict the patient's 14-day movement with the help of mobile phone signal positioning, and the police department will collect the surveillance videos of the places the patient has been to in the last 14 days (Gao, 2021). Based on this information, epidemiological survey can swiftly target close contacts, who will receive immediate nucleic acid testing. Then, based on the testing result, experts from the government, the CDC and the health commission can estimate the severity of this outbreak and decide whether to scale up the pandemic control. Above all, smart city projects make possible an accurate and immediate estimation of COVID-19 outbreaks. It enables the prefecture-level government to take targeted measures against COVID-19, and more importantly, it largely lowers the risk of the spread of virus even if the government takes targeted measures. Unlike their counterparts without enough smart city construction, the fear of political loss due to the failure to contain COVID-19 pandemics is significantly mitigated for those governments with a high level of smart city construction. Therefore, when facing a COVID-19 outbreak, they are more willing to employ a more targeted measure, like limiting the size of area and population to be controlled and maintaining the everyday life in the rest of the city. Based on the preceding discussion on the blame-avoiding incentive of prefecture-level government heads, my main hypothesis is that, *all else being equal, prefecture-level governments with a higher level of smart city construction will take more targeted measures towards COVID-19 pandemics.*

3.2 *Data*

As discussed above, this study assumes that every prefecture-level government has similar incentive to keep the pandemic in control as soon as possible, so the strictness of responses made by governments well reflects the extent of policy precision instead of being affected by their negligence. The empirical evidence also proves this assumption in that in most cases, the first official response to the COVID-19 outbreak is released to the public within several hours after the first case is detected. Due to the time limit, I divide mainland China into three parts–east, middle and west–and randomly select seventeen from altogether twenty-eight provinces and autonomous regions. Then, I mark every COVID-19 outbreak taking place in each prefecture-level city in the selected provinces and autonomous regions from May 2020 to the end of 2021.[2] Finally, I get a sample of 97 prefecture-level governments in seventeen provinces that have experienced at least one COVID-19 outbreak during that time period.

I decide to record the policies made by the prefecture-level government during the

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[2] In this study, a COVID-19 outbreak in a prefecture-level city is recorded as long as at least one case is confirmed within that prefectural administration. If the span of two adjacent days when cases are detected exceeds ten days, the second day will be regarded as the beginning of the second COVID-19 outbreak. The future study will extend the time frame to 2022.

five days since the first case of COVID-19 is detected. Observing only the first five days allows the study to reduce the ongoing effect of the pandemic itself on the extent of policy precision, like avoiding the escalation of policy strictness when the pandemic gets worse. Limiting the time frame can largely preserve the uncertainty of the COVID-19 outbreak and eschews the potential interaction between policy precision and pandemic severity so that the government makes decisions out of its blame-avoiding incentive and the strictness of policies can well reflect the extent of policy precision.

Variable	Description	Range
C1	School Closures	0-3
C2	Workplace closing	0-3
C3	Cancel Public Events	0-2
C4	Restrictions on gatherings	0-4
C5	Close public transport	0-2
C6	Stay at home requirements	0-3
C7	Restrictions on internal movement	0-3
Stringency Index	The extent of policy stringency	0-1

Table 1: Stringency Variables

My original data in the study firstly borrows insight from the project, the Oxford COVID-19 Government Response Tracker (OxCGRT), which collects systematic information on policy measures that governments have taken to tackle COVID-19 (Hale et al., 2020). Based on this, my data in this study extends China's province-level data in the OxCGRT project to prefecture-level one. As Table 1 shows, C1-C7 are the same ordinal variables that indicate the stringency of pandemic policies as in the OxCGRT data. The higher value the variable has, the stricter the measure is. Only a little adjustment has been made to the range of these variables to better fit them to the reality in China. Based on these seven variables, I also calculate a stringency index to reflect the extent of policy stringency.[3] This simple method is verified by the working paper of OxCGRT (Zha, 2022). For a prefecture-level city struck by a COVID-19 outbreak, I record these policy variables for the first five days and choose the day with the highest value to calculate the stringency index. Five days are long enough for the prefecture-level government to make decisions and also short enough to avoid the escalation of COVID-19 pandemics. Therefore, the stringency index can indicate the extent of policy precision of the prefecture-level government.

In addition to the same variables in the OxCRGT data, I add a few more important new indicators as alternative dependent variables close to China's condition. As shown in Table 2, *Lockdown*(C8), H1 and *Mode* are also ordinal variables. *Lockdown*(C8) shows in the first-five-day period, whether the prefecture-level government conducts targeted lockdown (0), partial lockdown (one or more county-level jurisdiction, 1), or full-scale lockdown (2). H1 shows in the first-five-day period, whether the prefecture-level government conducts targeted testing towards close contacts (0), partial testing (one or more county-level jurisdiction, 1), or full-scale testing (2). *Mode* enumerates every combination of lockdown and testing strategies, with the value from 0 indicating fully targeted measures to 5 indicating full-scale lockdown and nucleic acid testing.[4] *Lockdown Delay* is a numeric variable that records the number of lockdown days after the last COVID-19 case is detected. Besides, the study still concerns the variation in severity even during the beginning of an COVID-19 outbreak. That said, governments may react differently depending on the severity of pandemic at first. To solve this problem, I add a severity

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[3] The calculation method is to divide the value of every C1-C7 variable by their maxima respectively, and then to add these seven values up, further divided by seven. The formula is: $[\frac{C1}{3} + \frac{C2}{3} + \frac{C3}{2} + \frac{C4}{4} + \frac{C5}{2} + \frac{C6}{3} + \frac{C7}{3}] * \frac{1}{7}$. The range of this variable is 0-1.

[4] The interpretation of the *Mode* variable: 0, targeted lockdown and targeted nucleic acid testing; 1, targeted lockdown and partial testing; 2, partial lockdown and partial testing; 3, targeted lockdown and full-scale testing; 4, partial lockdown and full-scale testing; 5, full-scale lockdown and full-scale testing.

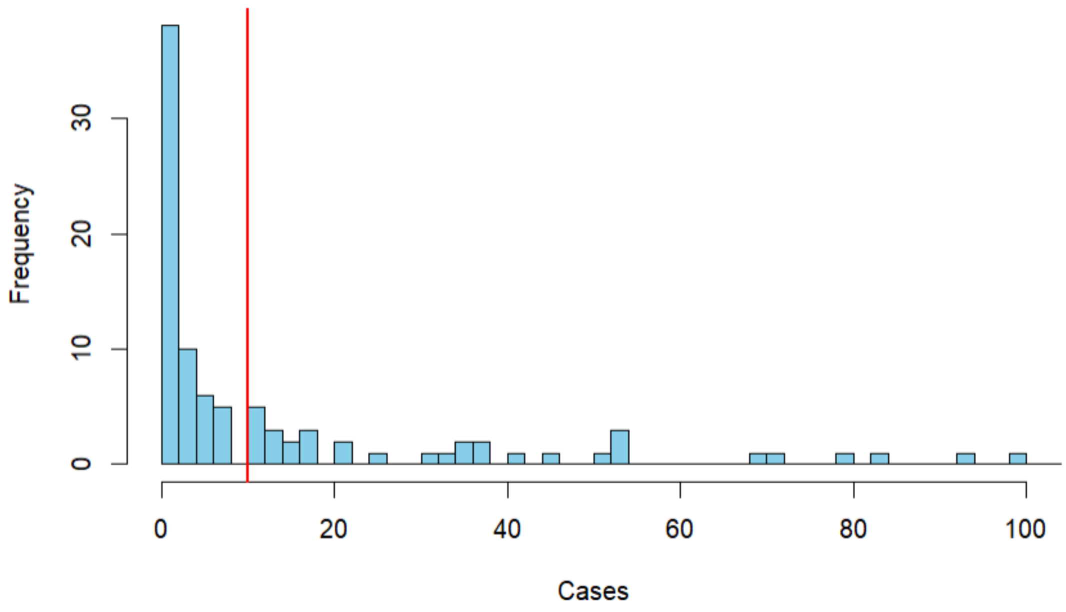


Figure 1: Cases confirmed in the first five days

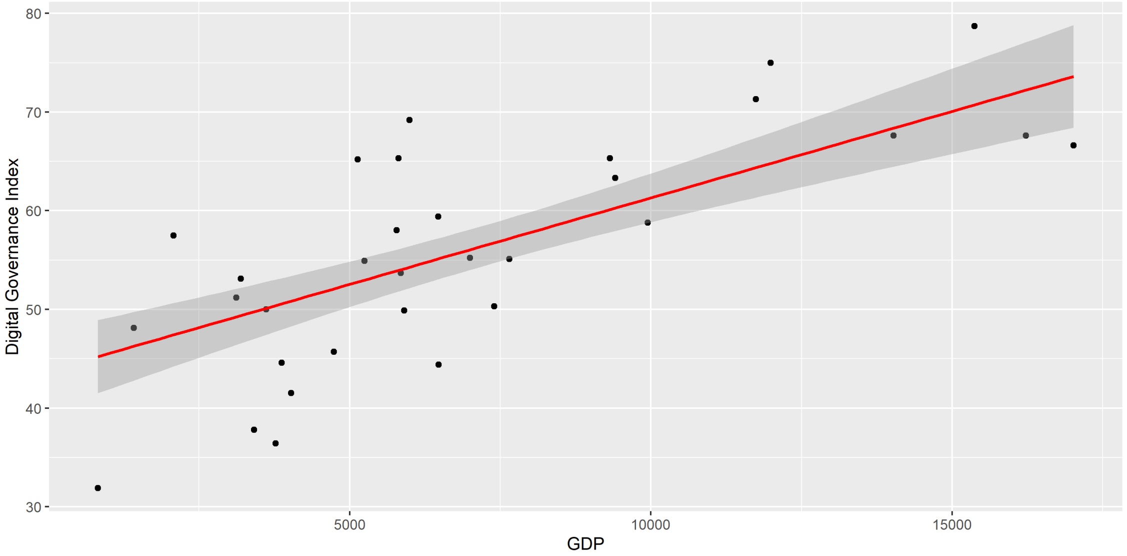
dummy variable that shows 0 if the total number of cases in the first five days is less than or equal to 10, and 1 otherwise. As shown in Figure 1, on the left side of the vertical red line whose value equals to 10, the distribution is very dense while on the right side the distribution is rather sporadic. It suggests that severe COVID-19 outbreaks can easily exceed 10 cases in five days while cases confirmed in mild ones often remain within 10 cases. Therefore, the classification turns out to differentiate mild outbreaks and severe ones quite well.

Variable	Description	Range
Lockdown(C8)	Full-scale lockdown	0-2
H1	Full scale testing	0-2
Mode	Mode of measures	0-5
Lockdown Delay	Days of lockdown after the last case	Numeric

Table 2: Alternative dependent Variables

In terms of independent variables, I use the digital government development index (DGD index) conducted by the Center on Data and Governance, Tsinghua University in

Figure 2: Linear relationship between GDP and DGD index



2020, as the proxy for the level of smart city. There is a considerable overlap between the goal of digital government and smart city, which both refer to the use of digital technologies to improve modern governance. Therefore, the development of digital governance can be interpreted as how smart city projects improve governance capacity through employment of digital technologies. In general, the DGD index estimates how local governments accustom accommodate the original bureaucratic system to the government digital transformation and how well local governments employ digital technologies to deal with public affairs and provide public services, which is close to the measurement of smart city. The DGD index altogether records the scores of 101 prefecture-level governments which include all the provincial capital cities and other top 80 cities by GDP in 2019.

I merge the DGD index into the existing data and manage to match 49 out of 97 governments. It suggests the other 48 governments without DGD indices are poorer than their counterparts. Omitting the remaining observations can cause severe selection-bias problem, so I come up with a strategy to mark the rest observations. As shown in Figure 2, this plot depicts the positive linear relationship between GDP and DGD index for the

49 observations with scores. Intuitively, this leads to the assumption that prefecture-level governments with lower GDP are generally supposed to have lower DGD indices. Besides, in the report, other than the DGD index, it also provides a categorical indicator signaling different levels of digital government development, ranging from 1 to 5. The higher value the variable has, the less developed the digital government is. Based on the findings above, the study categorizes the other 48 observations without DGD indices into the fifth category. Furthermore, I add several control variables to each observed city for better estimation, including GDP per capita, population, average medical resource (total and average numbers of hospitals, hospital beds and licensed doctors).

3.3 *Specification*

The main estimation framework is an OLS model and an ordered logistic regression model with the following specifications:

$$\text{Precision}_i = \boldsymbol{\beta}\text{Smart}_i + \mathbf{Z}_i\boldsymbol{\delta} + \boldsymbol{\epsilon}_i, \tag{1}$$

$$logit(P(\text{Precision}_i \leq j)) = \boldsymbol{\beta}_{j0} - \boldsymbol{\eta}\text{Smart}_i + \mathbf{Z}_i\boldsymbol{\delta} + \boldsymbol{\epsilon}_i, \tag{2}$$

where i indexes prefecture-level city. The dependent variable is the extent of policy precision measured by *Stringency*, *Mode*, *Lockdown*(C8) and *Lockdown Delay.* The OLS model applies to numerical variables, *Stringency Lockdown Delay*, while the ordered logistic regression model applies to ordinal variables, *Mode* and *Lockdown.* The key explanatory variable $Smart_i$ is the categorical score of each city. $\mathbf{Z}_i$ include a set of covariates for country i, including GDP per capita (gdpp$_i$), population (pop$_i$), the number of licensed doctors per 1,000 people (m_person$_i$), and the number of hospital beds per 1,000 people (m_bed$_i$).

4 Main Results

4.1 *Initial Results*

Table 3 presents the initial OLS and Logit results on the effect of smart city projects on the extent of policy precision. I uses *Stringency*, *Mode*, and *Lockdown*, *Lockdown Delay* as dependent variables respectively. I begin with the most parsimonious model that includes only the smart city indicator and then add the economic and medical controls in the next model. After controlling the economic and medical covariates, there is no statistically significant result in Model 2, 4, 6. Although the estimated coefficients of smart city are all positive, but they have too large standard errors. Model 8 suggests every increase in the smart city category leads to an average increase of 2.4 days in lockdown delay for the 58 prefecture-level governments that have ever conducted at least partial lockdown. The result is statistically significant and can deny the null hypothesis at 90%. Based on the initial result, the result is rather arbitrary and cannot reject the null hypothesis that smart city projects have no effect on the extent of policy precision.

Table 3: Initial Result

	Dependent variable:							
	Policy Mode		Lockdown		Stringency Index		Lockdown Delay	
	ordered logistic		*ordered logistic*		*OLS*		*OLS*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Smart	0.312**	0.113	0.484***	0.074	0.067***	0.044	1.869**	2.437*
	(0.140)	(0.246)	(0.161)	(0.269)	(0.020)	(0.036)	(0.845)	(1.270)
GDP per capita (log)		−0.456		−0.704		−0.056		0.465
		(0.500)		(0.526)		(0.071)		(2.282)
Population (log)		−0.155		−0.483		−0.031		0.951
		(0.331)		(0.357)		(0.052)		(1.631)
Beds per person		−0.379**		−0.437**		−0.044*		−0.177
		(0.158)		(0.172)		(0.023)		(0.752)
Docs per person		0.514		0.443		0.088		1.470
		(0.384)		(0.399)		(0.053)		(1.677)
Observations	97	97	97	97	97	97	56	56
R^2					0.102	0.148	0.083	0.101
Note:								*p<0.1; **p<0.05; ***p<0.01

However, this result needs to take heterogeneity effect into further consideration, especially for these three indicators, *Stringency*, *Mode*, and *Lockdown.* As discussed before, the severity of pandemic can affect governments' policy choices. When the COVID-19 outbreak is quite severe, even for those government with a high level of smart city construction, the risk of the spread of virus is too high to take any targeted measures. Governments can only resort to harsh measures to avoid blame for the failure to keeping the pandemic in control, despite how well the targeted system is established. In contrast, when the COVID-19 outbreak is relatively mild, the level of smart city can take effect, allowing governments to choose from the policy pools to decide which one can minimize political losses–the risk of spreading virus or the economic costs caused by full-scale lockdown. All the three variables *Stringency*, *Mode*, and *Lockdown* indicate policy choices made in the first-five-day period, which is sensitive to the severity of pandemic. On the other hand, the variable *Lockdown Delay* indicates policy choices after the pandemic is over, so it largely remains irrelevant to the severity of pandemic. Therefore, I further run the heterogeneity test to the first three variables.

4.2 Heterogeneity Effect

By setting the pandemic severity dummy variable, I split the data into two conditions: mild or severe pandemic outbreaks. Table 4 presents the heterogeneity results. Models with odd numbers refer to severe pandemic outbreaks while models with even numbers refer to mild outbreaks. The empirical evidence proves the previous hypothesis. On the one hand, Model 1/3/5 indicating severe pandemics produce no statistically significant result, which suggests that the fear of risk surpasses the confidence brought about by the improvement in governance capacity. Prefecture-level officials are still unwilling to take targeted measures against severe COVID-19 outbreaks even with high levels of smart city construction.

Table 4: Heterogeneity Effect

	Dependent variable:					
	Policy Mode		Lockdown		Stringency	
	ordered logistic		*ordered logistic*		*OLS*	
	(1)	(2)	(3)	(4)	(5)	(6)
Smart	0.096	0.939**	0.131	0.642	0.012	0.122**
	(0.443)	(0.426)	(0.460)	(0.500)	(0.038)	(0.053)
GDP per capita (log)	−0.788	0.056	−1.096	−0.533	−0.072	−0.006
	(0.776)	(0.759)	(0.854)	(0.802)	(0.071)	(0.106)
Population (log)	0.150	0.045	−0.320	−0.511	−0.037	0.008
	(0.532)	(0.523)	(0.562)	(0.561)	(0.049)	(0.083)
Beds per person	−0.448*	−0.227	−0.666**	−0.261	−0.032	−0.030
	(0.245)	(0.271)	(0.279)	(0.289)	(0.023)	(0.038)
Docs per person	0.046	0.348	−0.326	0.543	−0.021	0.102
	(0.616)	(0.573)	(0.684)	(0.582)	(0.055)	(0.077)
Observations	38	59	38	59	38	59
R^2					0.269	0.236
Note:				*p<0.1; **p<0.05; ***p<0.01		

On the other hand, focusing on Model 2 and 6, they suggest in mild COVID-19 outbreaks, there exist statistically significant relationship between the level of smart city construction and the extent of policy precision. In Model 2, the coefficient estimate suggests a positive relationship between the smart city and the extent of policy precision. All else equal, the less smart a prefecture-level government is, the harsher policy it is going to take. In Model 6, the coefficient estimate suggests every increase in the smart city category leads to an average increase of 0.122 point in the stringency index score, a quite huge number given the range. For three models, two out of three results are statistically significant and can deny the null hypothesis at 95%. The heterogeneity result verifies the discussion above that severe pandemic outbreaks leave prefecture-level governments with little choice but to resort to the harshest measures while under mild outbreaks, better smart city construction incentivize government heads to take more targeted measures, balancing the risk of virus spread and socio-economic costs.

Table 5: Final Result

	Dependent variable:			
	Policy Mode	Lockdown	Stringency	Lockdown Delay
	ordered logistic	*ordered logistic*	*OLS*	*OLS*
	(1)	(2)	(3)	(4)
Samrt	0.939**	0.642	0.122**	2.437*
	(0.426)	(0.500)	(0.053)	(1.270)
GDP per capita (log)	0.056	−0.533	−0.006	0.465
	(0.759)	(0.802)	(0.106)	(2.282)
Population (log)	0.045	−0.511	0.008	0.951
	(0.523)	(0.561)	(0.083)	(1.631)
Beds per person	−0.227	−0.261	−0.030	−0.177
	(0.271)	(0.289)	(0.038)	(0.752)
Docs per person	0.348	0.543	0.102	1.470
	(0.573)	(0.582)	(0.077)	(1.677)
Observations	59	59	59	56
R^2			0.236	0.101
Note:			*p<0.1; **p<0.05; ***p<0.01	

Finally, combining the initial result and heterogeneity result together, I form the final result in Figure 5. It shows that with a higher level of smart city construction, government heads are more likely to take targeted measures under mild COVID-19 outbreaks, while under severe COVID-19 outbreaks, smart city has no influence on government officials' decision-making. Besides, prefecture-level governments with a higher level of smart city construction tends to shorten the days of lockdown delay in spite of the severity of COVID-19 pandemics.

Arguably, the estimation still faces several defects. First, due to the data deficiency, I have to use ordinal indicators as the independent variable, which can cause inaccurate estimation of coefficients because the value of each category is not at equal interval. Second, whether the digital government development index is an appropriate proxy for smart city remains controversial in that the DGD index is more comprehensive. Future revision can use the amount of smart-city-related investment as the proxy for smart city projects, which can solve both data deficiency and inaccurate proxies.

5 Conclusion

By employing an original prefecture-level data on governments' response to pandemic outbreaks, this paper attempts to figure out what factors lead to the tremendous variation in governmental responses to COVID-19, entering the second phase of pandemic prevention and control. The result finds out that smart city projects increase the opportunity of prefecture-level governments to take more targeted measures against COVID-19 when the outbreak is relative mild (less than ten cases in the first five days). It also suggests that severe pandemic outbreaks almost leave government heads with little alternatives, which directly speaks to Chinese reality. The conclusion points out that the improvement of governance capacity doesn't necessarily lead to better performance by local governments. A static and strict national objective creates a blame-avoidance logic within the bureaucratic system, where leaders from every level administration are afraid of losses in their political careers. When the risk of failing some general goals, like the "dynamic zero-COVID policy", is relatively high, government heads will still have the prioritized incentive to minimize political losses instead of conducting policy innovations.

Besides, this study also needs to consider other alternative explanations, such as the role of informal ties within the Chinese bureaucratic system. Informal ties offer explanations to the variation in performance of officials from the same administration level. In terms of economic performance, informal institutions like patronage networks generate incentive-enhancing mechanism (Jiang, 2018). This perspective may also work in the domain of COVID-19 pandemic prevention and control. Prefecture-level officials with a close tie to provincial leaders may have a stronger incentive to implement more innovative policies as the tolerance and permission given to them can alter their cost-benefit analysis of their political careers. This explanation also speaks to the general central-local tensions. Besides, There are two directions this paper can make further improvement. First, I should spend more time completing the data, extending the observations to 2022 and all areas in mainland China. This will provide a clearer and fuller picture of China's overall efforts in COVID-19 prevention and control. Second, I should update the data on independent variables or add alternative indicators for a better estimation.

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