Policy Adoption and Diffusion during the COVID-19 Crisis

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Abstract

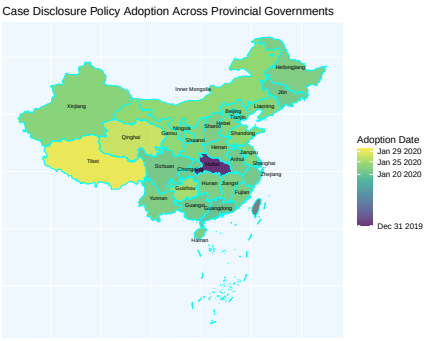
In the face of the COVID-19 crisis, what explains the variation in policy adoption choices among Chinese provincial governments? To answer this question, we gathered new adoption data on twenty-five policies used to contain COVID-19 in China from December 31, 2019, to March 18, 2020. We also conducted state-of-the-art multilevel pooled event history analysis to allow us to control for policy heterogeneity. Our results demonstrate that variation in policy adoption during the crisis largely follows politics as usual: policies diffuse from the center to the provinces in the same way that non-crisis policies diffuse. In addition, the characteristics of provincial leaders shape the pace of policy adoption. Our findings highlight the political dynamics of policy adoption and crisis response within China.

Keywords: policy diffusion; policy adoption; COVID-19; multilevel pooled event history analysis

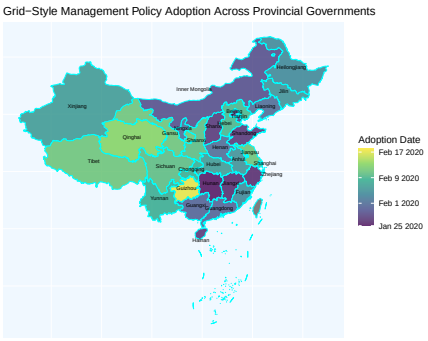
COVID-19 was first detected in Wuhan, Hubei Province, China in early December 2019, and it rapidly spread into a global pandemic. Initial efforts to cover up the outbreak in Wuhan later gave way to active and aggressive efforts to contain the spread and dampen the effects of COVID-19. While many policies were eventually widely adopted, provinces responded at different rates and in different ways (K. Zhou & Xin, 2021); however, not every policy was adopted widely or quickly. Among 25 policies aiming to control COVID-19, on average, each province adopted 22 policies between December 31, 2019, and March 18, 2020. Specifically, Hebei and Shaanxi adopted all 25 policies, Beijing and Shanghai adopted 22 policies, Zhejiang adopted 21, and Qinghai and Tibet adopted 17 and 16 policies, respectively.

Figure 1 displays the variation in policy adoption pace across regions for four sample policies. Hubei, the initial epicenter of the disease outbreak, started disclosing local case numbers on December 31, 2019. The central government then started disclosing the total number of national cases on January 20, 2020. By January 29, when Tibet started disclosing cases, all 31 provinces in Mainland China had adopted this measure in their jurisdictions – even though 29 provinces had fewer than 10 cumulative death cases as of March 17 (Figure 1a). The grid-style social management policy, a surveillance system to maintain public safety and social order, was also eventually adopted

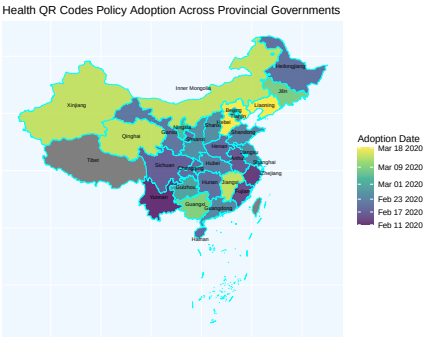
Figure1: Four Selected Policy Adoption by Provincial Government over Time



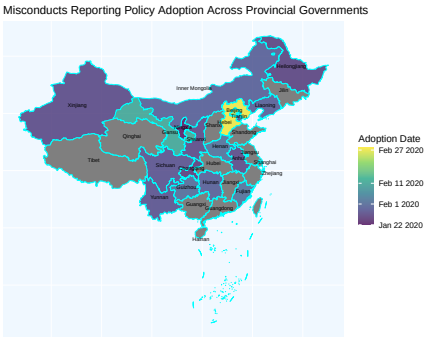
(a) Case Disclose Policy Adoption



(b) Grid Control Management Policy Adoption



(c) Health QR Codes Policy Adoption



(d) Misconduct Reporting Policy Adoption

Note: Figure 1 shows the pattern of policy adoption across regions for each of four sample policies: (a) case disclosure, (b) grid-style management, (c) health QR codes, and (d) misconduct reporting

by all provinces. The central government initiated this policy on January 24, 2020. One day later, on January 25, Hunan became the the earliest adopter despite having no COVID-19 deaths, while Guizhou, the last province to adopt, did not do so it until February 17 when it had only 1 death (Figure 1b). It is not a case that border regions were always slow adopters. Yunnan was one of initiators of health QR code policy, which requires individuals to obtain a QR code on their smartphone before they go to a public place (Shi et al., 2021). Twenty-nine regions ended up adopted this requirement, yet the central government did not endorse this policy until March 5 – after 21 provincial governments already required a QR code (Figure 1c). Ningxia, an autonomous region with zero deaths, adopted most policies after the central government's adoption, but it was the first one to provide a telephone number for the public to report local officials' misconduct on January 22. Ultimately, this policy was only adopted by 18 provinces, even though the central government endorsed the policy as early as January 24 (Figure 1d).

The variation in policy adoption is especially surprising during a crisis and in an authoritarian regime, where we might expect uniform and tightly controlled policy responses. This observed variation begs the question of why provinces made different policy decisions. During the Xi Jinping era, policy development in China is often characterized as top-down. However, in response

to COVID-19, the central government was relatively slow to guide provincial responses. Instead, provincial governments played a key role in developing responses and deciding which policies to adopt, despite the context of extreme uncertainty and high political and health risks within this policy-making. Recent scholarship has shown that provincial governments, as intermediary agents within China's political system, play a critical role in bringing local governments in line with central policy goals (Guo et al., 2022). We argue that understanding the political calculations in this unusual context is critical to explain the variation in policy adoptions.

We find that politics – central government intervention and regional leadership – are more important than the severity of local outbreaks to explain patterns of policy adoption. Using a novel multilevel pooled event history analysis (MPEHA) model, which specifically incorporates policy heterogeneity in adoption across units (Kreitzer & Boehmke, 2016), we draw upon an original dataset of 25 policies regarding transparency, public services, and social control during the COVID-19 pandemic. We focus on the first 79 days, when Chinese officials attempted to address a crisis characterized by uncertainty and high risk in both public health and politics. Our results demonstrate that the central government played a key role despite early signal delays; yet, the characteristics of regional leaders also determined the timing of policy adoption. The findings highlight

the policy variation that results from high uncertainty and inconsistent central government leadership, even in a relatively centralized country.

Our paper has three main contributions for scholars in and outside of China. First, understanding COVID response in China is important for public health reasons. China was the source of the COVID outbreak, and while it failed to prevent a pandemic, it did successfully contain the first wave faster than most other countries. The 25 policies on which we focus are those that well-known medical journals such as *The Lancet* identify as central to China's rapid and effective control of the pandemic (Burki, 2020). While these policies now appear successful in the aggregate, many were untested at the time, and the policies not uniformly adopted across the country. For those interested in public health crises, our research explains the role politics played in developing these responses and shaping their adoption.

Second, our findings highlight the similarities and differences between policy adoption during a crisis and policy adoption in "normal" policy-making. In normal times, need and public demand play a critical role in driving policy adoption. Logically, these same factors would seem critical to policy adoption in crisis response. However, we find that local outbreaks and local issue salience do not drive policy adoption in China; rather, it is political factors in the context of a national crisis.

We attribute this surprising conclusion to the political pressures surrounding crisis response. These lessons about the role of politics in inconsistent crisis response have potential to travel outside of the Chinese context during COVID-19.

Finally, our methodological approach moves diffusion studies forward by using a new multi-level pooled event history analysis (MPEHA) model to examine multiple policies at the same time. National and regional responses to COVID-19 have been studied widely and event history analysis (EHA) is a typical modelling approach applied in many studies. However, most studies either use data on a single policy or use pooled data without directly modelling policy heterogeneity (Adolph et al., 2021; Baccini & Brodeur, 2021; González-Bustamante, 2021). Our research highlights both the methodological and substantive benefits of using the MPEHA model in analyzing responses to COVID-19 that incorporate a mix of measures.

Why do we see variation in policy adoption?

Policy adoption in China follows a range of patterns due to the complex relationship between central and local governments. China is a unitary state, but the governing system is largely decentralized. Policy adoption often follows the fragmented authoritarianism framework (and version 2.0), which stresses the gaps in central control that create space for policy variation and interpreta-

tion (Lieberthal, 1997; Mertha, 2009). In general, the central government sets the goals and policy agenda, but it leaves the details of policy design to regional and local governments. As long as they conform with broad central government goals, regional governments are able to interpret central directives, create new policies, or selectively implement policies or aspects of policies such that the policies align central priorities and local conditions, capacities, or priorities. Regional and local governments may experiment, but they are still constrained by the larger system, where the central government can interfere quite directly on an ad hoc basis (Heilmann, 2008; Schubert & Alpermann, 2019). Therefore, this system thus results in diverse and even divergent regional policies under the broader umbrella of the centrally-defined policy goal.

When the central government wants more influence over regional policy, it can increase the likelihood of policy adoption by giving financial support rather than expecting regional governments to rely solely on local resources (Jiang & Zeng, 2020). The central government can also use the cadre management system, where promotion and demotion are tied to strict performance targets for regional officials (Edin, 2003; Gao, 2009; Landry, 2008). Although the inner workings of the system are not always clear (Wang, 2021), the cadre management system is meant to elevate officials based on merit and simultaneously encourage careful implementation of central

priorities. However, networks and connections also matter on the path to promotion. The system appears to foster 'merit-based patronage' in which officials who do not want to be demoted must maintain a minimum level of competency but also need the approval and support of their superiors in order to advance (Li & Gore, 2018). Under Xi Jinping, loyalty is particularly critical to cadre promotion (Teets et al., 2017). Indeed, while governance in China has seen a series of fluctuations between centralization and decentralization, the Xi Jinping era is largely characterized by 'top-level design,' i.e., more specific directives from Beijing with clearer control over the implementation process (Schubert & Alpermann, 2019). Clearly, the patterns of regional policy adoption reflect the structures and incentives inherent in the governing system. Policies that fit central government goals, that are explicitly supported by the central government, and that have already been widely adopted elsewhere are more likely to be adopted, but the cadre management system and fit of key personnel also matter. More specifically, previous research points to the key role of leaders in explaining variation in regional policy adoption.

Diffusion

The flexibility and adaptability inherent in the system also shape the pressure for policy diffusion in China. Policy diffusion is the adoption of a policy by one governing unit based on the policy

choices in another political unit (Gilardi, 2016). Horizontal diffusion is the spread of policies across units at the same level of government, such as provinces, while vertical diffusion generally refers to policies adopted at the center and then in regional units (Shipan & Volden, 2008). Policies diffuse as governing units (1) learn about the success or failure of a policy elsewhere, (2) adopt policies to ensure competitiveness with other government units, (3) are coerced by more powerful units and organizations to adopt, and (4) to emulate other political units (Gilardi & Wasserfallen, 2019).

In China, patterns of diffusion can be horizontal within or across provinces and vertical. Horizontal diffusion takes place when provinces learn from and/or emulate other higher performing regions (Y. Zhang & Zhu, 2019) or adopt policies to compete with peers (Zhu, 2014). Vertical diffusion in China can initiate at lower levels or in the central government (Teets, 2014). It is common for the central government to allow policies to be tried in the regions before adopting and promoting successful versions elsewhere. Once the central government does promote a policy, however, provincial governments typically follow (Teets & Hurst, 2015; Zhu & Zhang, 2019). Policies that are more specific, measurable, and have the clear support of the central government (e.g., one-child policy) are more likely to be adopted and fully implemented. Past studies have shown that pro-

motion by the central government has a strong influence on regional adoption (Y. Zhang & Zhu, 2019) and can eclipse the influence of peers and competitors (Y. Zhang & Zhu, 2020).

Leader connections

Political connections and networks among officials also play a role in policy implementation, whether in response to the central government or not. Provincial leaders who serve in their home province may be more effective and able to promote local initiatives based on their knowledge and experience (Zang, 1991). They tend to be more concerned about local issues, and they have well-built local networks that allow them to deviate from central policies when they conflict with provincial interests (Donaldson, 2009). Policy implementation in China often depends on informal institutions (e.g. lineage groups) and personal relationships (e.g. *guanxi*) (Huisheng, 2015; Oi, 1989); thus, leaders cultivate and value strong networks within their regions. Leaders who are more deeply embedded in their regional politics may be more successful at ignoring the central government and implementing their chosen policies.

Political networks can also lead to compliance, adoption of central priorities, and provide cover for ignoring local demands. For example, provincial leaders who simultaneously hold central positions, previously occupied central positions, or transferred from other provinces, are likely to

be more compliant with the center (Bo, 2002; Huang, 1996; Huang & Sheng, 2009). Patron-client relationships can motivate local officials to follow higher level policies closely (Dittmer, 1995) and help them gain access to scarce resources necessary for policy implementation (Shih, 2004). Strong networks among elites also provide officials cover when acting against vested interests in their region (Jiang & Zeng, 2020). Taken together, the embeddedness of local officials in their province and in government patronage networks can shape policy adoption, but in potentially conflicting ways.

Theory

Responding to a pandemic is potentially different from policy adoption in normal times due to the urgent and acute nature of the crisis. However, the general process of COVID-19 discovery and containment in China reflected politics as usual: initially risk adverse local officials covered up the outbreak but central government intervention quickly changed regional response and escalated the crisis to a top priority (Yang, 2021). We therefore derive our expectations of policy adoption during the COVID-19 crisis from observed trends in policy adoption during normal times. Those provinces that are most likely to be initial adopters in policies related to elder care, *hukou* regulations, or tax reforms are also those best positioned to take the lead in developing government

responses to COVID-19 or adopting policies when there is not yet clear political consensus. In this section, we explain five hypotheses that we derived from the existing literature on policy diffusion and adoption.

Local Need

First, we expect that local needs influence the likelihood that provincial authorities will adopt and develop response policies. In other policy contexts, the need to solve social problems efficiently drives innovation (Chen & Göbel, 2016). When it comes to policy diffusion and adopting policies that have been developed in other regions or even by the central government, responding to local need is paramount (Teets, 2014). COVID-19 spread across China in an uneven pattern and affected some provinces more swiftly and more dramatically than others, thus creating variation in local needs. We expect this variation in need to explain the variation in policy adoption. Regions with more severe outbreaks need different policy responses than those with only a low number of cases. In addition to responding to objective measures of outbreaks (e.g., the number of deaths), regional officials may respond to need local needs as perceived by the public. In other words, where regional publics are more aware and concerned about COVID-19, regional officials may feel they must respond to the concerns by adopting policies. In either form, we expect that local need drives

policy adoption.

Hypothesis 1 (**Local need**). *Provinces with greater local need are more likely to adopt policy responses.*

Diffusion

The central government in China typically provides guidance for provinces, and central government directives and goals shape provincial policies. During times of crisis and extreme uncertainty, following the central government's priorities may be the politically safe option, regardless of desire to alleviate the public health problems.

Hypothesis 2 (**Vertical diffusion**). *Provinces are more likely to adopt policies promoted by the central government.*

While horizontal diffusion patterns are generally inconsistent in China (Teets & Hurst, 2014; Y. Zhang & Zhu, 2019, 2020), previous studies have seen diffusion during previous public health crises (Adolph et al., 2021; Tai, Forthcoming). Crisis conditions differ from regular policy-making, as there is a need for rapid action with only limited information and, often, little guidance. The extreme uncertainty of the virus and political risk of missteps incentivizes conforming with peers, as copying neighbors provides political cover. In addition, adopting policies has the possibility

of successful containment of the virus, while waiting is unlikely to reduce the political and health risks of COVID-19 spread. We focus on diffusion from neighboring regions since COVID-19 is infectious spatially.Thus, we expect to observe regions adopting the same policies as their neighbors.

Hypothesis 3 (**Horizontal diffusion**). *As more neighboring regions adopt a policy, provinces are more likely to adopt that policy.*

Political Connections

The last set of hypotheses derive from the acknowledgement that bureaucratic politics plays a key role in policy adoption, even during a pandemic, and that political leadership matters. The use of the cadre management system during the Xi era has produced a notable shift in focus from strictly merit based evaluation to the inclusion of loyalty (Qiaoan & Teets, 2020). The bureaucratic evaluations focus on careful and exact policy implementation, leaving less room for leaders to deviate from official guidance. During times of uncertainty, officials may be even more reluctant to stand out or innovate because they fear punishment, particularly if their experiments prove unsuccessful.

We expect the degree of connection between officials to generate loyalty between central and

provincial officials. Since the central priority was to control the spread of COVID-19, we expect that the officials signal their loyalty by adopting centrally-approved COVID-19 control policies. While ties to the center are always important, we expect that the uncertainty of a public health crisis, the re-centralization of power, and the emphasis on loyalty observed during the Xi era will coalesce to reinforce the critical role connections play in policy adoption.

Hypothesis 4 (**Political ties**)**.** *Provinces where leaders have with closer ties to the central government are more likely to adopt policies.*

In addition to connections with the center, local networks are important. Longer leadership tenure can help build contacts, connections, and networks within the province, all of which help with effective policy development and implementation (Donaldson, 2009; Oi, 1989). We expect that leaders who have grown more deeply embedded in the province they govern are likely to be more independent from the center and develop solutions that are adapted to local conditions. A longer tenure may help cultivate access to local resources and more information about local conditions. In this case, the relationship between tenure and policy adoption is positive.

Hypothesis 5 (**Embeddedness**)**.** *Provinces where the leaders have a longer tenure are more likely to adopt policies.*

Alternatively, it is also possible that those who have just moved to the province are most eager to adopt policies in order to prove themselves to both their superiors and to the local population. In this case, adoption speed would decline with length of tenure. While ultimately we expect tenure to facilitate policy adoption, we acknowledge that the literature and logic support arguments for a positive or negative relationship between tenure and policy adoption.

Of course, balancing central and local relationships is complicated. Therefore, it is also possible that the relationship between tenure and adoption is nonlinear, as Zhu and Zhang (2016) found. If the willingness to adopt policy is high for those are new and the capacity is high for those with a long tenure, the relationship may form a U-shape. Alternatively, it is also possible that the relationship could form an inverted U-shape. Those who are new may not be integrated enough to implement new policies. Those who have been in the province for many years may be secure and therefore less responsive or perhaps know they will not be able to move up in rank regardless of what they do. Alternatively, mid-tenure officials who are embedded enough may be both capable of change and yet still ambitious enough to actively implement policy. We leave it to future research to thoroughly explore the reason behind various trends more thoroughly beyond our identification of the direction and the shape of the effect of leadership tenure on policy adoption.

A source of uncertainty in our expectations is the difference between the Chinese Communist Party and the government. Governors' primary responsibility is to promote local economic and social development and handle local affairs, while party secretaries' primary responsibility is personnel management and layout and planning (He & Kong, 2011). However, overlap often exists in personnel, and substantial interconnections occur among bureaucrats and offices serving both the party and government (X. Zhou et al., 2021). We therefore expect the logic motivating policy adoption and COVID-19 containment will hold for both types of officials.

It is worth noting here that our hypotheses are not exclusive. Rather, it seems likely that several factors together drive policy adoption. In addition, trends in policy adoption may vary by the type of policy. As our focus here is on the drivers of policy adoption in general, we test all of these hypotheses on a pooled policy data set, but hope to explore the differences among policy types in future research.

Empirical Approach

COVID-19 policies at the provincial level

The dependent variables of interest capture whether a provincial-level administrative division adopts a specific policy or policies on a given day. Our data set covers 30 divisions in Main-

land China including 21 provinces[1], four direct-administered municipalities, and five autonomous minority regions. We rely mainly on provincial governments' official WeChat accounts and other e-governance platforms such as government websites and official Weibo accounts to collect and date the adoption of COVID-19 policies.

We include 25 policies adopted to contain COVID-19 during a 79-day period from December 31, 2019, when Wuhan Municipal Health Commission reported a cluster of pneumonia cases in Wuhan, Hubei Province, to March 18, 2020, when the number of new daily COVID-19 cases was down to zero in Hubei province. Table 1 provides detailed descriptions of these policies.

For each policy, we code the dependent variable as 0 when a province had the potential to adopt a policy but did not. On the day when the provincial-level government announced the adoption of the policy, we code this variable as "1." We code the variable as 'missing' for subsequent days, as it is no longer at risk of adoption for this policy.

Key independent variables

We construct a set of key independent variables to test our hypotheses regarding the effects of local need, diffusion, and local leadership on policy adoption. Appendix A provides summary

[1]Hubei was excluded from analysis

Table 1: The Description of the Policies that Contain the Spread of COVID-19

	Policy	Description
1	Disclose no. of cases	Disclose the number of confirmed COVID-19 cases
2	Disclose case - breakdown	Disclose the number of confirmed COVID-19 cases in sub-regions
3	Disclose case - contact tracing	Trace contacts and disclose places visited by confirmed COVID-19 cases
4	Reporting local officials	Provide the telephone number that the public can call to report misconducts of local officials
5	COVID-19 information app	Introduce APP that provides disease control information
6	Online health counseling	Provide online healthcare counseling service
7	Remote psychological counseling	Provide psychological counseling service via internet or telephone
8	Clinics for fever screening	Designate a list of hospital clinics that are able to admit patients with fever
9	Hospitals for treatment	Designate a list of hospitals that are able to treat patients with COVID-19
10	Intervene intra-province public transportation (mild)	Introduce practices that slow down public transportation such as taking temperature on buses
11	Take temperature at ports	Take temperature at ports such as railway station, airports, etc.
12	Defer schooling	Delay the date of re-opening schools after the winter vacation
13	Defer work	Delay the date of going back to work after the Chinese New Year
14	Stop gathering	Prohibit gathering in public places
15	Reporting other citizens	Provide the telephone number that the public can call to report misconducts of other citizens
16	Mask mandate	Require wearing mask in public spaces
17	Introduce Health QR codes	Require individuals to obtain a health code on their smartphone before they go to a public place
18	Quarantine	Require people who come from other provinces to do quarantine at home or hotels for 14 days
19	Intervene intra-province public transportation (severe)	Introduce practices that shut down public transportation
20	Stop inter-province transportation	Stop inter-province transportation
21	Neighborhood lock-downs	Require residents to stay at home except for essential needs
22	Differentiated management	Implement different policies based on geographic regions with different levels of risk
23	Grid management	Grid-style social management - a surveillance system used to maintain public safety and social order
24	Online education	Introduce online platforms for schooling
25	Stop trading and selling wild animals	Stop trading and selling wild animals illegally

statistics and sources for the independent variables. To test hypothesis 1, we have two measures of local policy need. First, we measure the objective severity of COVID-19 with the number of cumulative confirmed deaths and the daily death toll (Hu et al., 2020). Second, we measure perceived need or demand for policy through a measure of public salience. We use Baidu Search Index's (BSI) record of searches for '新冠' (COVID-19) to scrape the provincial-level time series of the index between December 31, 2019, and March 18, 2020. As the province's distance to Wuhan may affect the risk of outbreaks, we include the distance between Wuhan and the target province. In addition, local officials may face more political pressure or be more concerned about

the crisis if they stand out from others in terms of outbreaks. We therefore include a variable that measures whether the regional number of confirmed COVID-19 deaths is larger than the national average. To test the horizontal influence (H3) on a focal province, we calculated the proportion of its directly adjacent provinces that have already adopted a policy (*proportion of adoption among neighboring provinces*) by the day before the focal province's adoption day (Parinandi, 2020). To measure vertical influence of the central government, we include a binary variable called *central intervention*. We code this variable as 1 for administrations that adopt a policy after the center adopted (issued or promoted) the policy; otherwise, we code this variable as 0.

Finally, to measure political connections, we use data about the experience of party secretaries and governors. To measure provincial leaders' tie with the central leaders (*connection to Xi*), we use the number of years that a provincial party secretary has worked with Xi Jinping. For embeddedness, we follow previous studies (J. Zhang & Gao, 2008; Zhu & Zhang, 2016) and create tenure in a province and tenure squared variables.

Control variables

First, we control for regional capacity. Governance is costly and challenging, and it requires a capable and effective bureaucracy that can implement the new policies. We use the economic output

per person (Log per capita GDP) to measure provincial capacity. We also control for other local conditions including unemployment and urbanization. Second, we control for administrative types, including regional minority autonomous status (1-0) and jurisdictions under direct control of the central government (1-0). Third, we follow other studies on COVID-19 and control for provincial health resources and conditions. We measure the number of hospitals per 1000 people and the hospital bed usage rate (Baccini & Brodeur, 2021; Toshkov et al., 2021). Following (Pacheco & Boushey, 2014), we measured the population at risk as the percentage of people over 65 years old.

To control for political leaders' personal characteristics, we measure leaders' sex, age, and education. For the sex variable, we only included it for governors, because in 2020 there were three female governors in Ningxia, Guizhou, and Inner Mongolia but no female party secretaries. Finally, in addition to local issue salience, we control for national issue salience using the same Baidu Search Index aggregated to the national level.

Estimating the models

We model COVID-19 policy with a multilevel pooled event history analysis (MPEHA) model that was introduced by Kreitzer and Boehmke (2016). Traditional pooled event history analysis (PEHA) is been widely used to study policy diffusion, with the advantage of finding consistent

patterns of diffusion over many policies in a single model (Boehmke, 2009; Makse & Volden, 2011; Shipan & Volden, 2006). However, PEHA has an assumption about homogeneity across policies, which is rarely observed in reality. Relying on this assumption may yield biased estimates of either standard errors or coefficients (Kreitzer & Boehmke, 2016). Although there are several strategies to capture various forms of heterogeneity in PEHA models, MPEHA outperforms alternatives in terms of accounting for heterogeneity in policies (Boehmke, 2009; Kreitzer & Boehmke, 2016).

MPEHA has not yet been used in Chinese studies for methodological reasons rather than theoretical reasons. Existing Chinese policy adoption studies focus on sub-provincial governments and one specific policy (Jiang & Zeng, 2020; Y. Zhang & Zhu, 2020; Zhu & Zhang, 2019), mainly because it is not common to observe variation in policy adoption at the provincial level in a political centralized country. However, the COVID-19 pandemic generated large numbers of different policies adopted across provinces in a short period of time. The 25 policies we study have the same aim to constrain the COVID-19 spread, but these policies focus on a wide range of issues from information release to lockdown to public supervision over governments. These policies are different on many dimensions, including but not limited to the central government's priorities, implemention complexity, technical requirements, and who is burdened by the policies. In order to

incorporate the heterogeneity across policies, we used both random intercept and random slope multilevel logit models. The model specification in latent-response for the random intercept logit model is as follows:

$$Y^*_{ipt} = \beta_{0p} + \sum_{j=1}^{J} \beta_{j0} * X_{jipt} + \varepsilon_{ipt} \tag{1}$$

$$\beta_{0p} = \beta_{00} + \mu_{0p} \tag{2}$$

where the latent continuous response Y^*_{ipt} indicating the propensity of whether province i adopted a policy p in day t. We allow each policy to have its own intercept through random effects for policies in equation 2. X_{jipt} represents our j independent variables. To address time dependency (Beck, 2010; Box-Steffensmeier & Jones, 2004), we include cubic splines of time to account for time dependency among adoption.

To explore policy heterogeneity further, we allow the effects of horizontal diffusion and vertical diffusion variables to differ across policies by using a random slope:

$$Y^*_{ipt} = \beta_{0p} + \beta_{1p} * VerticalPressure_{ipt-1} + \beta_{2p} * HorizontalPressure_{ipt-1} + \sum_{j=3}^{J} \beta_{j0} * X_{jipt} + \varepsilon_{ipt} \tag{3}$$

$$\beta_{0p} = \beta_{00} + \mu_{0p} \tag{4}$$

$$\beta_{1p} = \beta_{10} + \mu_{1p} \tag{5}$$

$$\beta_{2p} = \beta_{20} + \mu_{2p} \tag{6}$$

We choose this specification for three main reasons. First, the existing theories of policy diffusion suggest that policies with and without spillover effects may diffuse differently and therefore we decide to include a random coefficient for horizontal diffusion (Kreitzer & Boehmke, 2016). Second, the success of vertical diffusion may depend on policy complexity; thus, the impact of central intervention might be different across policies. Finally, though the impact of any of our independent variables can differ across policies, including all of them would be computationally impractical.

Empirical Results

Table 2 displays the results of one traditional PEHA model and two MPEHA models with random intercept and random slopes respectively. Model 1 is the traditional PEHA with clustered errors for provinceday to control for the dependency in adoption of multiple policies within provincedays (Makse & Volden, 2011). In Models 2 and 3, we take policy as the second level units. As shown in Table 2, the different results from the models demonstrate the heterogeneity in policies and supports the necessity of incorporating heterogeneity in models. Moreover, the MPEHA models outperformed the traditional PEHA model by having the smallest values for AIC and BIC, the tests for goodness of fit. We focus on the results from the MPEHA models in the following discussion.

First, we find no evidence for the local need hypothesis (H1) - regional pandemic severity does not affect the likelihood of a province adopting a policy. Policies are not more likely to be adopted when there is an outbreak or when cumulative death tolls are higher in the specific region. Local issue salience is also not significant, so neither subjective nor objective need drives policy adoption. Instead, provinces may adopt policies preemptively or in response to national level factors, as it was politically safer to be overzealous in containing infections (Huang et al., 2004). We suspect that political expedience shapes policy adoption during the first wave of COVID-19 was shaped by

Table 2: Multilevel Pooled EHA Estimates of Diffusion of 25 COVID-19 Policies

	Model 1 Logit Clustered	Model 2 MPEHA Random Intercept	Model 3 MPEHA Random Coefficient
Local Need			
No. of COVID-19 deaths	1.486	1.209	1.475
	(4.872)	(4.996)	(5.012)
No. of cumulative COVID-19 deaths	0.473	0.515	0.611
	(0.361)	(0.322)	(0.335)
Local concerns abt COVID-19	-0.058	-0.033	0.065
	(0.349)	(0.306)	(0.310)
Inverse distance to Wuhan	-10.464	31.907	39.607
	(100.598)	(92.705)	(95.133)
Fear of local officials	-0.672	-0.620	-0.587
	(0.606)	(0.624)	(0.626)
Diffusion			
Central intervention	0.747***	0.835***	0.803**
	(0.100)	(0.197)	(0.260)
Proportion of adoption among neighboring provinces	1.571***	0.517*	0.299
	(0.217)	(0.252)	(0.365)
Political Connections			
Governor's connection to Xi	-0.008	-0.019	-0.024
	(0.092)	(0.086)	(0.087)
Secretary's connection to Xi	-0.026	-0.024	-0.009
	(0.027)	(0.023)	(0.024)
Governor's tenure	-0.152	-0.201*	-0.192*
	(0.085)	(0.083)	(0.086)
Governor's tenure squared	0.004	0.005*	0.005*
	(0.002)	(0.002)	(0.002)
Secretary's tenure	0.053	0.086	0.062
	(0.067)	(0.061)	(0.062)
Secretary's tenure squared	-0.002	-0.003	-0.002
	(0.002)	(0.001)	(0.002)
Controls			
Log GDP per capita	1.059	1.076	1.208*
	(0.629)	(0.583)	(0.591)
Other local conditions	✓	✓	✓
Administrative type	✓	✓	✓
Hospital resource	✓	✓	✓
Local leaders' demographic information	✓	✓	✓
National issue salience	✓	✓	✓
Time dependence	✓	✓	✓
Constant	-10.677	-7.525	-7.659
	(7.095)	(7.495)	(7.722)
var(Constant)		0.641*	0.921*
		(0.260)	(0.446)
var(Proportion of adoption among neighboring provinces)		1.391*	
			(0.661)
var(Central intervention)			0.226
			(0.332)
Observations	8458	8458	8458
χ^2	309.93	119.25	105.38
AIC	2990.66	2932.62	2909.99
BIC	3208.99	3157.99	3149.45

Note:MPEHA = Multi level pooled event history analysis
Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

political expedience, as the subsequent hypothesis tests demonstrate.

Next, we find strong evidence for the vertical diffusion hypothesis (H2) and partial support for the horizontal diffusion hypothesis (H3). Central government endorsement is a strong predictor of policy adoption. The estimated fixed coefficient for central intervention is positive and significant across all models, which indicates that the central government's initiative or endorsement increases the odds that a region will adopt a policy. Specifically, according to the results of our MPEHA models, the odds of policy adoption are around 1.3 times higher if the central government intervenes. Moreover, the effect of central intervention does not vary significantly across policies, which suggests that provinces consistently follow the guidance of the central government. The strong vertical effect is not surprising given the feature of the Xi Jinping era was characterized by 'top-level design' (Schubert & Alpermann, 2019), but still interesting given the apparent lack of central leadership during the first weeks of the pandemic.

Our evidence partially supports the horizontal diffusion hypothesis. The impact of neighbor adoption is inconsistent across policies. This result implies that regional governments do not always follow their neighboring governments' behaviors. Though this finding does not clearly support our hypothesis, it is consistent with the mixed results about neighbor effects from previous

studies on a single policy (Tai, Forthcoming; Y. Zhang & Zhu, 2019).

Finally, we turn to leaders' political connections. Provincial leaders' ties to the central government do not matter for the adoption of policy, which contradicts the political ties hypothesis (H4). We know that political ties tend to play a role when there is a conflict exists between local interests and the policies promoted by the center (Jiang & Zeng, 2020). However, given high infection rates and the death toll in Wuhan combined with the unpredictable consequences of a COVID-19 outbreak in their own provinces, provincial leaders likely did not face strong local opposition on policy adoption.

Consistent with the embeddedness hypothesis (H5), the significant coefficients of tenure and tenure squared indicate a non-linear relationship between provincial leaders' embeddedness and the likelihood of policy adoption. However, the relationship between tenure and policy adoption is inconsistent across leadership posts. Specifically, the provincial governors' tenure has a U-shaped impact – governors are most likely to adopt policies very early in their tenure. From this point, the probability of adoption decreases until a provincial governor has governed a province for more than 19 years, after which the probability increases with tenure. In contrast, tenure is not relevant for party secretaries in policy adoption. This suggests that provincial governors and party secretaries

might have different considerations when deciding to adopt a policy, possibly because of their distinctive responsibilities or levels of influence in the governing hierarchy. Moreover, given Xi Jinping's focus on loyalty and faithful execution of party policies and degree of control over the party, it is perhaps unsurprising that the behavior of party secretaries does not vary with tenure.

Conclusion

To summarize our results, we do not find empirical evidence that the local severity of the pandemic increases the likelihood of a province adopting a policy measure. Rather, our findings provide strong support for our hypothesis that vertical pressure from the central government significantly increases the probability of adopting most policies during the pandemic in China. In contrast, horizontal diffusion only exists for some policies. Although we do not find any evidence that provincial leaders with closer ties to the central government adopt policies sooner, our findings show that governors' local embeddedness has a significant and nonlinear effect on policy adoption.

This article demonstrates the usefulness of MPEHA models to explore the adoption of multiple heterogeneous policies. To our knowledge, this is the first time MPEHA has been employed in the Chinese context, as most studies on policy adoption in China focus on only one policy at a time (Jiang & Zeng, 2020; Zhu & Zhang, 2019). Modeling policies with the same goal as multilevel

structures allows us to incorporate heterogeneity more efficiently and produce better estimates.

Substantively, we highlight two key lessons about China's policy-making and crisis response during COVID-19. First, political relationships among jurisdictions are crucial to explaining policy adoption, even during times of public health crises. While policy development under Xi Jinping is increasingly seen as top-down, our paper demonstrates the nuanced relationships between provinces and the central government. The central government's initiative and endorsement of a COVID-19 policy significantly increases the possibility of that policy being adopted at the province level. Importantly, the influence of central support is not just personal; provincial leaders' political ties to Xi Jingping do not affect for COVID-19 policy adoption.

Second, we highlight the importance of personal networks for provincial leaders. Our study further shows that the provincial leaders' ability and willingness to develop policies depends on their ties to the region, albeit in complicated ways. Newly appointed and deeply embedded governors are likely to adopt policies quickly while party secretaries' embeddedness does not influence adoptions of those same policies. These results deserve further study about the differences in roles and pressures shaping the actions of the party and the government leaders in regional policy adoption and the relative influence of these two positions during a public health crisis or policy adoption

more generally.

In response to the COVID-19 pandemic, Chinese provinces adapted to the crisis with a broad array of policies and pronouncements. Our research suggests that political structures are key to explaining the variation in these policy adoptions among region. Our clear evidence that the severity of the public health crisis at the regional level did not matter is surprising; yet, it speaks to the political nature of the crisis. Policy making in China is complicated thanks to the sheer number of actors, interests, and relationships involved, and it is generally seen as fragmented and inconsistent. While leadership under Xi Jinping has become more centralized and in the case of COVID-19, the central government was relatively slow to guide response and push forward specific policies to address the spread of the virus, the central government does have significant influence once they choose to support a policy. The ability of Chinese provincial governments to act quickly and develop context-appropriate responses illuminates the complex relationship between central and local governments. In several cases, regional governments acted first, but consistent and wide spread policy adoption primarily followed the center. These results highlight the challenges of designing and implementing policy in the world's most populous country and demonstrate the complex dynamics of leadership and inter-government relations within China.

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Appendix A: Summary Statistics and Sources of Independent Variables and Controls

Variable	Mean	Std.Dev.	Min	Max	Source
No. of daily deaths (in 10)	0.01	0.03	0.00	0.30	China COVID-19 Daily Cases with Basemap
No. of cumulative deaths (in 10)	0.23	0.37	0.00	2.20	China COVID-19 Daily Cases with Basemap
Local concerns about COVID-19	5.99	0.69	4.04	7.63	Baidu Searching Index
Fear of local officials	0.06	0.24	0.00	1.00	Authors' calculation
Inverse distance to Wuhan	0.001	0.001	0	0.004	Authors' calculation
Central intervention	0.66	0.48	0.00	1.00	Authors' calculation
Proportion of adoption among neighboring provinces	0.72	0.35	0.00	1.00	Authors' calculation
Governors' connection to Xi Jinping	0.30	1.13	0.00	5.00	Governments' Official Websites
Party Secretaries' connection to Xi Jinping	2.30	4.71	0.00	19.00	Governments' Official Websites
Governors' tenure	8.40	11.19	1.00	38.00	Governments' Official Websites
Party Secretaries' tenure	7.07	9.13	1.00	38.00	Governments' Official Websites
Log GDP per capita	11.05	0.40	10.40	12.01	China Statistic Yearbook 2020
Unemployment rate	3.13	0.57	1.40	3.99	China Statistic Yearbook 2020
Proportion of Urbanization	0.60	0.12	0.30	0.88	China Statistic Yearbook 2020
% of Senior population (over 65 years)	11.42	2.31	7.16	15.16	China Statistic Yearbook 2020
Minority autonomous region	0.17	0.37	0.00	1.00	China Statistic Yearbook 2020
Municipality	0.13	0.34	0.00	1.00	China Statistic Yearbook 2020
Number of hospitals/clinics (in 1000)	32.03	22.93	4.45	85.09	China Statistic Yearbook 2020
Utilization rate of hospital beds	82.77	4.89	73.20	95.90	China Statistic Yearbook 2020
Female governor	0.10	0.30	0.00	1.00	*Governments' Official Websites
Governors' education	2.50	0.56	1.00	3.00	Chinese Political Elite Database (CPED)
Governors' age	59.60	3.00	56.00	67.00	Chinese Political Elite Database (CPED)
Party Secretaries' education	2.13	0.72	1.00	3.00	Chinese Political Elite Database (CPED)
Party Secretaries' age	63.43	1.99	58.00	66.00	Chinese Political Elite Database (CPED)
National issue salience (log)	8.89	0.37	8.18	9.58	Baidu Searching Index
Time	28.84	16.89	1	79	-

Note: The summary statistics are based on the data of all provinces except Hubei.
We measure provincial leaders' tie with Xi by calculating the number of years they used to work with Xi Jinping.
We do not include gender as there are no female party secretaries in China.