Government Management Capacities and the Containment of COVID-19: A Repeated Cross-Sectional Study Across Chinese Cities

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Contributors and Sources
Wenchao Li, Jing Li, and Junjian Yi designed and performed the research, analyzed the data, and wrote the paper. All authors equally contributed to this research paper.

Conflicts of Interest
We have read and understood BMJ policy on declaration of interests and have none to declare.

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Abstract

Objectives: Better understanding of the dynamics of the COVID-19 (2019-novel coronavirus disease) pandemic to curb its spread is now a global imperative. While travel restrictions and control measures have been shown to limit the spread of the disease spread, the effectiveness of the enforcement of those measures should depend on the strength of the government. Whether, and how, the government plays a role in fighting the disease, however, has not been investigated. Here, we show that government management capacities are critical for the containment of the disease.

Setting: We conduct a statistical analysis based on cross-city comparisons within China. China has undergone almost the entire cycle of the anti-coronavirus campaign, which allows us to trace the full dynamics of the outbreak, with homogeneity in standards for statistics recording.

Participants: Not available.

Primary and secondary outcome measures: Outcome measures include city-specific COVID-19 case incidence and recoveries in China.

Results: The containment of COVID-19 depends on the effectiveness of the enforcement of control measures, which in turn depends on the local government's management capacities. Specifically, government efficiency, capacity for law enforcement, and the transparency of laws and policies significantly reduce COVID-19 prevalence and increase the likelihood of recoveries. The organization size of the government, which is not closely related to its capacity for management, has a limited role.

Trial registration: Not available.

Article Summary

The strengths and limitations of this study are as follows:

- We are among the first to examine the role of government management capacities in the containment of COVID-19.
- We conduct a repeated cross-sectional study in China, which ensures consistency in standards for statistics recording and homogeneity in institutional features.
- We are able to trace the full dynamics of the outbreak in the setting of Chinese cities.
- The specific measures of government management capacities may not be readily comparable to cities in other countries.
- The restrictive governmental disease control practices may also not be readily applicable to other countries.

Introduction

COVID-19 outbreaks have raced around the world and have exploded into a pandemic. About 47.3 million infections have been confirmed in more than 200 countries and territories. It has become a global imperative to better understand the dynamics of this pandemic in order to limit its ongoing spread.

China, which was the first country exposed to the coronavirus, has almost completed the full cycle of the anti-coronavirus campaign. Since mid- March 2020, daily new cases in China have been reduced to near-zero levels (Figure 1). This result is substantially attributed to the strict travel restrictions and containment measures—such as suspending public transport, closing entertainment venues, and banning public gatherings—implemented by Chinese authorities (1–5). The World Health Organization has repeatedly praised China for its effective response to the COVID-19 outbreak.

Yet China's response is not free of controversy—in particular, whether the government, and the measures it has taken, have succeeded in fighting the disease. For instance, skeptics point out that other places, such as Singapore, imposed similar containment measures but still experienced an enormous outbreak (6, 7).

The effectiveness of the enforcement of control measures should depend on the strength of the government, as indicated by the notion of state capacity. State capacity is shown to be crucial for economic development and technological change (8, 9). The rapid economic growth in East Asian economies, in particular, can largely be accounted for by states with a great deal of capacity (8). During this pandemic, heated discussions have centered on responses by different countries, which are said to "reveal the need for a strong state" (10). The discussions echo the notion of state capacity, or government management capacity. Anecdotal evidence indicates that within China there are fewer COVID-19 cases in cities that implemented control measures more preemptively (1), which highlights the importance of the management capacity of local governments for containing the disease.

Whether, and how, the government plays a role in fighting the disease, however, has not been formally investigated. In this paper, we show that government management capacities are critical for the containment of the disease by conducting a statistical analysis based on cross-city comparisons within China. Because China has undergone almost the entire cycle of the anti-coronavirus campaign, we can trace the full dynamics of the outbreak while being consistent in standards for statistics recording. We find that better government management—as measured by government efficiency, capacity for law enforcement, transparency of laws and policies, and an aggregate management index—is significantly associated with both reductions in case incidence and increases in recoveries. Government organization size, in comparison, has an insignificant effect.

These findings demonstrate the important role of government in controlling COVID-19 and, thereby, help political leaders and health authorities around the world better understand the dynamics of the pandemic. They also contribute to discussions of the need for strong states as revealed by the pandemic (10).

Government management capacity

In epidemiology, compartmental models suggest that the implementation of effective public health measures lowers the infection rate and reduces the case incidence (11, 12). The implementation of public health measures, in turn, is related to the notion of state capacity—or, more specifically, government management capacity—in economics (8, 9). To examine the role of state capacity in the containment of COVID-19 in China, we draw a spectrum of measures from the 2019 Global Urban Competitiveness Yearbook:

(i) Government efficiency measures administrative procedures and time lags in the local government's functions.

(ii) Capacity for law enforcement measures the local government's ability to enforce the rule of law.

(iii) Transparency of laws and policies measures how well laws and policies stipulated by the local government are known to citizens.

(iv) Government organization size refers to the number of employees in government agencies and organizations as a percentage of total population.

(v) An aggregate government management index measures the overall management level and public policy environment of a city.

The four sub-indicators and the aggregate index are closely related to the management capacity of local governments. All of them are on a 10–100 scale. A large value indicates better management of the local government. (See Supplementary File 1 for details about the construction of these measures.)

The study design

Our study design is based on three unique contextual features. First, as noted earlier, China is in the final stage of the COVID-19 outbreak, which allows us to trace the full dynamics of the outbreak. Second, a within-country analysis ensures homogeneity in the national response, institutional background, and, more important, standards for COVID-19 statistics recording. Third, China banned travel to and from Wuhan city—the epicenter of the outbreak—on January 23, 2020. The ban impeded the growth and limited the size of the epidemic elsewhere in the country and, as a result, allowed local governments to undertake effective control measures (5).

Specifically, we conduct a statistical analysis in which we exploit variations in a spectrum of city-specific government management capability measures and examine how those variations are linked to variations in the effectiveness of COVID-19 control. According to the Ministry of Civil Affairs, there are 333 prefecture-level cities in China, which include prefectures, municipalities, provincial county-level cities, and sub-provincial cities (special administrative regions, Hong Kong and Macau, and Taiwan are excluded). We include 332 in our sample and exclude the epicenter, Wuhan city. The sample spans a period of 3 months, from January to late March. This period immediately followed the Wuhan lockdown when local governments began to implement various measures to curb the further spread of infections (1). We use ordinary least squares regressions to examine the effects of government management in different phases of the outbreak, on a weekly basis. We carried out the statistical analysis using Stata 16.

In the regression models, outcome variables are the number of new cases and the number of new recoveries in a city. Those numbers have been recorded daily by the National Health Commission of China since January 2020, which we aggregate into weekly data. Recovery rate, defined as cumulative total recoveries over the cumulative number of closed cases (recoveries plus deaths), has been more than 95 percent.

Explanatory variables include a set of city-specific, time-invariant determinants of the spread and control of COVID-19. We are particularly interested in the above-mentioned government management capability measures. We also examine other important determinants: population age structure, connection with Wuhan, and the local health system's capacity. Data on population age structure (elderly, children, and working-age population as a percentage of total population) are from the 2015 China population mini-census. Based on an index of the size of daily population flow that proxies for the total intensity of migration out of Wuhan to other cities (provided by Baidu Migration), we construct a variable by calculating the average of the migration index over 14 days before the lockdown of Wuhan. We also consider the share of Wuhan-origin residents in the city, using data from the census. Health system capacity is proxied by the total number of hospital beds in the city and the total number of hospital employees, based on data from the 2019 China City Statistical Yearbook. (See Extended Data Table 1 in Supplementary File 1 for definitions and summary statistics of these variables.)

Patient and public involvement

This research has no patient involved.

Results

Figure 2 displays the estimated coefficients on the key determinants from regressions of the number of new cases (in panel A) and new recoveries (in panel B) in a week at the city level. Orange vertical bars are 90 percent confidence intervals. For example, the first bar in each plot of panel A regresses the number of cases for the week ending January 28 on city-level factors. The second bar regresses the number of cases for the week ending February 4 on the same city-level factors, and so on. Additional control variables include the share of Wuhan-origin residents, total population, employment rate, percentage of population with a college degree, and an indicator variable for municipality. For recoveries, regressions also control for the number of closed cases in that week. Conditional on those variables, estimated coefficients from the regressions reflect the effects of the determining factors of our interest during the coronavirus outbreak.

Population age structure: As the first column of Figure 2 shows, the proportion of people age 65 and above is closely related to the morbidity and mortality of COVID-19, especially in the initial phase of the outbreak. Specifically, a larger share of the elderly in the local population is associated with more confirmed cases and fewer recoveries. This is in line with our expectation that the elderly have higher COVID-19 infection and death rates, and more elderly predict a larger chance of infection among high-risk populations. In panel A, the small negative effects at the tail of the curve are in line with the interpretation that the elderly realize that they are particularly vulnerable, and therefore pay closer attention to protecting themselves from the virus. (See Tables S1-1 to S1-10 in Supplementary File 2 for regression results.) We also verify that normalizing the aggregate variables—such as the number of new cases, the number of new recoveries, and the number of hospital beds—by city-level population size yields similar patterns of results, as shown in Extended Data Figure 1 in Supplementary File 1.

In comparison, the share of children (age 0-15) does not have a clear relationship with the spread of the virus; the share of the working-age population (age 16-55) is negatively associated with the number of new cases and positively associated with the number of recoveries, as expected. (See Extended Data Figure 2 in Supplementary File 1 and Tables S2-1 to S2-10 in Supplementary File 2).

Connection with the epicenter: The second column of Figure 2 indicates that a connection with Wuhan is a crucial determining factor. A larger index of population flow from Wuhan to a destination city is associated with more infected cases and fewer recoveries. This finding corresponds with the interpretation that population flow out of the epicenter of the outbreak increases the likelihood that people who are infected will come into contact with people who are not. We observe that the effects on new cases vanish at the end of February, while the effects on recoveries appear strong across different stages of the outbreak and last to mid-March.

Health system capacity: The third column of Figure 2 shows that during early phases of the outbreak, health system capacity—as proxied by the total number of hospital beds—is negatively associated with the number of new cases and positively associated with the number of recoveries. A local health system's capacity to effectively admit those who are already infected is crucial for reducing transmission among residents, and the capacity to respond to the needs of the infected, who often require admission to an intensive care unit, is vital for increasing the chance of recovery.

During later phases of the outbreak, however, the effects of health system capacity become insignificant. At the end of March, the effects on new cases turn positive, which is partly because of China's patient-reallocation strategy: the central government transferred some patients from cities where local health systems were overwhelmed to nearby cities with greater availability of medical resources (13). However, this move may result in more coronavirus transmission in destination cities. (Using the number of hospital employees as a proxy for health system capacity yields similar conclusions; see Extended Data Figure 2 in Supplementary File 1 and Tables S2-1 to S2-10 in Supplementary File 2.)

Government management index: The last column of Figure 2 shows that the government management index is an important determining factor of the spread and control of COVID-19. Better government management is significantly associated with reductions in case incidence, with the largest effect observed from early through mid-February, when the outbreak was at its peak. This pattern is similar to the effects of local health system capacity shown in the third column of panel A. The small positive effect at the end of March can also be attributed to the patient-reallocation strategy, whereby patients tend to be transferred to cities with better government management.

In addition, better government management is associated with increases in the weekly number of recoveries conditional on the number of closed cases, as panel B shows. The effects appear to be the largest in mid-February, and are stronger and longer lasting than the effects of health system capacity. We further divide the cities into subgroups based on four criteria and conduct a series of subgroup analyses. We discuss the results in Supplementary File 1 under the “Subgroup Analysis” section (See Extended Data Figures 3-6 in Supplementary File 1 for results).

While governments with better functions, such as higher governmental efficiency and transparency of laws, can implement better disease control measures and, thereby, reduce new cases and increase recovery cases, there may exist the other pathway of the effects. For instance, it is possible that governments with a higher transparency are more accurate in releasing case numbers, which might lead to a larger number of new cases and a smaller number of recovery cases. This possibility, however, does not substantially affect the interpretation of our results. The other pathway of the effects implies that the values of the outcome variables contain nonrandom measurement errors, which would give rise to a downward bias in the estimations. Therefore, the effect we have identified in the statistical analysis at least represents a lower bound of the true effect of government management capacities on the disease control, which applies to both new and recovery cases.

To gain a more comprehensive understanding of the government’s role in curbing the coronavirus outbreak, we further regress the number of new cases and recoveries on a weekly basis on the four sub-indicators of government management capabilities separately, plus a range of control variables.

Figure 3 displays the estimated coefficients on the sub-indicators and the confidence intervals. We find that government efficiency, capacity for law enforcement, and transparency of laws and policies exhibit similar patterns of effects as the aggregate index: They are negatively related to the number of new cases and positively related to the number of new recoveries. The effects of government organization size, in comparison, are insignificant on both new infections and new recoveries. (See Tables S3-1 to S3-10 in Supplementary File 2 for regression results.)

For regressions of new cases, the R-squareds range from 0.1 to 0.6, showing a reasonably good goodness of fit. For regressions of new recoveries, the R-squareds are high because we control for the number of closed cases (recoveries plus deaths) in the week. Especially toward the end of the period, there were fewer deaths, and the number of recoveries was very close to the number of closed cases, which lead to high R-squareds.

Discussion

The patterns documented demonstrate that, in addition to demographic controls, the containment of COVID-19 critically depends on the effectiveness of the enforcement of control measures designed for this purpose, which in turn depends on the local government's management capacities. Specifically, government efficiency determines the local government's competence in implementing containment measures; capacity for law enforcement determines how well the government can strengthen and effectively enforce containment measures; the transparency of laws and policies determines how interim measures are understood, supported, and cooperated with by citizens. Therefore, they significantly reduce COVID-19 prevalence and increase the likelihood of recoveries. The organization size of the government, which is not closely related to its capacity for management, has a limited role.

In addition, our results show that new recovery rates, which have a positive association with health system capabilities, also have a positive association with government management capacities. This is possibly because health system capabilities heavily depend on governmental functions, especially in China, where a large share of healthcare sectors are managed—and at least partly owned—by the government. Therefore, government management capacity would have an impact on the efficiency and effectiveness of healthcare and medical resource allocations, which in turn determine the treatment outcomes for infected patients. Indeed, we have seen from Figure 2 that the graphical patterns of the effects of the proxy for health system capacity (the number of hospital beds) and the proxy for government management capability (the government management index) appear similar.

We now discuss the potential methodological limitations of our study. First, our study is based on observational data instead of experimental data. Unobservable heterogeneity across cities in, for example, hygiene and nutrition, is likely to be correlated with the capacity of the local government and, at the same time, has an impact on the containment of the disease. As a result, it is difficult to directly obtain rigorous causal inference from the regression analysis. Second, our findings are based on a repeated cross-sectional study across Chinese cities, which may lack external validity because of the potential differences across countries in terms of institutions and legal systems. Third, although we have provided some plausible explanations, we cannot identify the exact mechanisms through which government effectiveness plays a role in the containment of the disease—for instance, whether public health measures or restrictions of mobility are more critical. Last, while our study has shown that governments with higher management capacities could impose effective containment measures to reduce COVID-19 prevalence, it keeps silent on whether the measures are cost effective. A further cost-benefit analysis might be needed to provide better policy suggestions.

Conclusion

We have discussed, and formally investigated, the role of government in the containment of COVID-19, based on cross-city comparisons within China. We show that government management capacities are vital for controlling the disease.

Our analysis neither speaks to the feasibility of specific containment measures—whether they can be replicated outside China—nor to the suitability—whether they are violations of human rights (14). With that caveat, our analysis shows that government management capacities are strongly associated with the containment of COVID-19. This study could help political leaders and health authorities around the world better understand government's role in controlling the outbreak. In particular, governments that are slow and inefficient in response to the outbreak may contribute to its continuing spread worldwide (10). This could have important implications for future epidemics and public health emergencies.

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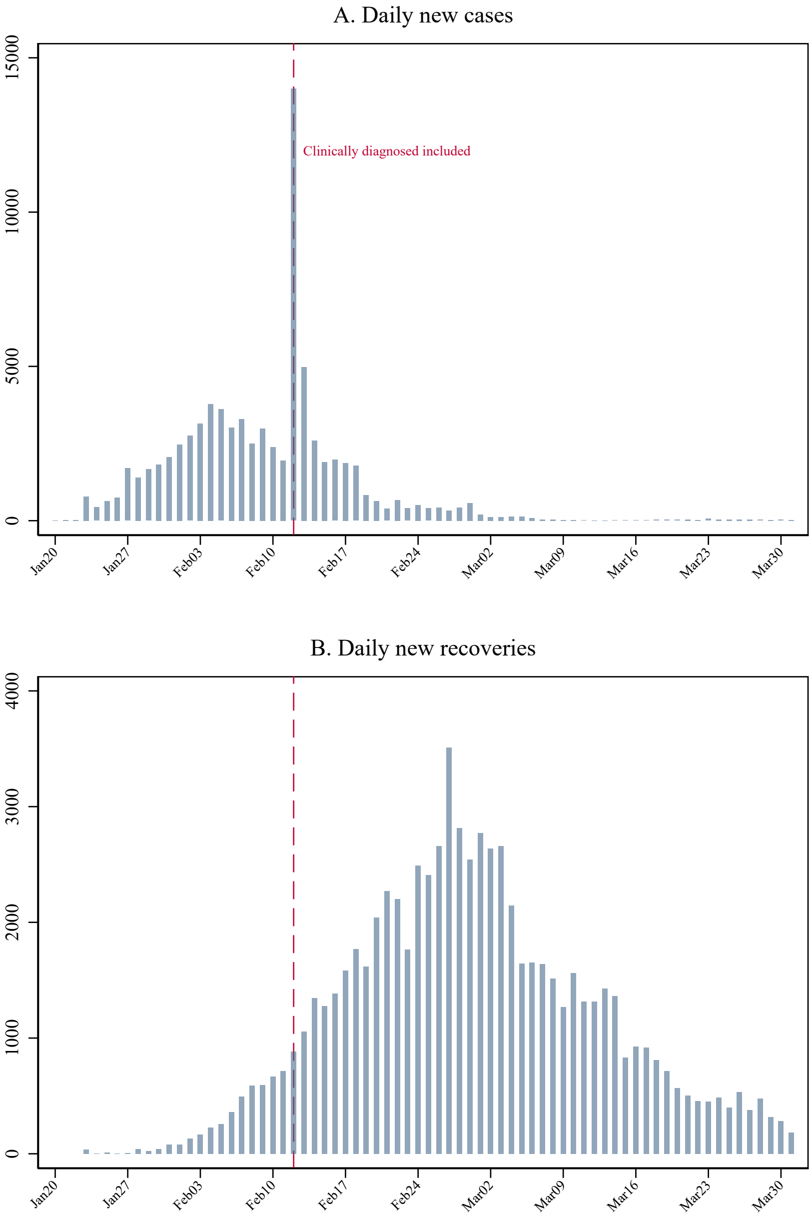

Figure 1. Daily new cases and recoveries in China, January to March. From February 12 on, new cases include clinically diagnosed cases—in addition to those confirmed by nucleic acid tests—for cities in Hubei province. This results in a sharp increase in the number of daily new cases, as indicated by the vertical line in the first plot.

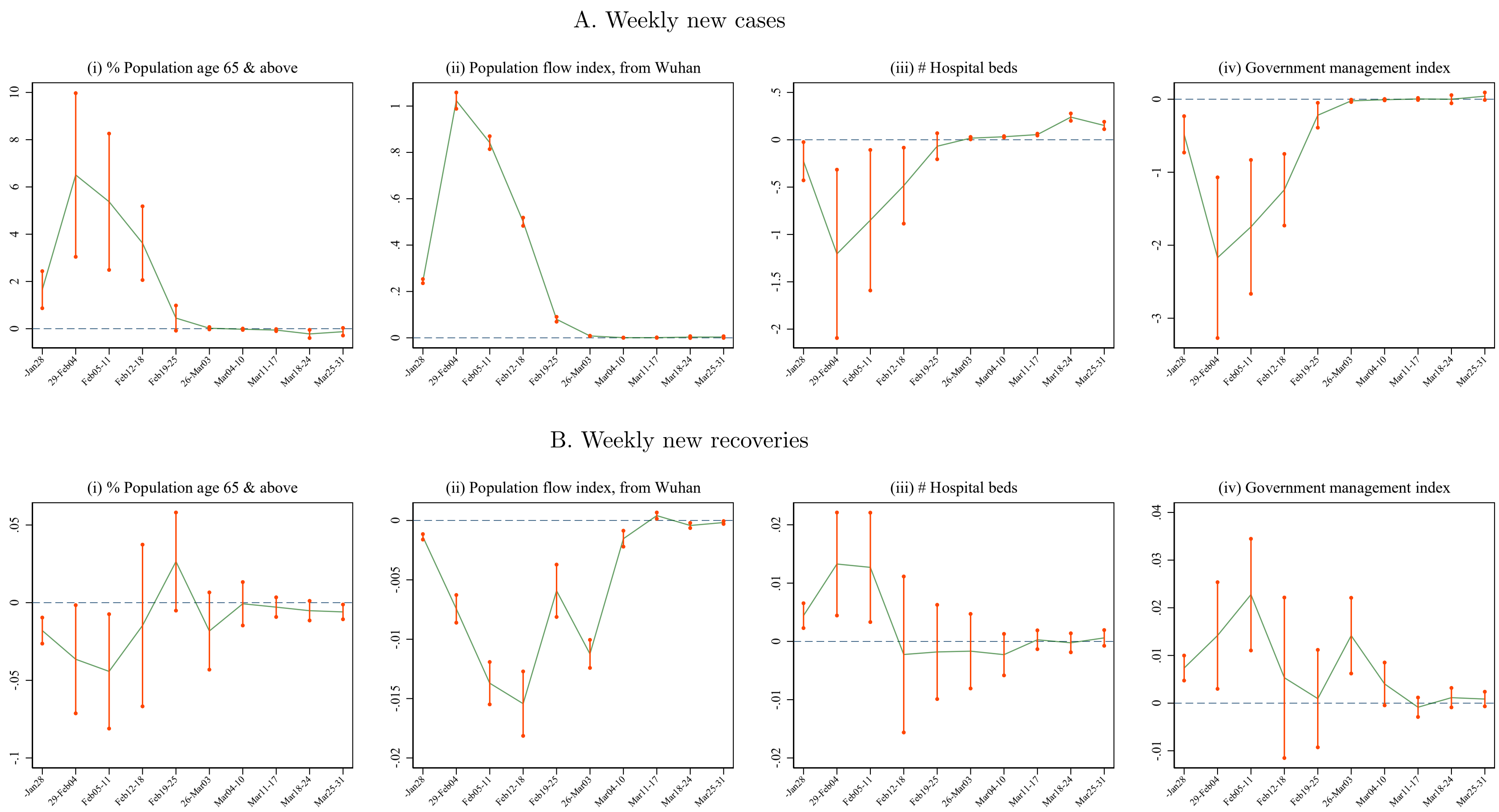

Figure 2. Coronavirus cases and recoveries: Key determinants. Each panel displays estimated coefficients from the regressions of weekly number of new cases and recoveries within a city on four key determinants; 90 percent confidence intervals are shown as orange vertical bars. All regressions control for percentage of population age 65 and above, the share of Wuhan-origin residents (or an index of population flow from Wuhan), total population, employment rate, percentage of population with a college degree, and an indicator variable for municipality. In panel B, regressions additionally control for the number of closed cases.

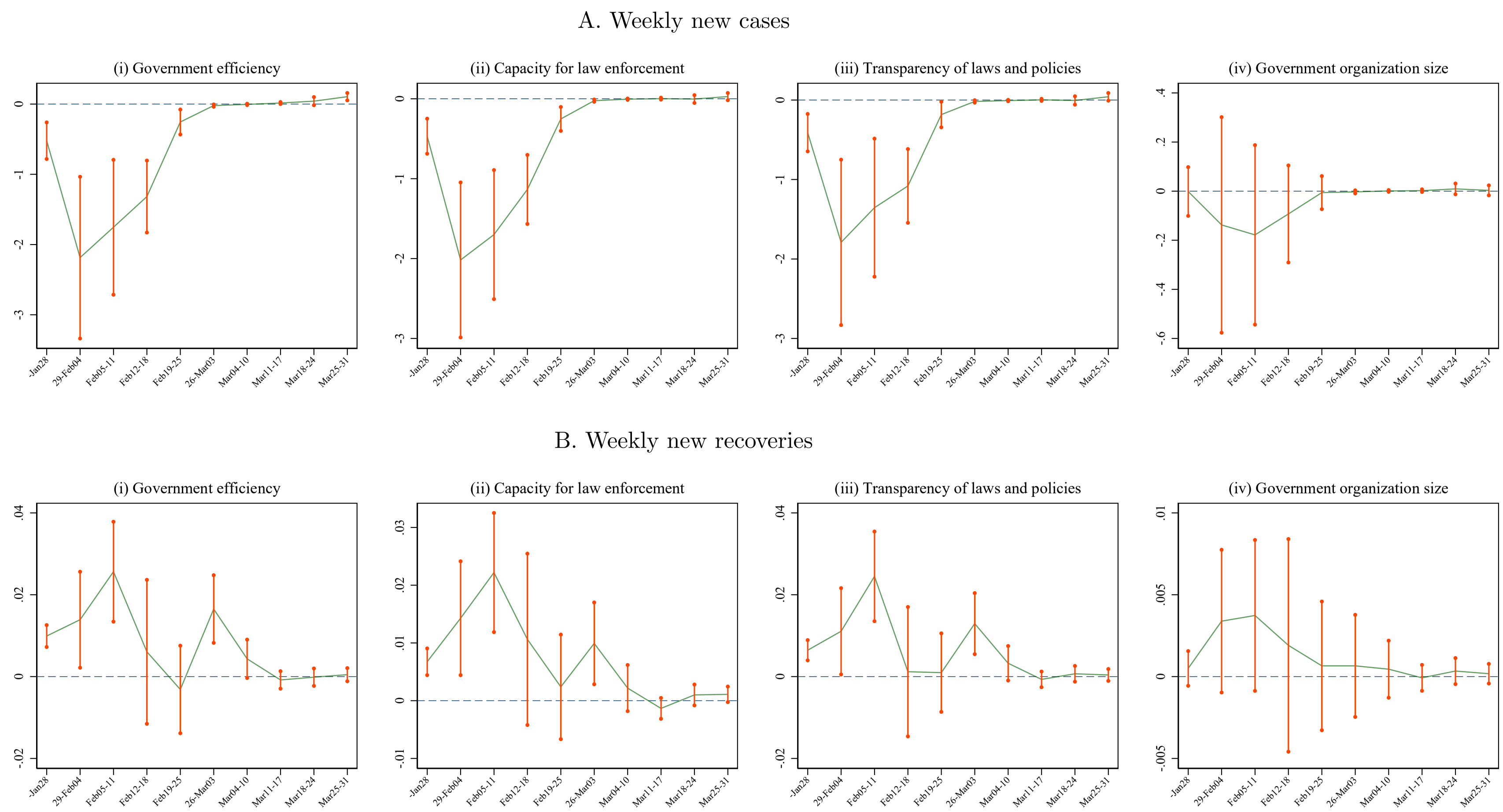

Figure 3. Coronavirus cases and recoveries: The role of government management. Each panel displays estimated coefficients from the regressions of weekly number of new cases and recoveries within a city on four indicators of government management capabilities; 90 percent confidence intervals are shown as orange vertical bars. All regressions control for percentage of population age 65 and above, the share of Wuhan-origin residents, total population, employment rate, percentage of population with a college degree, and an indicator variable for municipality. In panel B, regressions additionally control for the number of closed cases.