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From Bazaars to Barriers: The impact of governance on the spread of COVID-19 in Central Asia during the pandemic

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EXECUTIVE SUMMARY

This study investigates the relationship between the quality of governance and the spread of the COVID-19 contagion in Central Asia throughout the pandemic, with a focus on the second (2021) and third (2022) years of the crisis. Contrary to what was found for the first wave, and consistent with findings from regions of the European Union, governance quality did not influence the pandemic's evolution after the first year. Our quantitative analysis, utilizing hybrid models and Feasible Generalized Least Square estimators, presents findings that align with the evolving nature of public behavior during a pandemic, emphasizing the need for adaptable public health strategies. Our main result suggests that none of the three governance dimensions analyzed had a notable impact on COVID-19 dynamics during the period being studied. Potential mechanisms underlying the results and the implications of these findings are discussed.

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Introduction

The global response to the COVID-19 pandemic saw the enforcement of various strategies by different governments, principally in the health, political, and social domains. The Central Asian republics, characterized by distinctive approaches during both the initial (Alfano et al., 2023) and subsequent waves of the epidemic[1], were no exception to this, and at the same time can be taken as a pivotal case study. Indeed, given its history, political situation, and geographical position, Central Asia is a very interesting region with which to unravel the complicated impacts of governance quality on COVID-19 trends during the pandemic (Alfano, 2022).

The countries in the area tackled the crisis with different approaches and distinct public health strategies (Alfano et al., 2023), obtaining results of varying efficiency (Chung et al., 2021). These approaches were adopted by nations that present similar backgrounds and comparable contemporary living conditions. This makes them highly suitable case studies for an analysis of the impact governance had on the way the COVID-19 crisis unfolded (Alfano, 2022). The literature has already dedicated several studies to the intertwining of governance with the evolution of the pandemic. Indeed, the relationship has been studied in several empirical contexts, including one very early study on the length of outbreaks in a set of countries (Chien and Lin, 2020), while another studied the relationship between a summary of Worldwide Governance Indicators and a stringency index, finding a non-monotonic relationship. Other studies, closer to our framework, have analyzed numerous countries around the world (Alfano and Ercolano, 2022), examined a specific country looking at the subnational context (Alfano and Ercolano, 2021), and compared Nomenclature des Unités Territoriales Statistiques (NUTS)-2 regions of various nations within the European Union (Alfano, 2024). Furthermore, and of specific interest here, a previous study was dedicated to the impact of governance on the efficacy of Non-Pharmaceutical Interventions (NPIs) during the first COVID-19 wave in the Central Asian republics (Alfano, 2022), while another studied the moderating effect of governance quality on the impact of COVID-19 on stock returns (Almustafa, 2022). Nonetheless, to the best of our knowledge, so far no study has analyzed the impact of governance on the trend of COVID-19 for the total number of years that the pandemic lasted. Such an approach may be worthwhile, highlighting the varying role of governance quality during the unfolding of the pandemic, from the initial shock that governments had to face, to the more "routine" administration of the emergency after years of living with the virus. Previous findings, obtained in very different contexts (e.g. the NUTS-2 regions in the European Union), and with limited timespans, have suggested that the impact of governance may indeed vary over time (Alfano, 2024). Hence, this study aims to shed some light on this dynamic, thereby helping to fill the gap in the literature with regard to the Central Asian republics. For the purposes of the present work, we will consider the impact of governance on the evolution of the epidemic over a period lasting from the beginning of the pandemic in 2020 until the end of the first ten months of 2022 (i.e. the months of that year when cases were still being reported), with a specific focus on the final years, which to the best of our knowledge have not yet been studied in as much detail as the first wave.

In other words, this study examines the relationship between governance quality and the evolution of COVID-19 infections, via the channel of NPI effectiveness, in Central Asia, over the course of the pandemic, and especially during the waves subsequent to the first. The aim of the study is to analyze, in a quantitative framework, the connections between governance quality, NPI effectiveness, and COVID-19 outcomes during the years of the pandemic that affected the Central Asian republics. This can foster regional co-operation,

[1] Following Oxford language definition, in the present article the word epidemic refers to "a widespread occurrence of an infectious disease in a community at a particular time.", while with pandemic we mean "a widespread occurrence of an infectious disease over a whole country or the world at a particular time."

encourage the adoption of best practices in neighboring countries, and of course highlight the importance of good governance. The study seeks to elucidate how different governance dimensions can shape the trajectory of COVID-19 cases, mainly through the channel assumed by previous literature of influencing public compliance with NPIs. Additionally, the research explores the implications of these findings for the prevention of future epidemics, and assesses overlooked spillover effects of governance, an outcome that both domestic and international organizations are devoting considerable resources to, in the broader Central Asian context.

In pursuit of these objectives, the study makes several inquiries. First, we examine the quality of COVID-19 data in the Central Asian republics over the years of the pandemic, in order to obtain a first result and have a preliminary assessment of the reliability of findings based on such data. Next, we explore through a regression analysis how governance quality, in three of its dimensions – those identified as being relevant in this context by previous research (Alfano, 2022 and 2024) – influenced the evolution of the COVID-19 pandemic during its first three years in the Central Asian republics, with a focus on the second and third years of the crisis. Additionally, we delve into the explanatory mechanisms that underlie the relationship, namely the role of the public's compliance with NPIs and the impact of this on pandemic management outcomes, given the multifaceted nature of governance. This study also seeks to extrapolate the empirical findings to help enhance good governance efforts in Central Asia, with due acknowledgement of the various channels through which different governance dimensions may affect policy outcomes. Furthermore, it contextualizes the results by comparing them with conclusions drawn from prior research on European countries and regions, and also globally offering a broader perspective on the influence of different governance dimensions in distinct contexts.

This research is important in several ways. The first is its geographical focus. As already highlighted by Alfano (2022), examining Central Asian republics is particularly worthwhile because of their historical significance as central locations in Eurasia (Rakhimov, 2010) and their growing international importance (Blank, 2008). Although the nations we are referring to – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan – have been independent from the Soviet Union for over 30 years, their geopolitical centrality and rich energy resources continue to position them as major players in global trade (Yenikeyeff, 2011). Their strategic location, reminiscent of the Silk Road era, makes them potential trade corridors between Asia, Europe, and the Middle East, and there is significant interest in both Europe and the United States regarding Central Asian gas supplies. The post-Soviet period has necessitated regional cooperation among these nations (Rakhimov, 2010), albeit amidst challenges such as ethnic diversity, corruption, and human rights issues (Gleason and Baizakova, 2020). The COVID-19 pandemic, originating in nearby China, further underscored the vulnerability of these countries, prompting swift NPI responses by their governments (Gleason and Baizakova, 2020), tailored to the specificities of each nation (Alfano et al., 2023). Investigating compliance with NPIs in these post-Soviet societies over a longer timespan may offer insights into trust dynamics between citizens and governments, which are particularly pertinent during a global health crisis like COVID-19. The pandemic thus provides a unique opportunity to observe public behavior in this setting (Rose-Ackerman, 2001a and b; Marinova, 2011; Özbek et al., 2016).

The reason behind the focus on NPIs when exploring this dynamic is simple. As already highlighted by previous studies, lockdown and confinement policies are typically stringent measures with which the population is unfamiliar, and whose efficiency is significantly influenced by voluntary compliance, which in turn is affected by governance quality and public trust in government efficacy (Alfano and Ercolano, 2021). Lau et al. (2020) note that such measures can recall traumatic historical episodes, and emphasize the role played by governance in shaping public acceptance and compliance. Thus, the perceived benefits of government actions, in this case a lockdown or other social distancing policies, may vary considerably depending on governance quality, given that this latter variable, in all its dimensions, has an impact on citizens' willingness to adhere to restrictions. Perry et al. encapsulate this by defining good governance as that which contributes to societal well-being (2014: 27). It has already been suggested that individuals' trust and compliance in post-socialist countries can be affected by specific drivers that are able to affect individuals' compliance in a particular way (Alfano, 2022). Hence, Central Asia would seem to be a highly appropriate case with which to study the impact of governance quality on NPI efficacy over time, in the various years affected by COVID-19 waves.

Moreover, evaluating how governance quality influences the effectiveness of NPIs over time during the pandemic in the Central Asia region is important for two principal reasons. First, it enhances our comprehension of the correlation between governance quality and NPI efficacy over lengthier periods of time, offering valuable insights that will help us to address future health crises – which are projected to occur with increasing frequency (Simpson et al., 2020; Adamson et al., 2021; Hotez, 2021) – more effectively. Second, it provides guidance on how to prioritize aspects for institutional development in these nations; investing in improved government effectiveness, regulatory quality, or rule of law may yield substantial benefits in policy efficacy when such external crises arise.

To answer these questions, in the present study we have chosen to adopt a quantitative framework, which, following an analysis of the quality of reported COVID-19 data in Central Asia, uses regression analysis with hybrid models and a Feasible-Generalized Least Square (F-GLS) estimator to assess the relationship between governance quality and the evolution of COVID-19 cases. Our results suggest that unlike what happened during the first wave, when governance quality played an important role, as the previous literature has highlighted (Alfano, 2022), this is not a factor that significantly affected the evolution of the epidemic in the Central Asian republics in the second (2021) and third (2022) year of emergency, or when considering the three years together. This result is in line with what previous studies have found when analyzing the impact of governance on the trend of the pandemic in the European Union's subnational regions (Alfano, 2024), and hence suggests that in the case of Central Asia as well, while governance was an important factor that played a pivotal role in reacting to the exogenous shock of the COVID-19 pandemic, with the passing of time these dimensions became increasingly unimportant when it came to managing the crisis. This may be true for at least two reasons: 1) large parts of the population adapted to the "new normal", spontaneously changing their behavior and making NPI enforcement less important; and 2) the policies it was necessary to adopt, as well as the optimal institutional path to emerge from the pandemic, became increasingly clear to governments around the world, and were eventually adopted almost universally, meaning that less public trust in governments, and accordingly less efficacy from government institutions, was required for the measures to be adequately enforced.

The rest of the article is organized as follows. The next section discusses the quality of COVID-19 data for the Central Asian republics using Benford's law, while the third section introduces the methodology that was adopted and presents the data that were used in the analysis. The fourth section highlights the results obtained by the analysis, while the last, as usual, concludes.

Are COVID-19 data in Central Asia reliable?

A preliminary question to answer before embarking on a quantitative analysis of the impact of governance quality on the spread of COVID-19 regards the quality of the data reported by public authorities. Naturally, analysis performed on poor quality data gives unreliable results, whose utility is dubious. This is a problem that seems particularly important in the case of the COVID-19 pandemic, where many doubts have been raised about the reporting of the number of cases and deaths in a number of countries. In particular, some authors have suggested that findings claiming that autocracies consistently outperformed democracies in managing the early phase of the pandemic (Karabulut et al., 2021) may in fact be far from the truth and deceptive (Laishram and Kumar, 2021), arguing that these results could be driven by differences in transparency and data manipulation, rather than greater efficiency in enforcing restrictions on freedom in non-democratic countries (Chen, 2020; Badman et al., 2021).

This argument appears particularly pertinent in the case of Turkmenistan, which, following Alfano's (2022) approach, will be excluded from our analysis, since to date the country has not reported a single COVID-19 case within its borders. This has raised the concerns of various scholars (Balakrishnan, 2020; Ibbotson, 2020; Yaylymova, 2020), given the spread of COVID-19 in bordering countries. While recognizing the issue, aside from removing Turkmenistan from our sample, there is little that can be done to address the issue, given the lack of available data.

The other four Central Asian republics (Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan) have been suggested to have data in line with Benford's law (Benford, 1938) during the exponential growth part of the first wave (Alfano, 2022). Indeed, as noted by Sambridge and Jackson (2020) and Balashov et al. (2021), Benford's law can be applied to COVID-19 cases in that phase, and it is a feasible strategy to address the quality of reported data.

The literature suggests that by predicting the relative frequency distribution of digits of numbers in real-world number sets (Sambridge and Jackson, 2010), anomalies can be (and have been) used to expose errors and fraud (Nigrini, 1996). Alfano (2022), following Mosimann et al. (1995) and Diekmann (2007), running a test on the second digit in the exponential-growth phase of COVID (as suggested by Balashov et al., 2021), where the number of total cases are expected to obey the law, has suggested that during the exponential growth part of the first wave, in each of the four Central Asian republics that reported cases, figures presented by the authorities were consistent with the expected distribution of digits predicted by Benford's law.

Given the points raised by Balashov et al. (2021), any such test in subsequent periods has to be viewed with greater caution, given that the growth in cases is no longer in the exponential phase, and hence may not necessarily follow the distribution predicted by Benford's law. Nonetheless, to the best of our knowledge, given the lack of other options, testing Benford's law remains the optimal tool for obtaining an idea of the quality of the data reported. It is a procedure already used for some cases, including Brazil (Silva and Figueiredo Filho, 2020), authoritarian regimes (Kilani, 2021), Gjika et al. (2021) in the Balkans, and Central Asia during the first wave (Alfano, 2022). Figures 1, 2, and 3 present graphs comparing the actual and the expected (according to Benford's law) distribution for, respectively, the complete dataset (beginning in May 2020 to avoid an excess of 0 cases reported), a subset composed of only the second year (2021), and a subset composed of only the third year (2022), where data collection ends on 31 October, when all four republics reported 0 new cases for the vast majority of the month.

As can be seen, considering the points that have already been raised, Figure 1 suggests that COVID-19 cases reported in the four Central Asian republics being analyzed do not approximate Benford's law distribution very well. In particular the cases of Kyrgyzstan, which reported an excess of 0 in second digits, and Tajikistan, which reported a very high number of 3 and 7 in second digits, attract attention and raise suspicion about the accurateness of the data that have been reported. Although the other countries' second digits seem, if we look at the graph, to be fairly consistent with what is expected (again, bearing in mind that the remarks about the exponential growth period cannot be constantly taken into account in this period, and that pauses between waves imply a reduction of new cases and hence a repetition of the same digits), it should be highlighted that all of them fail a goodness of fit test (reported in Table 1). While this is not conclusive proof of fabrication – and it should be remarked once again that over each year there is no constant exponential growth, a condition that would be the optimal way for cases to follow a Benford's law distribution – it must be stated that this analysis raises a number of concerns about the reliability of these data, and caution is thus necessary when it comes to interpreting the results of our analysis.

It should also be noted that the observed disparities, aside from intentional manipulation, may stem from: inaccuracies in data gathering or unclear and inconsistent local reporting methods (Kossovsky, 2014; Eutsler et al., 2023); variations in reporting criteria among national (for instance, Kyrgyzstan changed the reporting statistics in July 2020, leading to a sudden increase, see https://ru.sputnik.kg/20200717/kyrgyzstan-koronavirus-pnevmoniya-statistika-1049043354.html) and subnational authorities; deficiencies in the national healthcare systems; and delays in data transmission, with consequent erroneous reporting in the days, or other shortcomings in disease monitoring (Farhadi and Lahooti, 2021; Campanelli, 2022). Moreover, recent research suggests that testing Benford's law is more complex than previously supposed, meaning that our results, obtained in a classical framework of distance from the theoretical distribution, may be questionable (Campanelli, 2022).

If we look at the test for the second pandemic year (2021), whose distribution of second digits in the number of cases is compared with the predicted distribution in Figure 2, and the third year (2022), compared in Figure 3, while once again tests (presented in Tables 2 and 3) suggest inconsistency with the predicted distribution, it is worth highlighting that if we look at Figures 2 and 3, the quality of data seems to deteriorate over time. As has already been discussed, this result may be due to a number of factors other than intentional data-tampering, and in the absence of any error due to manipulation some discrepancies may of course be ascribed to the non-exponential nature of the epidemic trend in 2021 and 2022, and to a greatly reduced number of cases in the "pauses" of the epidemic between the waves. This possibility has to be taken into serious consideration, especially given the greater distance from the predicted distribution in 2022, if compared to 2021 (as seems clear from the observation of the graphs presented in Figure 2 and 3). In other words, it is important to highlight that the points during the window in which second digits of COVID-19 cases should approximate Benford's distribution are only partially met in 2021, and are not at all met in 2022, when the resurgence of cases was sometimes limited to some regions and highly localized, and the number of cases no longer presented exponential growth.

Hence, while these tests do not present any conclusive proof, it is nonetheless important to highlight that the overall quality of data seems worrying, especially for the years 2021 and 2022. Nonetheless, assuming that the reported data are at least correlated with actual numbers, which should be the case if the distance from the distribution is due to good faith errors, and thus that there is not any intentional tampering that would totally undermine the results of quantitative analysis, we decided to proceed with the regression analysis. However, the reader should approach our findings with due caution.

Methodology and Data

During the initial phase of the COVID-19 pandemic, the implementation of NPIs by government bodies was widely regarded as the primary factor influencing the trajectory of COVID-19 (Alfano and Ercolano, 2020). On the other hand, mass vaccination and changes in people's behavior as they adapted to the new situation are usually considered the main drivers of the downward trend during the subsequent waves. This is because initially, given the absence of treatments or vaccines, imposing social distancing and other NPIs was the principal method of curbing contagion. With the passing of time, as vaccines became available and people understood better how to behave in the new situation, these variables became crucial, and played a major role in determining the trend of contagion. NPIs are commonly considered by the literature as policies whose efficacy depends to a large extent on voluntary compliance among the public, given the challenges associated with government enforcement using coercive measures (Alfano and Ercolano, 2021 and 2022; Alfano, 2022). Therefore, when comparing the spread of COVID-19 across different nations, adjusting for variations in the stringency of NPIs serves as a useful proxy for gauging compliance levels within populations (Alfano and Ercolano, 2021), at least during the first wave. On the other hand, when analyzing subsequent years, vaccination becomes a very important variable (Alfano, 2024), since it can obviously affect both the spread of the virus and public compliance with NPIs, with people feeling safer and therefore less compelled to comply with NPIs.

Modeling the spread of COVID-19 across countries poses several empirical challenges, mostly due to the lack of precise data. Utilizing data-driven models emerges as a viable approach for estimating contagion patterns and assessing the influence of NPIs (Alfano and Ercolano, 2021). While fixed effects models are favored in the literature for panel data analysis (as they effectively account for unobserved heterogeneity across countries, which is crucial in this effect, as highlighted by Alfano and Ercolano, 2021), challenges arise when assessing the impact of time-invariant variables, such as governance quality. This prompts alternative approaches, such as hybrid models, which combine fixed and random effects estimations (Allison, 2009; Neuhaus and Kalbfleisch, 1998; Raudenbush, 1989; Wooldridge, 2010). As emphasized by Schunk (2013), this methodology enables the incorporation of random slopes, facilitating the assessment of the impact of time-invariant variables that vary across clusters.

Consequently, in line with prior research (Alfano and Ercolano, 2021; Alfano, 2022 and 2024), this study creates and employs a panel dataset comprising daily data from the Central Asian republics to evaluate the effects of governance quality on COVID-19 cases, taking into account the NPIs in place at the time, and the vaccination rates once these remedies are available. Following previous literature (Alfano, 2022 and 2024; Alfano and Ercolano, 2021), to measure the impact of governance on COVID-19 cases we build a panel dataset, which takes daily data from the four Central Asian republics as the basic statistical unit of observation. In more formal terms, we estimate the following equation:

$$\Delta i_{ct}=\alpha+\beta_1(i_{ct-1}-\bar{i}_c)+\beta_2\bar{i}_c+\beta_3(Str_{ct-28}-\bar{Str}_c)+\beta_4\bar{Str}_c+\beta_5 WGI_c+\beta_6 Vax+\beta_7 T_t+\varepsilon \qquad (1)$$

where the dependent variable *Δi* represents the increase in new COVID-19 cases at time *t* compared to *t-1* in country *c*, i.e. the number of new daily cases. It is important to note, in line with previous literature, that our decision to track the pandemic trend based on daily new cases may pose limitations to this study, a caveat we wish to highlight early on. Indeed, we acknowledge that this choice means that it may not be possible to capture the true number of COVID cases, which are due to various factors (such as national testing policies, test quality, asymptomatic cases, and government transparency). Nonetheless, we consider it the most suitable option available. Indeed, while acknowledging potential biases, we argue that alternatives – such as death counts attributed to COVID-19, or excess deaths compared to previous years – are even less reliable strategies, due to limited data availability and difficulties in attributing deaths specifically to COVID-19 and non-compliance with NPIs.

Regarding the independent variables included in equation (1) and hence considered in this study, following previous literature (Alfano, 2022) they encompass:

- the previous day's total infections in country *c*, represented as , a variable decomposed, as usual in hybrid models, into a *within* country deviation (the difference from the country mean of each observation) and a *between* country part (each country mean,);

- an index, *Str*, quantifying the stringency of NPIs in place in country *c* for at least twenty-eight days at time *t*, similarly decomposed into within country and between country parts. The level measures the stringency of the different NPIs in place in country *c* for at least twenty-eight days at time *t* (a lag necessary to allow NPIs to have a measurable effect on the reporting of new COVID-19 cases);

- the number of people vaccinated for every hundred people in the population, labelled *Vax*, to take into account this important determinant of the pandemic trend and people's behavior;

- a time-invariant variable, labelled *WGI*, reflecting three dimensions of governance quality: government effectiveness, regulatory quality, and rule of law;

- a set of binary dummy variables, to incorporate fixed effects for each month being analysed (except January which serves as the reference category), to control for temporal variations and the evolution of the pandemic.

The objective of this empirical approach is to estimate the coefficient , capturing the influence of governance measures on COVID-19 infections, accounting for country-specific contagion trends, the stringency of governmental responses, and the share of the population that has been vaccinated. To conduct this estimation, daily COVID-19 infection data for Central Asian republics, daily NPI stringency and vaccination data, and operationalizations of governance quality were collected. The data collection process utilized the Oxford COVID-19 Government Response Tracker (OxCGRT) dataset for both infection and NPI stringency data (Hale et al., 2021), while Our World In Data (OWID) dataset was used to track the vaccination.

The first source offers a dataset that compiles publicly available information, run by a team of academics and students at Oxford University, who belong to different disciplines and come from every part of the world. It is led by the Blavatnik School of Government (Hale et al., 2021). 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 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. This is of particular interest also because of the lack of information obtained by governments at the time, as they were not expecting such a crisis. From OxCGRT we gathered or calculated:

- *New cases pm*, which is represented by in equation (1). This is the first difference between the total number of COVID-19 cases registered on day and on day for each country *c*. It is expressed in per million inhabitants terms (data on the population of each country *c* are obtained from the 2019 variable in the World Bank dataset);

- *YCases pm*, which is represented by in equation (1), and is equal to the total number of registered COVID-19 cases in country *c* on day , once again in per million inhabitants terms;

- *Str*, which is represented by *Str* in equation (1), and is the level of stringency of all the NPIs in place in each country *c* on each day *t*. The index is bounded between 0 and 100, and equals 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). In line with previous studies (Alfano, 2022; Alfano and Ercolano, 2021 and 2022), we lagged this variable by 28 days, given that NPIs need some time to show results in terms of impacting contagion rates. Previous literature also identified a "weekend effect" on COVID-19 cases (Soukhovolsky et al., 2021), which makes the number of cases lower on Saturdays, Sundays and Mondays, possibly because limited resources are invested in testing and processing the tests during weekends. Hence, lagging *Str* by 4 weeks, i.e. 28 days, allows us to avoid biasing this measure, and avoid attributing the impact of *Str* to people who did not show symptoms after enforcement of the NPI. In other words, 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*. This is not likely since not enough time will have passed to allow the NPIs to affect the contagion trend.

From the OWID dataset we gathered the number of fully vaccinated people per hundred inhabitants, which we proceeded to interpolate linearly to obtain daily data, which are more granular and more appropriate for our analysis. Moreover, the World Governance Indicator (WGI) dataset from 2019 provided our analysis with governance quality proxies, rescaled for consistency following Alfano's (2022) approach. In order to examine how various aspects of governance quality impact the transmission of COVID-19, we utilized data from the 2019 edition of the World Governance Indicator (Kaufmann et al., 2010), which encompasses three primary governance dimensions: Government Effectiveness, Regulatory Quality, and Rule of Law. Drawing from prior studies (Alfano and Ercolano, 2021 and 2022; Alfano, 2022 and 2024), we assessed how these dimensions influence the relationship in the first phase of the pandemic. The original dataset values range from -2.5 to 2.5, which we transformed for clarity, following Alfano (2022), into a 0-10 scale by adding 2.5 to each value, dividing by 5, and multiplying by 10. As these governance assessments precede the COVID-19 crisis, there is no influence from pandemic management strategies, mitigating the risk of reverse causality.

The final dataset is composed of 1,007 daily observations for the 1,035 days from 1 January 2020 to 31 October 2022, when all the countries included in the analysis reported a total of 0 cases during the majority of the days in the month, meaning that keeping the collection of data after this date would not only be useless, but also harmful insofar as it would introduce a bias due to the lack of positive observations for the dependent variable. Note also that the observations are reduced to 1,007 as it is necessary to exclude the 28 observations lost to lag the values of *Str*. These 1,007 observations were taken for four countries (i.e. all the Central Asian republics except for Turkmenistan, which declared 0 COVID-19 cases for the entire period we are looking at), giving a total of 4,028 observations. Descriptive statistics for the variables adopted in the study are presented in Table 4, while Figure 4 presents heat maps with the average for the most important variables used for each of the four countries included, to give an idea of the mean values at a glance.

Results

Equation (1) was estimated using the dataset described with the use of F-GLS estimators, with standard errors clustered at the country level, on three distinct samples: a first one including all the observations, a second one including the observations referred to 2021, and a third one including the observations referred to 2022 (of which, as explained, only the first ten months are considered, since a lack of new cases was already registered in this month for all of the four republics). The results of the estimation for the first sample are presented in Table 5. As can be seen, no variable has statistical significance, with the exception of the number of fully vaccinated people per hundred inhabitants, which is significant at the 10 percent level and positive. This is not especially remarkable, in regard to either the threshold of significance achieved, or its interpretation, which, given the sign, suggests reverse causality. This finding is in line with an interpretation that sees no variable, in a time span this long (over 1,000 days), as explaining the trend of cases in a statistically significant way. NPIs, which were used less and less by governments as a public health tool, became less useful as a means to curb cases over the course of the pandemic, with their role being replaced by people changing their behaviour and adapting to the "new normal", and vaccination, which fostered both personal and herd immunity, thus greatly reducing the danger of the pandemic. Different operationalizations of governance do not appear to play a role in this dynamic, since none of them is statistically significantly correlated to the trend of cases. None of the other control variables that are included (with the exception of the time fixed effect, which is included in the regression to control for the elapsing of time, but whose single coefficients are not presented, since their interpretation would probably be merely speculative) present any statistically significant correlation. This is in line with the idea of a lack of a unique determinant of the contagion trend in the long run.

Table 6 presents the results for equation (1), estimated with WGI operationalized as a proxy of Governance Effectiveness, for a subsample including all the data from 2021 (6.1), which presents 1,460 observations, or 365 for each of the four countries included, and another subsample including data from 2022 (6.2), which presents 1,216 observations, or 305 (the days between 1 January and the end of October, when there were no longer any new cases registered for the vast majority of the month in all of the four republics) for each of the four countries included in the analysis. In this case too the coefficient measuring the impact of this dimension of governance quality on the COVID-19 trend fails to achieve any of the usual thresholds adopted by the literature to indicate statistical significance. These results can be interpreted as suggesting that on average in all the Central Asian republics that reported COVID-19 cases, in neither 2021, nor in 2022, did governance effectiveness play a role in curbing the infection trend, unlike what has been suggested as happening during the first wave (Alfano, 2022).

Tables 7 and 8, respectively, the Regulatory Quality and Rule of Law dimensions of governance, present a replication of the same analysis for this other dimension of governance quality. In this case as well, the results are equivalent: none of these dimensions played a statistically significant role in determining the evolution of the contagion in the Central Asian republics in 2021 or 2022.

Conclusions

In conclusion, the present study explores the relationship between governance quality and COVID-19 outcomes throughout the course of the pandemic in Central Asia, focusing particularly on NPIs and vaccination, during the second and third years of the pandemic. Unlike the significant role that was identified in the literature during the first wave (Alfano, 2022), and in line with what was found in European Union regions for the second wave (Alfano, 2024), our findings suggest that governance quality did not notably influence the evolution of the epidemic in either 2021 or 2022, or when looking at the 2020-2022 time span. Our quantitative analysis, employing regression techniques with the use of hybrid models and F-GLS estimators, presents findings whose interpretation is in line with the idea that the evolving nature of the public's behaviour and the availability of vaccines during the pandemic influenced contagion trends. This underscores the importance of adapting public health strategies that take this into account. By leveraging a quantitative approach and drawing on prior literature, the present study offers a comprehensive understanding of how governance dynamics shape pandemic trajectories in the long term.

Our main result is that none of the three different governance dimensions that were analysed could be found to have had a statistically significant impact on the COVID-19 trend over the first three years of the pandemic considered jointly, or on 2021 and 2022 taken on their own. These empirical findings can be attributed to different causal mechanisms.

An initial possible explanation is the reduced importance of NPIs in managing the pandemic after the first phase, when they proved crucial (Alfano and Ercolano, 2020). Indeed, while previous literature has highlighted the importance of governance in curbing the spread of COVID-19 during the first wave, thanks to enhanced NPI effectiveness (due to higher compliance among the public) in a number of contexts, from a worldwide sample of countries (Alfano and Ercolano, 2021), and in subnational studies both in Italy (Alfano and Ercolano, 2022) and in a cross-national context (Alfano, 2024), the importance of NPIs in reducing contagion over time, in a three-year long epidemic, is likely to decline. This may happen for several reasons. First, it has been suggested that pandemic fatigue emerges among the public after a while, a phenomenon that reduces people's compliance with social distancing and other measures, and consequently hinders these measures' effectiveness. Second, it is likely that over time, after months of people living with the virus, absorbing public information about its dangers, and being exposed to public health campaigns suggesting how to reduce the risk of contagion, there is a reduced utility in using NPIs to impose behaviours whose utility is already clear and which has been willingly adopted by the public. Also important is the role played by vaccines, which create and increase herd immunity. While during the first wave the only available remedy to public health strategists was the imposition of NPIs, with the arrival of vaccines the game changed.

Our results could also be seen as being determined by the poor quality of the data regarding reported COVID-19 infections, as highlighted in the second section of this paper, which seem to become even worse over time. This may of course affect the results of our regression analysis, which would be meaningless if the data were unreliable. Unfortunately, given the lack of alternative sources, while we recognize this potential limit there is not much that can be done to address the issue, aside from warning the reader to treat our results with due caution.

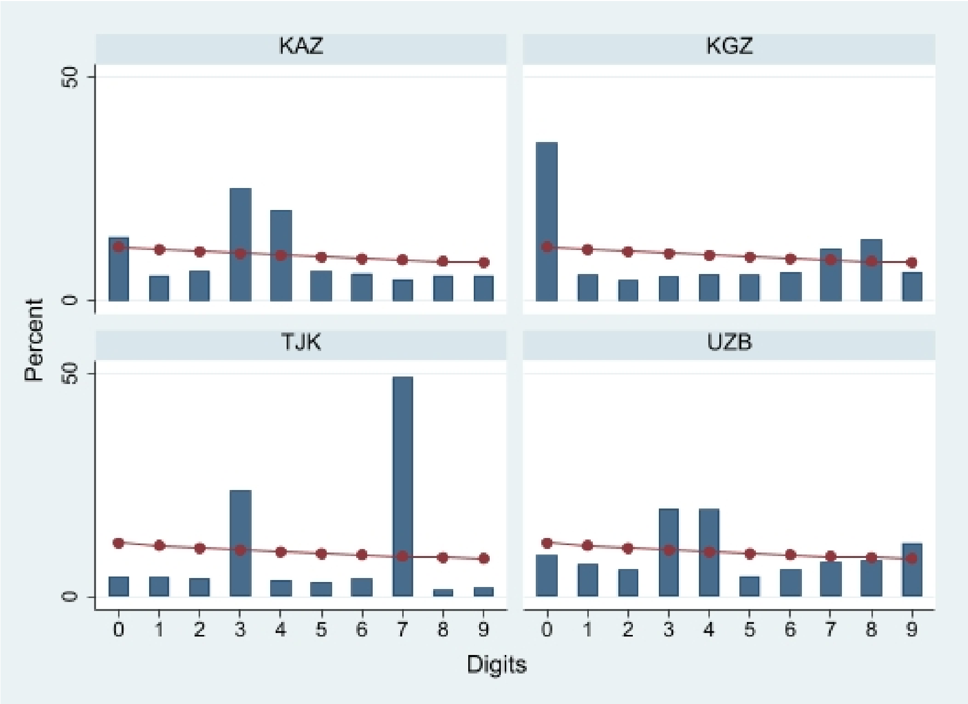
Finally, another possible explanation for our empirical results is the possibility that governance quality changed greatly in the years immediately after 2019, making our operationalization (which cannot be different if we are to avoid reverse causality, which would hinder the interpretation of any result so obtained), based on 2019 data, inapplicable to 2021 and 2022, and incapable of grasping the relationship between actual governance quality and the COVID-19 trend in the long term. While this seems a very unlikely hypothesis, especially in the case of the Central Asian republics, which, to the best of our knowledge, did not see any important institutional reform or experience some exogenous shock in these years that could have impacted governance quality, the hypothesis is worth noting.

In conclusion, it seems important to highlight that our findings appear very much in line with what has been found within the European Union at a regional level (Alfano, 2024). This indicates that the first explanation we proposed, which assumes the reduced role of NPIs, and consequently of governance quality, in managing the pandemic after the initial shock, seems the most likely, and hence the explanation to be preferred.

While contributing to both academic discourse and practical policy considerations by providing, to the very best of our knowledge, the first analysis of the impact of governance on the COVID-19 trend in the later years of the pandemic, the present study is not exempt from limitations. The first is its reliance on quantitative methods, which, while offering valuable insights, may overlook nuanced contextual factors that influence governance dynamics in Central Asia. Additionally, it is important to highlight that our study focuses solely on the impact of governance quality on COVID-19 outcomes, potentially neglecting other crucial determinants, such as cultural attitudes, socioeconomic disparities, and healthcare infrastructure, which while similar across the different Central Asian republics, and hence theoretically leaving the *ceteris paribus* condition unaffected, may nonetheless introduce some biases into the analysis. Furthermore, it is important to highlight that our analysis spans a relatively short timeframe, primarily covering the second and third years of the pandemic, which may limit the generalizability of our findings to longer-term epidemic management strategies. Moreover, our study assumes a linear relationship between governance quality and NPI effectiveness, overlooking potential nonlinear or interactive effects. Lastly, as highlighted by our analysis using Benford's law, some limitations in data quality and consistency across Central Asian republics may introduce bias or uncertainty into our results.

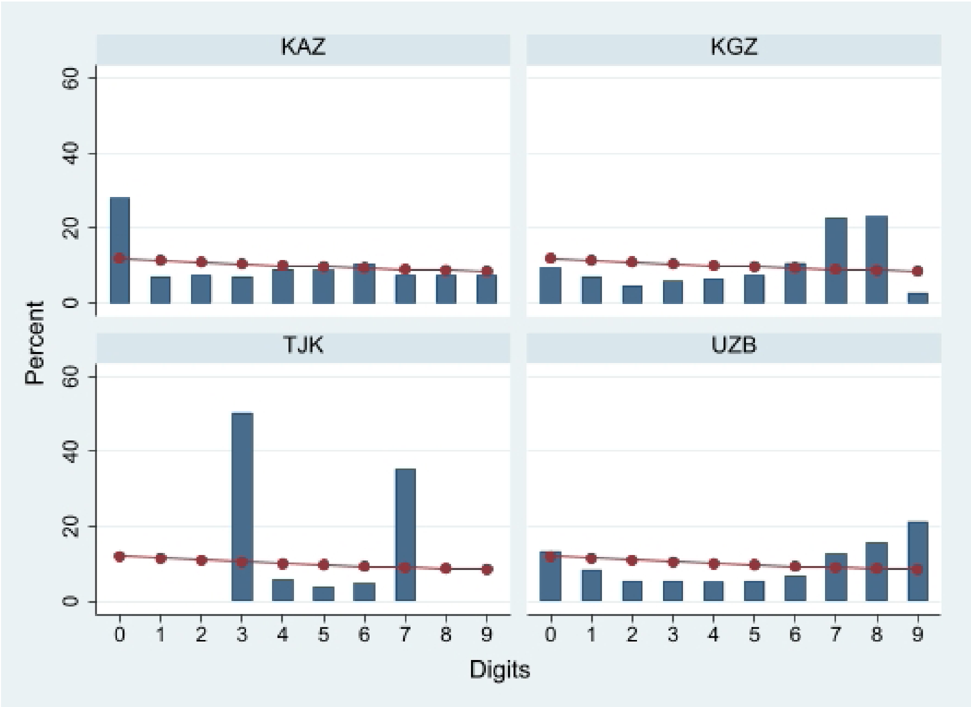
For all these reasons, more research on the subject seems necessary. Future studies could explore several avenues in order to enhance our understanding of the intricate relationship between governance dynamics and pandemic management in Central Asia. First, qualitative studies could delve into the intricate cultural, socioeconomic, and institutional factors that can shape governance responses to health crises. Furthermore, comparative studies across regions or countries with similar geopolitical characteristics but varying governance systems could provide valuable comparative insights. Lastly, interdisciplinary approaches integrating political science, sociology, and public health perspectives could offer a holistic understanding of the multifaceted relationship between governance, public health, and societal responses to crises. By addressing these research gaps, future studies can contribute to more effective and resilient pandemic preparedness and response strategies in Central Asia and beyond.

Figure 1 *Benford's law predicted and actual distribution of COVID-19 cases 2nd digits – Complete sample*



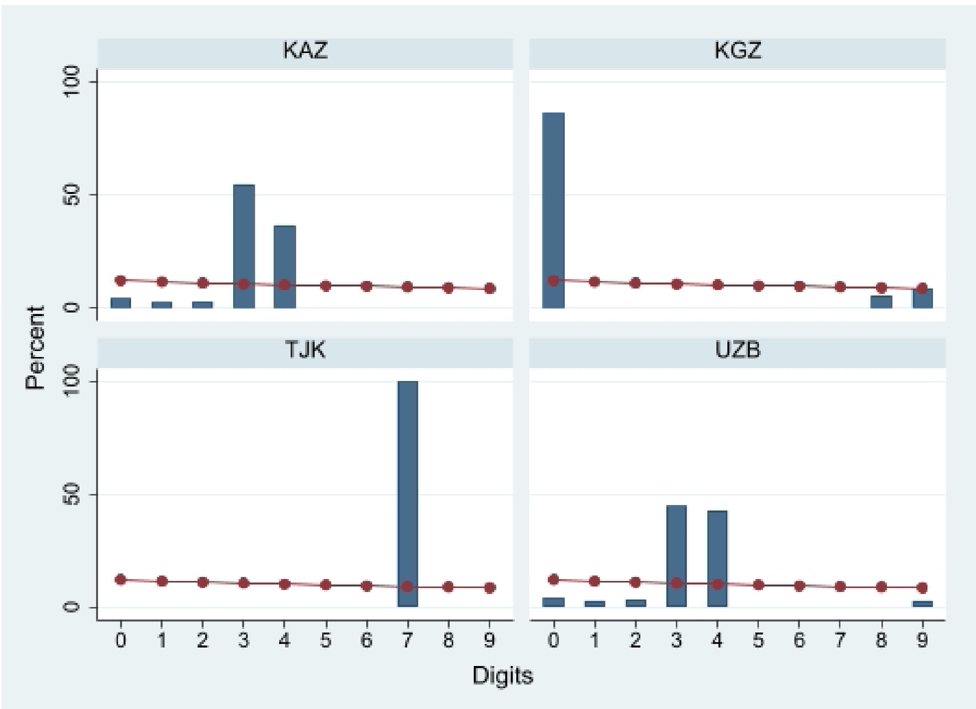
Source: Figure created by the author with the sources detailed in the text.

Figure 2 *Benford's law predicted and actual distribution of COVID-19 cases 2nd digits – 2021*



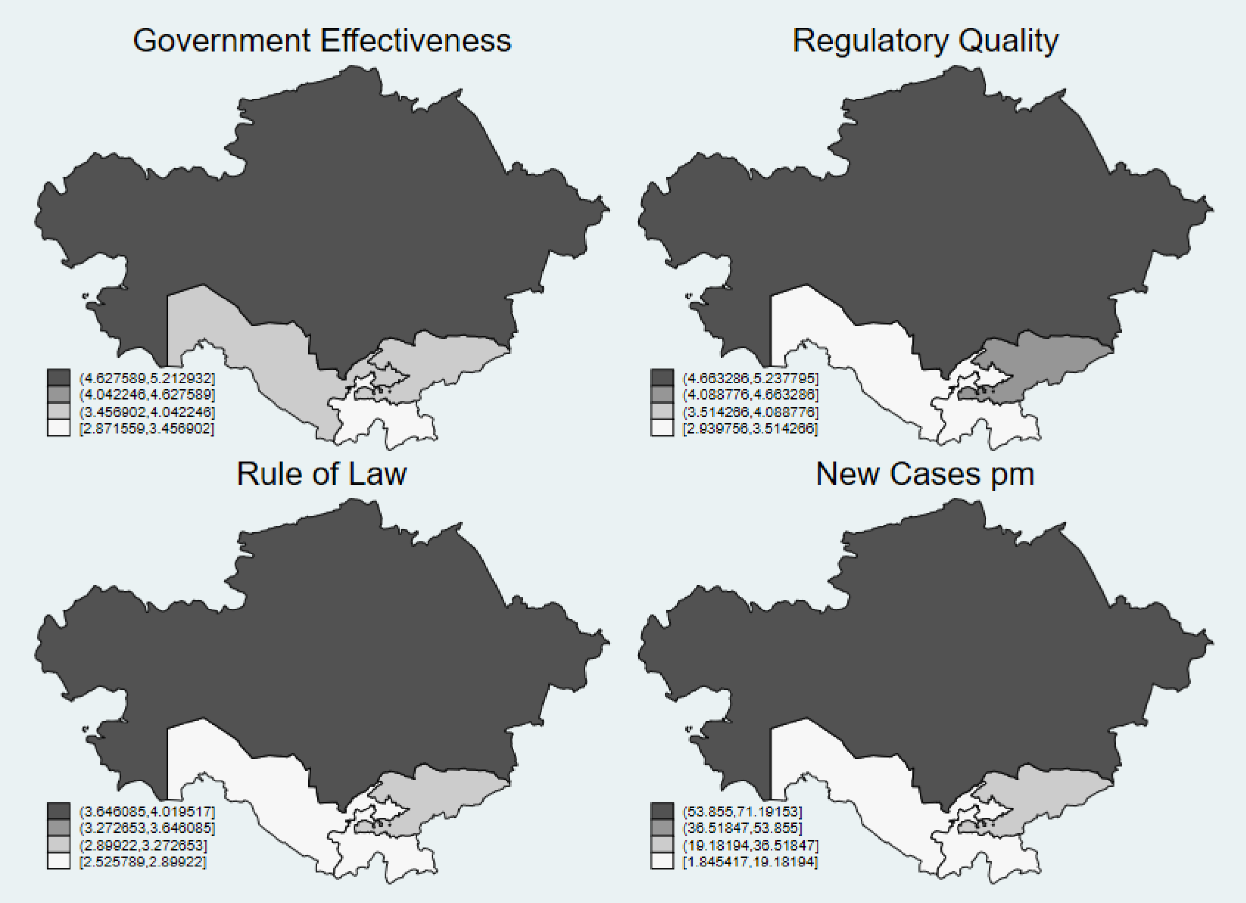
Source: Figure created by the author with the sources detailed in the text.

Figure 3 *Benford's law predicted and actual distribution of COVID-19 cases 2nd digits – 2022 (up to 31 October)*



Source: Figure created by the author with the sources detailed in the text.

Figure 4 *Heat maps of the averages for the most important variables adopted in the study*



Source: Figure created by the author with the sources detailed in the text.

Table 1 *Goodness of fit test – Complete dataset*

Country	Obs.	X2	P-value	LR	P-value
KAZ	914	388.1294	0.0000	331.4481	0.0000
KGZ	914	572.6972	0.0000	453.5424	0.0000
TJK	914	2109.36	0.0000	1353.893	0.0000
UZB	914	247.0381	0.0000	226.1827	0.0000

Table 2 *Goodness of fit test – 2021*

Country	Obs.	X2	P-value	LR	P-value
KAZ	365	95.08057	0.0000	75.64565	0.0000
KGZ	365	210.4732	0.0000	173.3928	0.0000
TJK	365	1054.75	0.0000	858.7089	0.0000
UZB	365	135.1081	0.0000	117.1167	0.0000

Table 3 *Goodness of fit test – 2022*

Country	Obs.	X2	P-value	LR	P-value
KAZ	304	976.1894	0.0000	764.6263	0.0000
KGZ	304	1618.51	0.0000	1018.541	0.0000
TJK	304	3060.619	0.0000	1461.658	0.0000
UZB	304	844.6913	0.0000	680.2404	0.0000

Table 4 *Descriptive statistics*

Label	Variable	Obs	Mean	Std. dev.	Min	Max
NewCases pm	First difference between the total COVID-19 cases per million inhabitants reported in each country on time t and the time t-1.	4,028	30.13247	112.2637	-3207.045	3571.419
YCases pm	Total number of cases per million inhabitants reported on t-1.	4,028	14871.67	21460.98	0	80195.51
Str	Daily value of the Stringency Index in country c from the Oxford COVID-19 Government Response Tracker.	4,028	47.51341	26.21579	2	98
FulVax ph	Number of fully vaccinated people per 100 inhabitants, for each day t (obtained through linear interpolation) and each country c.	4,028	15.33177	19.4658	0	54.67
Gov.Eff.	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.	4,028	3.916394	.8452188	2.871559	5.212932
Reg.Qual.	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.	4,028	3.855252	.9733543	2.939756	5.237795
Rule of Law	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.	4,028	3.15877	.5527723	2.525789	4.019517

Table 5 *F-GLS estimation on the complete dataset*

	(5.1) NewCases pm	(5.2) NewCases pm	(5.3) NewCases pm
YCases pm Within	0.000155 (0.53)	0.000155 (0.53)	0.000155 (0.53)
YCases pm Between	0.000384 (0.31)	-0.00181 (-0.60)	0.00114* (1.74)
L28.Str Within	-0.105 (-1.41)	-0.105 (-1.41)	-0.105 (-1.41)
L28.Str Between	6.394 (1.41)	4.890 (1.46)	6.963 (1.39)
FulVax ph	2.520* (1.92)	2.520* (1.92)	2.520* (1.92)
Gov.Eff.	-8.310 (-1.25)		
Reg.Qual.		31.31 (1.25)	
RuleLaw			-34.47 (-1.25)
Time Fixed Effects	YES	YES	YES
Constant	-272.0 (-1.57)	-323.7 (-1.51)	-233.0 (-1.63)
Observations	4028	4028	4028

t statistics in parentheses

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

Table 6 *F-GLS estimation for Gov. Eff. in 2021 and 2022*

	(6.1) NewCases pm	(6.2) NewCases pm
YCases pm Within	-0.00214	-0.0157***
	(-1.08)	(-6.03)
YCases pm Between	0.000355	0.0110
	(0.12)	(0.63)
L28.Str Within	-0.441	0.203***
	(-1.50)	(2.60)
L28.Str Between	7.742	30.23
	(0.91)	(0.53)
FulVax ph	5.489*	7.486
	(1.70)	(1.28)
Gov.Eff.	-14.50	-17.90
	(-0.90)	(-0.23)
Time Fixed Effects	YES	YES
Constant	0	-1568.1
	(.)	(-0.66)
Observations	1460	1216

t statistics in parentheses

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

Table 7 *F-GLS estimation for Reg. Qual. in 2021 and 2022*

	(7.1) NewCases pm	(7.2) NewCases pm
YCases pm Within	-0.00214	-0.0157***
	(-1.08)	(-6.03)
YCases pm Between	-0.00347	0.00629
	(-0.49)	(0.16)
L28.Str Within	-0.441	0.203***
	(-1.50)	(2.60)
L28.Str Between	5.118	26.99
	(0.92)	(0.64)
FulVax ph	5.489*	7.486
	(1.70)	(1.28)
Reg.Qual.	54.64	67.43
	(0.90)	(0.23)
Time Fixed Effects	YES	YES
Constant	0	-1667.8
	(.)	(-0.59)
Observations	1460	1216

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8 *F-GLS estimation for RuleLaw in 2021 and 2022*

	(8.1) NewCases pm	(8.2) NewCases pm
YCases pm Within	-0.00214	-0.0157^{***}
	(-1.08)	(-6.03)
YCases pm Between	0.00167	0.0126
	(1.16)	(1.24)
L28.Str Within	-0.441	0.203^{***}
	(-1.50)	(2.60)
L28.Str Between	8.737	31.46
	(0.91)	(0.51)
FulVax ph	5.489^{*}	7.486
	(1.70)	(1.28)
RuleLaw	-60.17	-74.25
	(-0.90)	(-0.23)
Time Fixed Effects	YES	YES
Constant	0	-1472.3
	(.)	(-0.74)
Observations	1460	1216

t statistics in parentheses

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

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