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Original Article

COVID-19 in Central Asia: exploring the relationship between governance and non-pharmaceutical intervention

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Abstract

To fight coronavirus disease 2019, non-pharmaceutical interventions were adopted all over the world. Non-pharmaceutical intervention (NPI) effectiveness also depends on governments' capacity to implement sound policies. Stay-at-home orders are binding measures that can raise serious concerns among the population. The perceived quality and effective need for these measures are therefore crucial for the willingness of the citizens to accept NPIs. This study investigates the relationship between the efficacy of NPIs and governance quality in Central Asia. Results suggest that overall governance quality matters and that in this relationship regulatory quality is more important than rule of law, which matters more than government effectiveness.

Keywords: COVID-19, Central Asia, governance, WGI, non-pharmaceutical intervention

Key messages

- There is no proof of fabrication for Central Asian republics reported COVID-19 cases;
- Government effectiveness, regulatory quality and rule of law increase the efficiency of NPIs;
- The most important dimension is regulatory quality, followed by rule of law and government effectiveness.

Introduction

After an initial outbreak of coronavirus disease 2019 (COVID-19) in China in December 2019, in the beginning of 2020 the crisis went global. By April 2020, the contagion had already spread all over the world. It became clear relatively quickly that the main risk posed by this virus was its ability to threaten the capacity of national healthcare systems to offer adequate services to the population, as it filled intensive therapy units very quickly. To ease the strain on health services by slowing down the outbreak (Hamzelou, 2020), a number of countries adopted social distancing policies. These aimed to reduce the probability of people contracting the virus. During the first wave of the pandemic (January–August 2020), these measures were of the utmost importance, since these were governments' principal weapons in the absence of a vaccine or cure. Conceptually, these remedies are not dissimilar from the strategies adopted to fight the plague by the first offices devoted to safeguarding public health in the 16th century (Alfano and Sgobbi, 2021). In this phase of the pandemic, the main challenge was the difficulty in identifying the chain of transmission (Munster *et al.*, 2020), due largely to the possibility of asymptomatic carriers infecting other people without realizing it (Rothe *et al.*, 2020).

Since the COVID-19 crisis began, several contributions have emerged in the literature assessing the effectiveness and efficiency of this type of non-pharmaceutical intervention (NPI). The first studies, which analyse the Chinese case, highlighted the importance and centrality of such measures in reducing the probability of contagion and thus in 'flattening the curve', which, as explained, was the main objective of policymakers in the pandemic's initial phases. Lau *et al.* (2020) state that 'a significantly decreased growth rate and increased doubling time of cases was observed, which is most likely due to Chinese lockdown measures' and advise stricter confinement of people in high-risk areas to prevent the diffusion of COVID-19. On the other hand, Shao (2020), through a Susceptible-Asymptomatic-Infected-Removed-Dead model, analyses the effectiveness of lockdown in China, noting the complementarity between lockdown and policies aimed at increasing the number of hospital beds. Sardar *et al.* (2020), examining the situation in India, have less clear-cut findings. By means of a Susceptible-Infected-Removed model that includes lockdown as a factor, the authors reach the conclusion that the lockdown produces observably positive effects in only some provinces. Another study from the Istituto Superiore di Sanità and Bruno Kessler Foundation of Trento, which investigates the reproduction trend of the virus, 'underlines

the importance of non-pharmaceutical control measures' (Riccardo *et al*., 2020). Other studies have instead adopted a cross-country perspective: the results of Alfano and Ercolano (2020) suggest the efficacy of lockdown measures in slowing down the number of new cases.

However, the effectiveness of such measures depends on several other factors. Among these, the literature has identified many different factors in determining NPI efficiency, such as work ethics (Alfano, 2021), social capital (Alfano and Ercolano, 2021b) and governance (Alfano and Ercolano, 2021a). Indeed, lockdown and confinement policies, in general, are binding measures that people are not accustomed to (Alfano and Ercolano, 2021a), and thus, governance quality and the perceived effectiveness of governments play a very important role in encouraging people to follow the prescribed restrictions. Furthermore, Lau *et al*. (2020) state that a lockdown may occasion grave concerns among the population, as such policies are reminiscent of traumatic historical periods. For all these reasons, governance quality may affect how the benefits related to the government's decision to impose a lockdown are perceived, and citizens could be more inclined to accept it and thus restrict their movements. If this mechanism is in place in a country, as has been proven from a cross-country perspective by Alfano and Ercolano (2021a), governance quality should be capable of having an effect on the efficacy of such measures. With this in mind, the central issue observed by Perry *et al*. (2014: 27) may be worth recalling: 'good governance is that which contributes to the good of society'.

While the manner in which citizens' perception of the capacity of government to set up and implement sound policies (i.e. the link between the effectiveness of NPIs and the quality of governance) has already been investigated from a cross-country perspective (Alfano and Ercolano, 2021a) and Worldwide Governance Indicators (WGIs) have been used to proxy for corruption in a study on the attitude towards vaccines (Farzanegan and Hofmann, 2021), to the best of our knowledge, this relationship has not yet been investigated from a regional perspective, which, as Alfano and Ercolano (2021a) suggest in their concluding remarks, would be a very important addition to the literature, given the very intrinsic limits of worldwide cross-country research. Moreover, individuals' trust and compliance in post-socialist countries can be affected by some specific determinants, different from other countries with different cultures and history, able to affect individuals' compliance in a peculiar way. The objective of the present study is therefore to investigate the impact of governance on the effectiveness of NPIs in the Central Asian republics.

The literature shows a link between the effectiveness of NPIs and the quality of governance from a cross-country perspective (Alfano and Ercolano, 2021a), but there are reasons to believe that this relationship may be different from a regional perspective. This means it is important to investigate the relationship in a subset of countries. Why is this the case?

First, as already highlighted, while cross-country investigations are useful in having greater external validity and assessing a general trend, they are sub-optimal in providing precise estimates of effects, due to the increase in variability and the inflation of the standard deviations. This is especially true for a phenomenon that is easily influenced by exogenous factors, which is certainly the case with COVID-19; for instance, just imagine the impact that average temperatures and the weather in general may have on the likelihood of transmission and how hard it is to assume this as being equal from a cross-country perspective. In that sense, more restricted samples may give us better insights into a dynamic for a specific region. Second, and related to this, studying more homogeneous sets of countries can easily give more relevant insights to policymakers interested in a specific region of the world and consequently sharper tools for them to intervene in the best possible way. Third, focusing on a more restricted area allows us to increase the knowledge about this specific part of the world, with precise results that can be useful as baselines for other studies.

We consider it especially important to investigate Central Asian republics in this respect. This region is a landlocked location, with some countries located in the very heart of Eurasia. Historically, its central location has meant that the region has often been important to powerful empires (Rakhimov, 2010), and its international relevance has continued to grow, at least since the new millennium (Blank, 2008). 2021 marked 30 years since the dissolution of the Soviet Union, to which the area now belonging to the republics of Central Asia (e.g. Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan, which, unfortunately, will not be included in this study given the lack of official recognition of COVID-19 cases within its borders) was part. Its geopolitical location at the crossroads of Eurasia, at the very nexus of Russia, China, South Asia and the Middle East, in addition to the availability of rich energy resources in the region, makes it very important in the international arena (Yenikeyeff, 2011). Leveraging their comparative advantage, which lies in this critical geographic position, these nations are renewing their historical roles as the crossroads of trade between the West and Asia. As we have seen in the last 20 years, this is resulting in significant economic development, especially in the sectors of energy and natural resources.

The region's location, furthermore, makes these countries a potential transport corridor for trade between Asia and Europe, or Asia and the Middle East, as it was for a large part of the Middle Ages with the Silk Road. Indeed, a number of large markets lie just beyond the region's borders. Moreover, Europe and the USA are particularly interested in gas supplies from Central Asia. But there is more: according to Mackinder (1981: 124), Central Asia is the heart of the world, and in order for a great power to control the world, Central Asia must be under its control.

The five countries listed above gained independence from the Soviet Union in 1991 and since then have had to engage in regional cooperation and integration (Rakhimov, 2010: 95). Cooperation in a region that continues to face internal threats does not come without struggle; however, it has been suggested that working together the five countries are able to solve many of their common problems and create a more stable and secure environment (Kubicek, 1997). The disintegration of the political and economic ties of the Soviet Union period pushed these relatively new sovereign states to quickly establish institutions of national policy and identity (Gleason, 2001). They have all shared the Soviet Union experience and are all at the same early stage in their nation-building process. Ethnicity, languages, history and culture are somewhat similar across these states (Fergus *et al*., 2011): in this sense, they can be considered quite homogeneous. Moreover,

while important moves towards liberalization and full democracy have been made since independence, corruption and human rights issues remain a prevalent concern throughout the region. An exogenous shock such as that represented by the COVID-19 pandemic can easily be a fatal blow to this process, due to the broad range of social and economic difficulties that it implies (Gleason and Baizajova, 2020): from the disruption of supply chains to the increase in commodity prices and from the loss of opportunities for migration to the fall in remittances from abroad. This is possibly even more true because of the proximity of Central Asia to the epicentre of the pandemic, which originated in China—this is a country that borders the region and a very powerful one in the area, and one with which many goods and services are traded. As regards recent history, in March 2020, soon after the report of the first COVID-19 case in Kazakhstan, its government implemented an NPI. Uzbekistan and Kyrgyzstan soon followed this strategy. Tajikistan also had to follow the same route, albeit later on (Gleason and Baizajova, 2020).

From a more theoretical perspective, involving measuring obedience among citizens to NPIs implemented by governments, we believe that it is very interesting to investigate these specific countries. As has already been highlighted in the literature, individuals' trust and compliance in post-socialist societies follow peculiar dynamics when compared with other countries. These post-Soviet societies, which as a group are broadly similar, offer an interesting setting in which to test the impact of governance on that relationship.

Indeed, following the seminal works of Rose-Ackerman (2001a) and Rose-Ackerman (2001b) on the subject, the dynamic of interpersonal trust and trust in the government of the citizens of these 'failed states' has attracted the attention of several scholars. They have investigated the effect of the generally lower levels of trust in the government in a number of contexts, for instance, with regard to civil organizations (Marinova, 2011) and justice (Özbek *et al.*, 2016). Now, for the first time, it is possible to test this dynamic with regard to citizens' behaviours during a global health crisis, in which trust in government prescriptions plays a major role. In that sense, the COVID-19 crisis offers an interesting natural experimental setting for us to observe citizens' behaviours.

Furthermore, assessing the impact of governance quality on the efficacy of NPIs in the region is important for at least two reasons. On the one hand, it contributes to our understanding of the relationship between governance quality and NPI effectiveness, with specific reference to the region, giving useful indications on how to deal with these health crises more effectively (all the more so given that they have been predicted to become more and more common in future by Adamson *et al.*, 2021; Hotez, 2021; Simpson *et al.*, 2020). On the other hand, it gives a useful indication of which aspects to privilege in the path of institutional development in these countries, since investing in better government effectiveness, regulatory quality or rule of law may have important spillover effects in policy effectiveness when it comes to facing such exogenous crises.

For all these reasons, we consider it an important exercise to assess the impact of governance quality on the evolution of COVID-19 in the four Central Asian republics that reported cases, i.e. Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan. This is interesting since these countries lie at the heart of the Central Asia Regional Economic Cooperation (CAREC) programme and are quite homogeneous also in terms of weather and other exogenous factors that may influence this relationship, making the study less likely to be affected by the biases it would have, were the analysis extended to the other CAREC members, which are for various socio-economical, political and historical reasons very different from these republics.

The idea of linking governance quality to compliance is found in several studies. Hooghe and Marien (2011) suggest that this mechanism may work through better institutions, which tend to incentivize individuals' compliance with the law through the positive effect of political trust on the legitimacy and effectiveness of the government action. Alabede and Zainal Affrin (2011) discovered in the case of Nigeria that public governance quality also has a significant positive relationship with tax compliance.

Following this rationale, in this study (in line with the contribution of Alfano and Ercolano, 2021a), we try to estimate whether the efficacy of NPIs depends on the relationship between citizens and 'the traditions and institutions by which authority in a country is exercised', following the definition of governance proposed by Kaufmann *et al.* (2010).

More specifically, assuming that different individuals' perception of governance affects the effectiveness of lockdown, we aim to verify the following research hypotheses:

- *H1: Central Asian republics characterized by higher levels of government effectiveness before the crisis have better results, in terms of the reduction of new COVID-19 cases, from the implementation of NPIs.*
- *H2: Central Asian republics where the government has better regulatory quality tend to have better results, in terms of the reduction of new COVID-19 cases, from the implementation of NPIs.*
- *H3: The capacity of the Central Asian republics' governments to ensure the rules of society is an incentive for their citizens to effectively respect NPIs, leading to better results, in terms of the reduction of new COVID-19 cases.*

The rest of the paper is organized as follows: after this introduction, the 'Methods' section presents the data and methodology, the 'Results and discussion' section reports the main results and some robustness checks, and the 'Conclusion' section concludes this paper.

Methods

The imposition of NPIs by public authorities is usually considered to be the major determinant in the COVID-19 trend, at least during the pandemic's first wave (Alfano and Ercolano, 2020). This happens because, without cures or vaccines, the only ways to halt the spread of contagion are social distancing and other NPIs. Another common assumption in this literature (Alfano and Ercolano, 2021a,b; Alfano, 2021; 2022) is to consider NPIs as policies whose effectiveness depends principally on voluntary compliance among the population, given how complex it would be for a government to enforce

them through the use of public force. Hence, when comparing country-level COVID-19 diffusion rates among different countries, controlling for the different levels of NPI stringency is considered a good measure of the levels of compliance with these policies among the population (Alfano and Ercolano, 2021a; Alfano, 2021). Of course, the quality of the data reported varies depending on the country (Lloyd-Sherlock *et al.*, 2021; Vasudevan *et al.*, 2021). Several scholars have expressed concerns that Turkmenistan, 2 years since the outbreak of the crisis, has still not reported any case of contagion (Balakrishnan, 2020; Ibbotson, 2020; Yaylymova, 2020). In any case, given the absence of official numbers regarding contagion, we have excluded it from the empirical analysis to avoid biasing the results.[1]

Empirically modelling COVID-19 contagion in a cross-country context is a challenge, given the lack of precise data so far. Data-driven models have been shown to be a good option for estimating contagion trends, as well as for determining the impact NPIs have on them (Alfano and Ercolano, 2020; 2021a).

The literature broadly recognizes (Alfano and Ercolano 2020; 2021a,b; Alfano, 2021) that fixed effects models have an advantage over random effects models when analysing panel data as they control for all level-2 characteristics, whether these are measured or unmeasured (Allison, 2009; Halaby, 2004; Wooldridge, 2010). As already highlighted (Alfano and Ercolano 2021a), this is a very important advantage in empirical strategy when the objective is to model a new phenomenon in which time-invariant characteristics (for instance, population density, demographic composition, characteristics of the healthcare system and more generally all the variables that do not change during the time span in question) are highly likely to play a significant role and for which not all the determinants are entirely clear yet, from a theoretical perspective. By employing fixed effects, the empirical estimation implicitly controls for all the variables that are not included in the regression and which do not vary in the time span under the analysis and which may affect the diffusion of COVID-19.

At the same time, this advantage becomes a considerable drawback when one aims to estimate the impact of a time-invariant variable, as is usually the case of operationalizations of governance quality (at least in a framework with daily data, for which it is difficult to imagine daily operationalizations of governance quality). This limit has been overcome by previous studies (Alfano and Ercolano, 2021a,b) by dividing the sample by quantiles of the variable of interest and estimating the impact in different subsamples, for later comparison among the betas. It has been noted that this empirical strategy has two main limitations (Alfano, 2021; 2022): first, comparing betas that have been estimated in different samples may lead to inconsistent conclusions, since these could be subsamples affected by different biases and errors; second, dividing the sample by quantiles of one variable also implies dividing it by all the variables that are highly correlated with it, creating uncertainty in the identification of the effect, which could be due to some omitted variable.

An alternative strategy, already used (Alfano, 2021; 2022), is to include time-invariant variables in the analysis. This, while maintaining the advantages of a fixed effects estimation, would avoid the need of dividing the sample into quantiles. This strategy relies on the use of within effects to be estimated in random effects models (Allison, 2009; Neuhaus and Kalbfleisch, 1998; Rabe-Hesketh and Skrondal, 2008; Raudenbush, 1989; Wooldridge, 2010)—so-called hybrid models. As already highlighted by Schunck (2013), this empirical approach allows the inclusion of random slopes, permitting the estimation of the effects of time-invariant variables, which vary between clusters.

Therefore, following Alfano and Ercolano (2020; 2021a,b), to measure the impact of NPIs on COVID-19 cases, we build a panel data set, composed of daily data from the four Central Asian republics as the basic statistical unit of observation. In more formal terms, we estimate the following equation:

$$\Delta i_{ct} = \alpha + \beta_1 \left(i_{ct-1} - \overline{i_c}\right) + \beta_2 \overline{i_c} + \beta_3 \left(Str_{ct-28} - \overline{Str_c}\right) + \beta_4 \overline{Str_c} + \beta_5 WGI_c + \beta_6 T_t + \varepsilon \quad (1)$$

where the dependent variable Δi is new COVID-19 cases at time t (with respect to $t - 1$), in country c. It is important to highlight that the decision to model the trend of the pandemic by counting the new daily cases of COVID-19 may be a limitation of the present study, which we believe it is important to warn the reader about at this early stage. While we recognize that this is far from a perfect operationalization of the effective number of cases that each country has experienced and that these figures are influenced by national testing policies, the quality of the tests itself, the number of asymptomatic cases and many other factors (not least the willingness of the government to control this kind of information), we still believe it is the best option available. We recognize this potential source of bias, but we also believe that either of the common alternatives in the literature, i.e. the number of deaths ascribed to COVID-19 or the excess deaths with respect to 2019, is even the worse option. While the former is potentially affected by the same issue and incentivizes the misreporting of the number of cases, the latter, although it may seem a better operationalization for the effects of COVID-19 in a country, suffers from other problems. The availability of data about the daily number of deaths in 2019 and 2020 is very limited and to the best of our knowledge is not available in the countries we investigated on a daily basis or a weekly basis (nor on a monthly one, which in any case would drastically reduce the number of observations and the quality of the analysis). This reduces the possibility of using excess deaths as a proxy for the spread of COVID-19. Possibly an even more important factor is that even more important, it is very hard to compute which deaths occurred because of COVID-19, and hence a lack of compliance with NPIs in the population, and which deaths would have occurred regardless, due to older age or pre-existing medical conditions. More precisely, while it seems reasonable to connect the event of COVID-19 contagion to a personal lack of compliance with an NPI that occurred a short time before, it is harder to connect COVID-19 deaths to the moment when the contagion occurred, which may be an event distant in time from death, and harder to connect to the level of stringency of measures.

But are these data reliable? We tested them using Benford's law (Benford, 1938), as suggested with regard to COVID-19 cases by Sambridge and Jackson (2020) and

Table 1. Goodness of fit test

Country	Observations	Pearson's chi-squared	*P*-value	Log-likelihood ratio	*P*-value
KAZ	168	9.712326	0.3743	9.456124	0.3963
KGZ	163	7.710951	0.5635	8.120015	0.5221
TJK	123	2.789545	0.9721	2.812521	0.9713
UZB	167	3.837243	0.9218	3.771229	0.9258

Note: H0: the second digits are Benford-distributed; Ha: the second digits are not Benford-distributed. KAZ: Kazhakistan; KGZ: Kyrgiz Republic; TJK: Tajikistan; UZB: Uzbekistan.

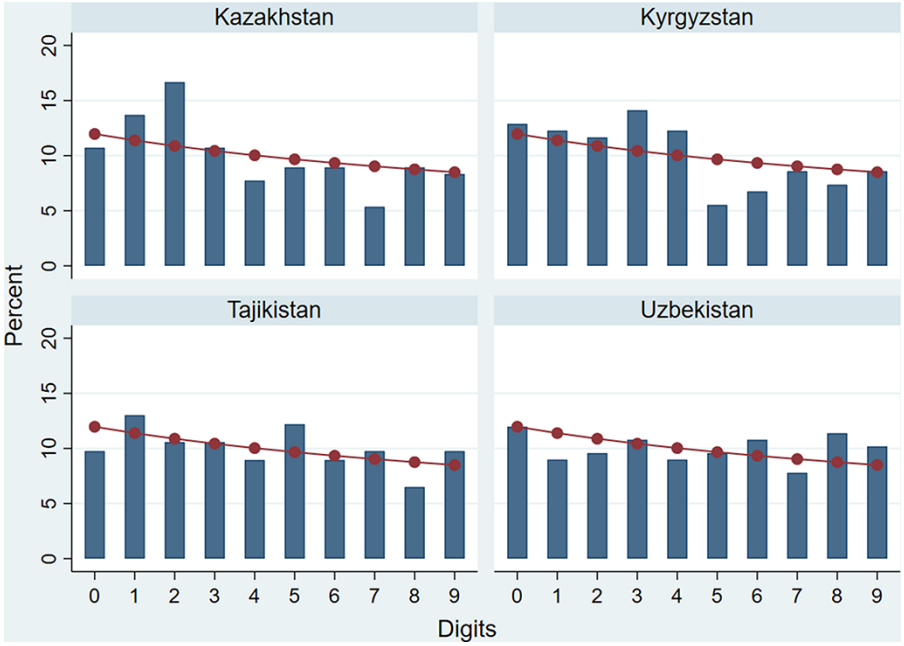

Figure 1. Frequency of the second digits in the cumulative number of COVID-19 cases, March–August 2020
Note: Bars represent relative frequencies of the second digits; the red line represents the distribution predicted by Benford's law.

Balashov *et al.* (2021). Benford's law predicts the relative frequency distribution of digits of numbers in real-world number sets (Sambridge and Jackson 2010). Anomalies have been used to expose errors and fraud (Nigrini, 1996). Following Mosimann *et al.* (1995) and Diekmann (2007), we run our test on the second digit, in the exponential-growth phase of COVID-19 (as suggested by Balashov *et al.*, 2021) where the number of total cases is expected to be in accordance with the Benford's Law. Results, presented in Table 1 analytically and in Figure 1 graphically, show that for all the countries the distribution of the second digit of the cumulative cases in March–August 2020 is consistent with what is predicted by Benford's law.

Moving on to the independent variables included in the study, these are as follows:

- the total infections in country c on the previous day (i_{t-1}), decomposed as usual in a hybrid model into a 'within' country part (the difference from the country mean of each observation $i_{ct-1} - \overline{i_c}$) and a 'between' country part (each country mean, $\overline{i_c}$);
- an index measuring the level of stringency of the different NPIs that are in place in country c for at least 28 days at time t (a lag necessary to allow NPIs to have a measurable effect on the reporting of new COVID-19 cases), once again decomposed into its within $Str_{ct-28} - \overline{Str_c}$) and between $\overline{Str_c}$ effects;
- a time-invariant variable for each of the three dimensions of governance quality, the literature (Alfano and Ercolano, 2021a) suggests, is relevant in our analysis: government effectiveness, regulatory quality and rule of law, labelled *WGI*;
- and finally, a matrix of dichotomous variables to include fixed effects for each of the months included in the analysis (except for January, used as reference category), in order to control for the time friction and the evolution of the pandemic T.

This empirical strategy aims to measure in the coefficient β_5 the impact of the governance measures on the COVID-19 infection. This takes into account both the trend of the contagion in each specific country, especially with regard to the total number cases of cases so far, and the stringency of government policies implemented in the period.

To empirically estimate equation (1), the following are needed: the number of daily infections of COVID-19 in each of the Central Asian republics, daily data on the levels of stringency of the NPIs in place in the same countries and an operationalization of governance quality for each of these countries.

We gathered data to compute the first two variables from the Oxford COVID-19 Government Response Tracker data set, henceforth OxCGRT (Hale *et al*., 2020a).[2] This source offers a data set that compiles publicly available information, run by a team of academics and students of Oxford University, that belong to different disciplines and that come from every part of the world. It is led by the Blavatnik School of Government (Hale *et al*., 2020b). OxCGRT offers a daily country-by-country estimation of COVID-19 cases. With the goal of avoiding a bias in our estimations because of the different speed and the variance of the spread of COVID-19 over time, as well as the variations in the testing strategies adopted by the different countries and the correspondent reporting, we decided to focus our analysis on the first wave of the pandemic, from 1 January 2020 to 31 August 2020. It is more interesting also because of the lack of information that caught at the time all the governments that of course did not expect such an emergency. From OxCGRT, we calculated the following:

- *New cases pm*, a variable that represents Δi in equation (1). It is equivalent to the first difference between the total number of COVID-19 cases of the day i_t and i_{t-1} for each country c. It is expressed in per million inhabitant terms, dividing by the population of country c (data from 2019 variable in the World Bank data set) and then multiplying by 1 million;
- *YCases pm*, a variable that represents i_{ct-1} in equation (1). It is equal to the total amount of cases in country c at $t-1$, once in per million inhabitants terms;
- *Str*, representing *Str* in equation (1), means as the level of stringency of NPIs on a daily basis, from the 'Oxford Stringency Index'. It is an index measuring the stringency of measures in place to fight COVID-19 in each country c for each day t. It is a 0–100 variable, calculated as the sum of several different sub-indexes (workplace closures, restrictions on the size of gatherings, cancellations of public events, home confinement orders, closures of public transportation and restrictions on internal and international travel). This variable is lagged in the regression analysis of 28 days, given that NPIs need some time to show results in terms of reducing contagion rates, as previous contributions in the literature have suggested (Alfano, 2021). To measure the spread of COVID-19 through the daily count of new people who tested positive, it was very likely (especially during the first wave) that one would need to exhibit some symptoms first. Mass testing and mandatory tests were used less in 2020. According to the literature, 97.5% of people who develop symptoms show them within 11.5 days from the infection (the 95% confidence interval is between 8.2 and 15.6 days, Lauer *et al*., 2020). The literature also identified a 'weekend effect' on COVID-19 cases (Soukhovolsky *et al*., 2021), possibly due to limited testing and processing of these tests

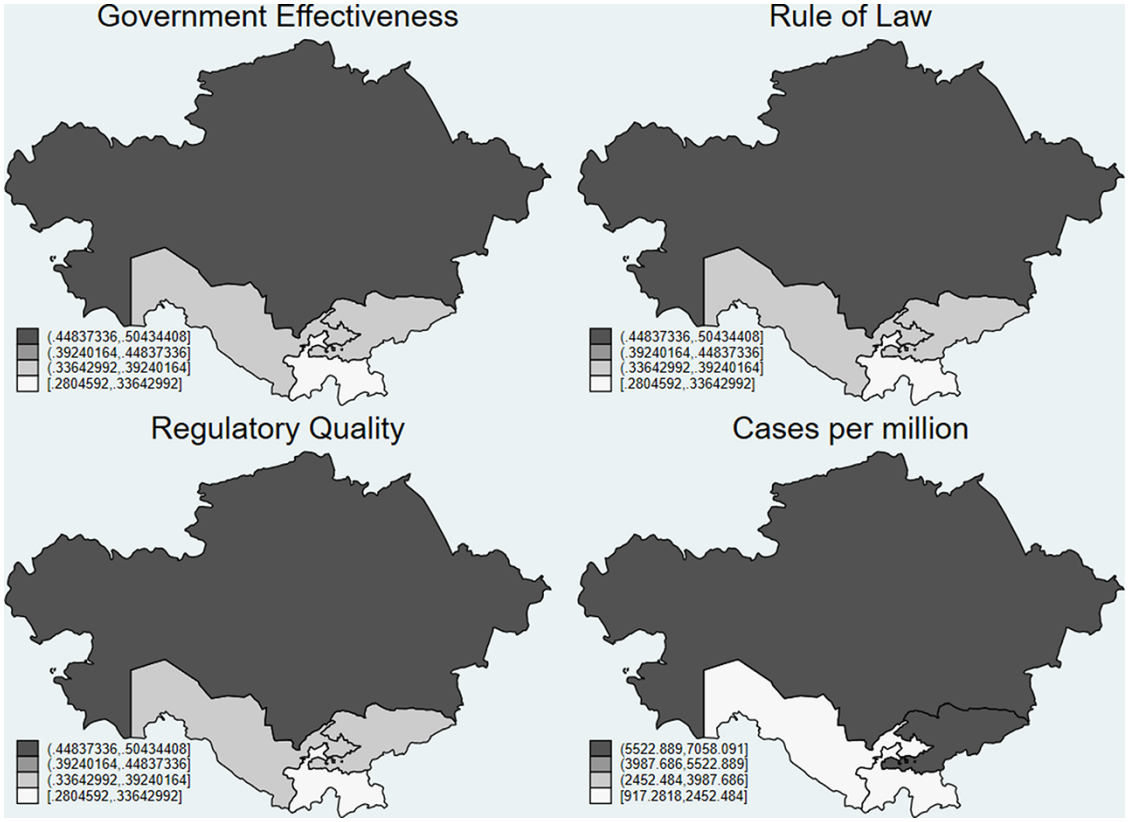

Figure 2. Heat maps

Government effectiveness, rule of law, regulatory quality and cases per million inhabitants in the four Central Asian republics studied. Authors' elaboration from data reported in the text.

during weekends, which makes the number of cases lower on Saturdays, Sundays and Mondays. For this reason, in order to have the same number of days of the week and avoid having the weekend effect bias our estimations, we decided to lag *Str* in the regressions by 28 days.[3] It lets us to avoid measuring the impact of *Str* on people who did not show symptoms after enforcement of the NPI. Thus, the value of *Str* in country *c* when $t = 29$ is equal to the value of the Oxford Stringency index for country *c* on day *t*. This avoids referring to a change in *New cases pc*, which is not likely to be because of the NPIs, since not enough time has passed to allow the NPIs to affect the spread of contagion.

Then, there is the operationalization of *WGI* in equation (1). To empirically test the impact of the different dimensions of governance quality on the spread of COVID-19, we gathered data from the World Governance Indicator in its 2019 edition (Kaufmann *et al.*, 2010), which refers to three main dimensions of governance that, following Alfano and Ercolano (2021a), we expect to affect this relationship, namely government effectiveness, regulatory quality and rule of law. The original values in this data set are scaled in a –2.5 to 2.5 range. For easier readability, we rescaled them into a 0–10 range by adding 2.5 to each value, dividing it by 5 and multiplying the result by 10. Since the values of the WGI in question date from 2019, this assessment of governance quality is before the COVID-19 crisis, and hence, these proxies are not affected by the different ways national governments have managed the pandemic. There is thus no risk of reverse causality.

The final data set is composed of 216 daily observations (for the days from 1 January to 31 August, excluding the 28 observations lost to lag the values of *Str*) in four countries (all the Central Asian republics except for Turkmenistan, which declared 0 COVID-19 case for the full period we are looking at), giving a total of 864 observations. Descriptive statistics are presented in Table 2, while Figure 2 presents

Table 2. Summary statistics

Label	Variable	Mean	Sample	Standard deviation	Min.	Max.	Observations
New cases pm	First difference between the total cases per a million inhabitants reported today and the ones reported yesterday	18.53211	Overall Between Within	76.15371 15.65642 74.93552	0 4.239225 –14.14274	1781.815 32.67485 1768.874	$N = 864$ $n = 4$ $T = 216$
YCases pm	Total amount of cases reported yesterday	881.9793	Overall Between Within	1749.252 696.9374 1641.697	0 244.1405 –679.4391	7058.091 1561.418 6378.652	$N = 864$ $n = 4$ $T = 216$
Str	Daily value of the Stringency Index from the Oxford COVID-19 Government Response Tracker	58.78559	Overall Between Within	29.40093 13.89078 26.82408	5.56 38.18991 –0.2664	96.3 67.38199 92.3968	$N = 864$ $n = 4$ $T = 216$
GovEff	Government Effectiveness from World Governance Indicator, rescaled on a 0–10 scale by adding 2.5 to the value, dividing by 5 and multiplying by 10	0.3882698	Overall Between Within	0.0794399 0.0916762 9.97e-16	0.2804592 0.2804592 0.3882698	0.5043441 0.5043441 0.3882698	$N = 864$ $n = 4$ $T = 216$
RuleLaw	Rule of Law from World Governance Indicator, rescaled on a 0–10 scale by adding 2.5 to the value, dividing by 5 and multiplying by 10	0.3152232	Overall Between Within	0.062783 0.0724536 1.11e-15	0.2434768 0.2434768 0.3152232	0.413679 0.413679 0.3152232	$N = 864$ $n = 4$ $T = 216$
RegQua	Regulatory Quality from World Governance Indicator, rescaled on a 0–10 scale by adding 2.5 to the value, dividing by 5 and multiplying by 10	0.3819632	Overall Between Within	0.1032487 0.1191523 9.34e-16	0.2794266 0.2794266 0.3819632	0.5281289 0.5281289 0.3819632	$N = 864$ $n = 4$ $T = 216$
Basic Administration	This variable, on a 1–10 scale, is the answer to the question: 'To what extent do basic administrative structures exist'?	6.75	Overall Between Within	0.8296365 0.9574271 0	6 6 6.75	8 8 6.75	$N = 864$ $n = 4$ $T = 216$
Hanson & Sigman State Capacity Index	This index: employs three dimensions of state capacity that their estimate relies on are extractive capacity, coercive capacity and administrative capacity	0.2316075	Overall Between Within	0.3540951 0.4086371 0	–0.07955 –0.07955 0.2316075	0.8113 0.8113 0.2316075	$N = 864$ $n = 4$ $T = 216$

Table 3. Hausman test for fixed vs random effects, baseline model

Ho: difference in coefficients not systematic
chi2(1) = $(b-B)'[(V\_b - V\_B)^{(-1)}](b-B) = 8.69$
Prob > chi2 = 0.0130

Table 4. F-GLS hybrid model—Central Asian republics and governance quality

	(4.1) *New cases pm*	(4.2) *New cases pm*	(4.3) *New cases pm*
YCases pm_within	0.00771**	0.00771**	0.00771**
	(2.54)	(2.54)	(2.54)
YCases pm_between	0.0229***	0.0241***	0.0278***
	(39.36)	(41.40)	(47.91)
L28.Str_within	−0.0692	−0.0692	−0.0692
	(−0.47)	(−0.47)	(−0.47)
L28.Str_between	0.235***	0.197***	0.145***
	(30.06)	(25.32)	(18.78)
GovEff	−1.772***		
	(−1421.40)		
RuleLaw		−2.515***	
		(−1421.40)	
RegQua			−2.949***
			(−1421.40)
Time fixed effects	Yes	Yes	Yes
Constant	−20.87**	−18.76**	−15.62*
	(−2.23)	(−2.01)	(−1.67)
Observations	864	864	864
Within R^2	0.119	0.119	0.119
Between R^2	1	1	1.000
Overall R^2	0.147	0.147	0.147
Within Sigma	70.84	70.84	70.84

t-Statistics in parentheses.
*$P < 0.1$.
**$P < 0.05$.
***$P < 0.01$.

four heat maps with the most important variables for the four countries included in the study, to give an idea of the distribution at a glance. Table 3, meanwhile, presents a Hausman test, which (apart from the theoretical reasons already explained) confirms the appropriateness of a fixed effects estimation instead of a random effects one.

Results and discussion

The main results are shown in Table 4, which estimate the impact of governance quality on the evolution of COVID-19 in Central Asia, *ceteris paribus* for NPIs and the pandemic's evolution. First of all, as can be seen in all the different specifications of the model, *YCases pm* has a statistically significant and positive coefficient, suggesting that the model confirms the exponential nature of COVID-19, and the fact that the more cases there were yesterday, the more there will be tomorrow.

Coming to the variables of most interest, all three dimensions of governance show a negative and statistically (very) significant coefficient, suggesting that governance quality plays a very important role overall in determining the reduction in COVID-19 cases, once NPIs are implemented. We can thus state support for hypotheses H1, H2 and H3. This result is in line with previous findings (Alfano and Ercolano, 2021a), confirming once again the relevance of these dimensions to efficient and effective NPIs capable of curbing contagion.

In more detail, the analysis suggests that the most important dimension is regulatory quality, since *RegQua* in 4.3 has a coefficient of −2.9, suggesting that an increase in this dimension leads to about three daily COVID-19 cases fewer per day for every million inhabitants. While this may seem like a low number, it is on the contrary very significant, given the exponential nature of the COVID-19 pandemic, which means that three more cases per day can easily lead to thousands of cases in a very short period of time.

The second most important dimension is rule of law, whose increase would result in about −2.5 daily cases (4.2) per million inhabitants. Finally, the dimension of governance with the lowest impact in this relationship appears to be government effectiveness (4.1), which has an impact of −1.7 daily cases per million inhabitants. All of this suggests the importance of governance quality in the fight against COVID-19 and the importance of sound institutions and good governance for a stable situation. In particular, regulatory quality is the most important dimension of governance in this relationship and the one that plays the greatest role in helping to curb infections with effective NPIs that citizens comply with.

As a robustness check, we also adopted two alternative operationalizations of governance, the Basic Administration (Donner *et al.*, 2020)[4] and State Capacity Index[5] (Hanson and Sigman 2021). The estimated coefficients, presented in Appendix 2, are once again consistent with our main results.

Conclusion

In 2020 and 2021, we discovered that for governments, the decision of whether or not to impose social distancing and lockdown measures is a very difficult one. This is of course due to the troublesome trade-off between the economic costs associated with NPIs and the cost of having an uncontained disease that freely infects a country's citizens. What previous contributions have highlighted is that there are also individual costs to NPIs, related to severe restrictions on people's freedom. Consequently, citizens' perception of their governments' capacity to plan and implement sound policies, measured following the 'governance' approach proposed by Kaufmann *et al.* (2010), may determine the effectiveness of NPIs.

Following the assessment of this effect from a cross-country perspective (Alfano and Ercolano, 2021a), useful to identify a relationship, but necessarily less precise in terms of estimation of the impact, the present study provides the first empirical evidence regarding the impact of governance on the efficacy of NPI measures in Central Asia.

A first, important result of our analysis is that it confirms previous findings suggesting that government effectiveness, regulatory quality and rule of law have a positive impact on the efficiency of NPIs. We consider this consistency to be a very important point and one worth highlighting. This literature is still emerging, and these kinds of studies need validation. Therefore, focusing on different samples and using different estimation strategies would be useful as a way to advance this literature and generalize the results of cross-countries studies with more precise estimates. Moreover, in our framework, we were also able to assess the relative

importance of governance quality in the effectiveness of NPIs. This is something that was not possible given the empirical strategy of previous contributions and hence is a novel finding of the present study.

Thus, while these findings shed further light on the hidden benefits related to better institutional environments, which may affect citizens' compliance positively even in the presence of very restrictive policies, we can also state now that, at least in the case of the Central Asian republics, the most important dimension is regulatory quality, followed by rule of law and finally by government effectiveness. This suggests that supranational institutions should aim to foster investment and policy reforms aimed at increasing regulatory quality over the rule of law and this in turn over government effectiveness, in order to help these countries to benefit from spillover effects in terms of more effective and efficient NPIs and to better fight the pandemic.

Moreover, these results contribute to furthering the debate around defining the 'optimal lockdown', the optimal 'mitigation measures' and the best 'exit strategy' from the pandemic. Indeed, our empirical analysis confirms that countries that perform better in these three governance dimensions also perform better in NPI effectiveness and thus have lower levels of contagion and possibly reduce infection levels more quickly. While this study has focused on a specific area of the world and is thus much narrower than previous analyses (such as Alfano and Ercolano, 2021a), it is nonetheless important to highlight that this research is also based on the cross-country analysis, and hence, results have to be considered as measuring average effects for the Central Asian republics. While this brings benefits in terms of generalization, it is at the same time a limit to deriving precise estimates. Caution is therefore suggested in reading these results. For this reason, we highlight the importance of and need for further investigation of this topic.

Data availability

The data underlying this article are public in the sources cited in the text. They will be shared on reasonable request to the corresponding author.

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Notes

1. Nonetheless, as a robustness check, we replicated the analysis including Turkmenistan. The results, presented in Appendix 1, seem largely consistent, at least for two of the three dimensions of governance studied.
2. We use the latest version available at the time of writing, namely the edition of 23 September 2021.
3. Please notice that results are robust to several tests with different lags of *Str*.
4. This variable represents the answer to the question: 'To what extent do basic administrative structures exist?' It is coded between 1 and 10, where 1 means: 'The administrative structures of the state are limited to keeping the peace and maintaining law and order. Their territorial scope is very limited, and broad segments of the population are not covered'; 4 'The administrative structures of the state extend beyond maintaining law and order, but their territorial scope and effectivity are limited'; 7 'The administrative structures of the state provide most basic public services throughout the country, but their operation is to some extent deficient' and 10 'The state has a differentiated administrative structure throughout the country which provides all basic public services' (Donner *et al.*, 2020).
5. According to the authors, the index uses three dimensions of state capacity to inform their estimate: 'extractive capacity, coercive capacity, and administrative capacity. The authors use Bayesian latent variable analysis to estimate state capacity at the conjunction of indicators related to these dimensions'.

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Appendix 1.

Table A1. Feasible-Generalized Least Square hybrid model—Central Asian republics (including Turkmenistan) and governance quality

	(A1.1) *New cases pm*	(A1.2) *New cases pm*	(A1.3) *New cases pm*
YCases pm_within	0.00869***	0.00869***	0.00868***
	(4.90)	(4.90)	(4.90)
YCases pm_between	0.0227***	0.0243***	0.0268***
	(21.34)	(40.00)	(37.97)
L28.Str_within	0.0871	0.0873	0.0881
	(0.55)	(0.55)	(0.56)
L28.Str_between	0.123*	0.138**	0.143***
	(1.81)	(2.48)	(21.78)
GovEff	−0.981		
	(−1.17)		
RuleLaw		−2.720***	
		(−7.69)	
RegQua			−2.346***
			(−12.84)
Constant	−6.826	−4.187	−6.334
	(−0.66)	(−0.41)	(−0.78)
Observations	1080	1080	1080
Within R^2	0.106	0.106	0.106
Between R^2	0.995	0.997	1.000
Overall R^2	0.144	0.144	0.144
Within Sigma	63.75	63.75	63.75

t-Statistics in parentheses.
*$P < 0.1$.
**$P < 0.05$.
***$P < 0.01$.

Table A2. F-GLS hybrid model—Central Asian republics and alternative governance quality

	(A2.1) ***New cases pm***	**(A2.2)** ***New cases pm***
YCases pm_within	0.00771**	0.00771**
	(2.54)	(2.54)
YCases pm_between	0.0260***	0.0247***
	(44.76)	(42.48)
L28.Str_within	−0.0692	−0.0692
	(−0.47)	(−0.47)
L28.Str_between	0.155***	0.141***
	(19.96)	(18.23)
Basic Administration	−2.648***	
	(−1421.40)	
Hanson & Sigman State Capacity Index		−4.192***
		(−1421.40)
Time fixed effects	YES	YES
Constant	−8.102	−23.29**
	(−0.87)	(−2.49)
Observations	864	864
Within R^2	0.119	0.119
Between R^2	1	1
Overall R^2	0.147	0.147
Within Sigma	70.84	70.84

t-Statistics in parentheses.
*$P < 0.1$.
**$P < 0.05$.
***$P < 0.01$.