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Original Article

Effectiveness of Government Policies in Controlling COVID-19 in India

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Abstract

The purpose of this study is to find the demographic factors associated with the spread of COVID-19 and to suggest a measure for identifying the effectiveness of government policies in controlling COVID-19. The study hypothesizes that the cumulative number of confirmed COVID-19 patients depends on the urban population, rural population, number of persons older than 50, population density, and poverty rate. A log-linear model is used to test the stated hypothesis, with the cumulative number of confirmed COVID-19 patients up to period *t* as a dependent variable and demographic factors as an independent variable. The policy effectiveness indicator is calculated by taking the difference of the COVID rank of the *i*th state based on the predicted model and the actual COVID rank of the *i*th state. Our study finds that the urban population significantly impacts the spread of COVID-19. On the other hand, demographic factors such as rural population, density, and age structure do not impact the spread of COVID-19 significantly. Thus, people residing in urban areas face a significant threat of COVID-19 as compared to people in rural areas.

Keywords

corona, COVID-19, lockdown, pandemic, social distancing

The year 2020 gave birth to a pandemic called COVID-19, which overshadowed all the existing problems faced by the world. It led to the suspension of social and economic activities in almost all countries. The reinstatement of all aspects of social and economic life depends on how effectively governments across the globe tackle this pandemic and protect their populations from getting infected.

The development plan adopted in 2015 by the United Nations General Assembly, called the Sustainable Development Goals, aims for development that ensures healthy lives and promotes the well-being of people of all ages. A fundamental assumption of the goals is that health is a significant contributor and beneficiary of sustainable development policies.[1] The COVID-19 pandemic has disrupted public health policies in both developed and developing nations across the globe. Consequently, governments around the world have devoted their public policies to fighting the pandemic.

The success of public policy depends on its adequate implementation. Any public policy will cease to become successful if the public does not readily accept it. The success of a public program or plan depends on several factors. McConnell[2] concludes that the success of public policy has 3 realms: processes, programs, and politics. Awareness of the development plan among the public determines its success. The government spends a substantial amount of money on advertisements for socioeconomic development programs directed toward the enhancement of health and education levels. As per the latest record, public expenditure on print, electronic, outdoor media, and printed publicity was approximately US$500 million in the 3 financial years from 2016–2017 to 2018–2019.[3] In India, the average annual public expenditure on advertisement is approximately US$166 million.

The outbreak of COVID-19 in India began appearing in late January. Since then, the number of patients infected with COVID-19 has increased exponentially. Despite the current slowdown in the Indian economy,

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the government responded proactively and imposed a nationwide lockdown on March 25, 2020, to control the pandemic.[4] Making lockdown successful in a nation with a population of approximately 1.30 billion is a mammoth task for both national and subnational governments.

Public policy designed with an understanding the behavior of the masses has a greater chance of achieving success. India is a democratic republic full of diversity in religion, caste, demography, and culture across its 28 states and 8 union territories. The behavior of the Indian people, firmly guided by social, religious, and cultural norms, can be influenced by introducing the principle of behavioral economics into action. The national government successfully employed the behavioral economics principles in the success of socioeconomic development programs such as the Swachh Baharat Mission and the Beti Bachao and Beti Padhao Yojana.[5] Guided by the social norms approach,[6] Swachh Baharat Mission and Beti Bachao and Beti Padhao Yojana established usage of toilets and empowerment of girls, respectively, as social norms. In compliance with the behavioral expectations within the society, people stopped defecating in the open because their neighbors were not doing it and started valuing their girl children because that became a social norm.

The lockdown in India started with a 14-hour voluntary public curfew on March 22, 2020. Public curfew was a self-quarantine request to the citizens by the prime minister of India. The unanimous acceptance of the public curfew across the nation shows that the term "public curfew" nudged people toward the behavior desired by the government. Asking citizens to clap for coronavirus warriors such as doctors, nurses, and police personnel for 5-min periods nudged people to respect the frontline fighters in this war against the pandemic. It motivated doctors and police officers to perform their duties efficiently in this difficult time. It also nudged the common public to respect doctors and police personnel. This nudge later turned out to be successful in keeping infected patients under quarantine on the instruction of doctors. The lighting of lamps, candles, or flashlights across the country on the same date and time symbolized the acceptance of the public policy of lockdown and generated a sense of collective consciousness. All these initiatives, prompted by the government, became social norms and influenced the behavior of people in the desired manner.

Despite being in the lockdown state for approximately 2 months, different Indian states and union territories have shown mixed trends of COVID-19 cases over the period. This outcome motivates the present study to achieve the following objectives: (*a*) to find the demographic factors affecting the spread of COVID-19, (*b*) to establish a suitable econometric model for predicting the hotspots of COVID-19, and (*c*) to suggest a measure identifying the effectiveness of government policies in controlling COVID-19.

Review of Related Literature

Countries across the globe are seeing lockdown and social distancing as solutions to stop the spread of COVID-19. The mass population movements in China during the Chinese New Year holiday are seen as a significant cause of the spread of COVID-19 in China.[7] The daily movement of population is bound to be more in urban areas as compared to rural areas.

The available literature on COVID-19 identifies that age structure plays an essential role in the spread of COVID-19. Countries having a higher number of older people are facing a severe threat of COVID-19.[8] Singh and Adhikari[9] analyzed the age-structured impact of social distancing and find that age structure contributes to assessing the impact of social distancing. Age structure is relevant because, among patients who died in Italy because of COVID-19, approximately 42% were aged between 80 to 89 years, approximately 32% were aged between 70 to 79 years, approximately 8% were aged between 60 to 69 years, and approximately 28% were aged 50–59 years.[10] The median age of COVID-19 patients is 47.5 years.[11]

Fang and Sameh,[12] in their study on Chinese cities, found evidence against the argument that density is a key determinant of COVID-19 transmission. The study finds the existence of fewer cases of COVID-19 in cities with very high population densities and more cases of COVID-19 in cities with relatively lesser population densities. Contrary to this, Rocklöv and Sjödin[13] argue that it is difficult to maintain a distance of more than 1 m between people, as recommended by the World Health Organization in areas with higher population densities. Thus, it is likely that the spread of COVID-19 will be higher in areas of high population density.

Jack Tsai[14] argues that the probability of the spread of COVID-19 among the poor and homeless people is high. Ahmed et al.[15] emphasized that because the most impoverished populations suffer from chronic conditions, they are at a higher risk of mortality associated with COVID-19.

Because COVID-19 is a recent phenomenon, there exists a paucity of peer-reviewed literature on the subject matter. The majority of the available articles are either under the process of peer review or non-peer-reviewed. Also, none of the available articles tried to find the role of the demographic factors in the spread of COVID-19 using a regression approach. Thus, this study aims to fill a gap in the existing literature.

Methodology and Model

To study the stated objectives, we based our study on Indian states. We hypothesize that the number of patients tested positive with COVID-19 in Indian states depends on the urban population, rural population, number of persons older than 50, population density, and poverty rate in the state. The following simple linear regression model is used to test the stated hypothesis:

$$\sum C_{ti} = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \mu_{ti} \quad (1)$$

Here, C_{ti} is the dependent variable that shows the cumulative number of confirmed COVID-19 patients in the ith state up to period t, X_{1i} is the total population in the urban areas of the ith state, X_{2i} is the total population in the rural areas of the ith state, X_{3i} is the total population older than 50 in the ith state, X_{4i} is the population density in the ith state, X_{5i} is the poverty rate in the ith state, and μ_i is the random error term.

On substituting the estimated values of the significant parameters in equation (1), we predict the confirmed cases of COVID-19 in the states and rank them in descending order. Then we measure the effectiveness of government policies in controlling COVID-19, as suggested in equation (2):

$$E_i = CR_{ai} - CR_{pi} \quad (2)$$

where, E_i is the policy effectiveness indicator highlighting the effectiveness of government policies in controlling COVID-19 in the ith state, CR_{ai} measures the actual COVID rank (in descending order) of the ith state, and CR_{pi} measures the COVID rank of the ith state based on the predicted model.

Effective pandemic control policies would reduce the number of COVID-19 cases in the state, leading to a lower actual rank. However, the predicted rank of the state (CR_{pi}) does not count for the reduction in COVID-19 cases due to government policies. Thus, ceteris paribus, it can be argued that the difference in actual rank and predicted rank is due to the effectiveness of government policies. Given the considerable value of demographic factors, the predicted rank of the state (CR_{pi}) will be high, and effective pandemic control policies will lower the actual rank of the state (CR_{ai}). Thus, a positive value of E_i will be obtained if $CR_{ai} > CR_{pi}$ depicting that pandemic control policies have been effective in controlling the COVID-19 cases. If $CR_{ai} < CR_{pi}$ then E_i will be negative, revealing the ineffectiveness of pandemic control policies.

Data Description and Sources

The detailed literature review led to the selection of variables for this study. The data of the selected variables were collected for 35 states and union territories of India. Because the data for all the variables was not available for the Telangana state separately, its data was merged with Andhra Pradesh state, from which Telangana was separated on June 2, 2014. A description of the variables is presented in Table 1.

Data on the cumulative confirmed cases of COVID-19 for each state were collected from covid19india.org, a crowdsourced data platform. This platform uses official bulletins and government information to provide the latest data. The authors further verified the collected data on confirmed cases of COVID-19 from data available on the website of the Ministry of Health and Family Welfare, Government of India. The cumulative confirmed cases of COVID-19 measure the total number of patients tested positive for COVID-19 in each state. Data on demographic variables such as urban population, rural population, age structure, and population density were taken from the Office of the Registrar General and Census Commissioner, Ministry of Home Affairs, Government of India. Data on poverty were taken from the National Sample Survey Organisation, NITI Aayog.

Results and Discussion

This section presents the results of the regression model shown in equation (1) and interprets the results. By observing the scattergrams of the variables with and without natural logarithms, it became clear that the log-liner model best explains the relationship between the variables. The scattergrams, shown in Figure 1, present the relationship between the dependent variable and explanatory variables.

Table 1. Description of the Variables.

Variable	Description
Confirm	It shows the total number of patients tested positive for COVID-19 as on May 9, 2020.
Urban	It shows the total population in urban areas of the state, measured in millions.
Rural	It shows the total population in rural areas of the state, measured in millions.
Age	It shows the total population aged 50+ in the state.
Density	It shows the density of population in the state per square kilometer.
Poverty	It shows the poverty rate in the state, in millions, based on Tendulkar Methodology.

Source: Authors' original work.

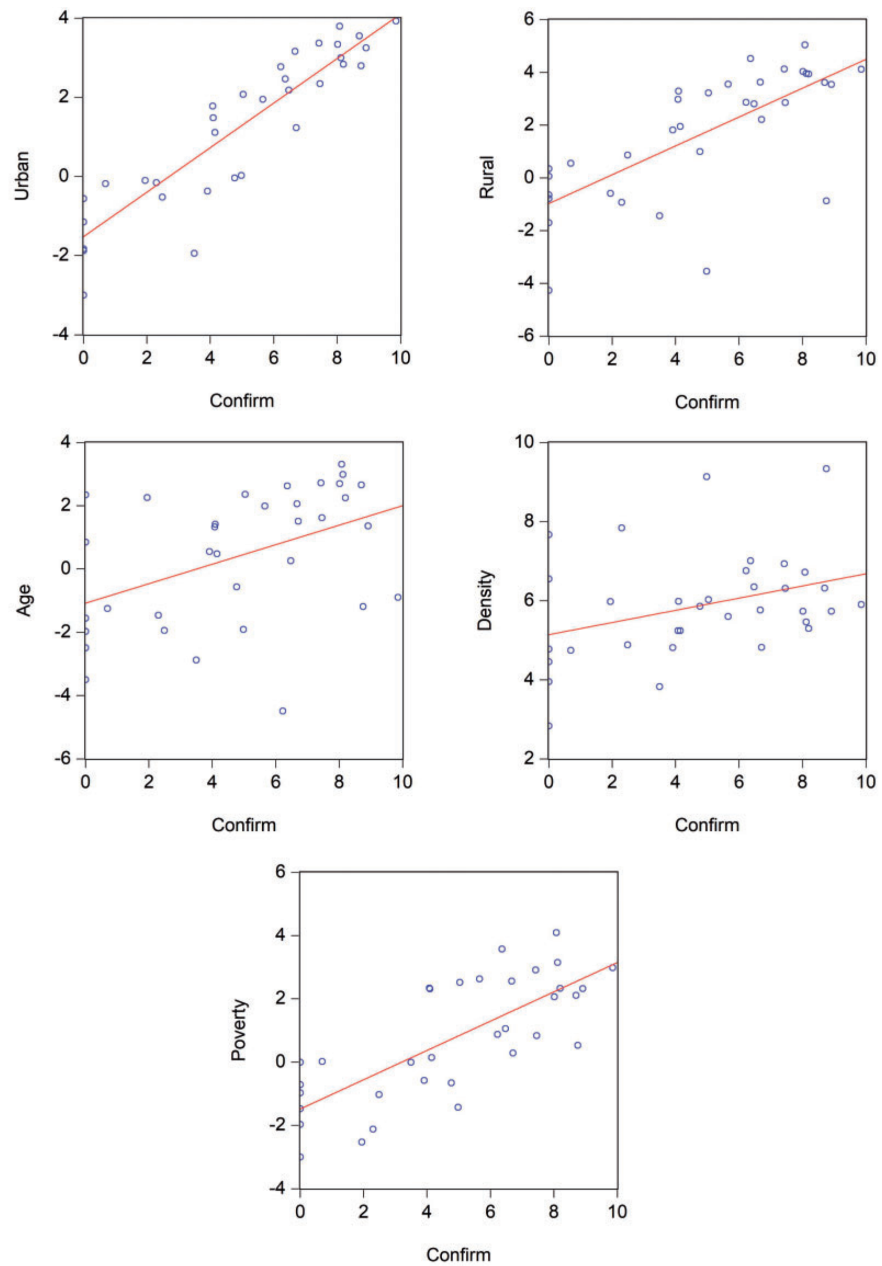


Figure 1. Scatterplot of independent variables against dependent variables.

Table 2. Summary of Statistics.

	Confirm	Urban	Rural	Age	Density	Poverty
Mean	4.81	1.18	1.65	0.40	5.88	0.74
Median	5.01	1.63	2.51	1.09	5.81	0.69
Maximum	9.86	3.93	5.05	3.31	9.33	4.09
Minimum	0.00	−3.00	−4.27	−4.49	2.83	−3.00
Std. Dev.	3.14	1.95	2.42	2.14	1.36	1.93
Skewness	−0.27	−0.36	−0.69	−0.52	0.49	−0.16
Kurtosis	1.82	1.94	2.55	2.11	3.77	1.91
Sum	163.54	40.16	56.13	13.62	199.86	25.25
Sum sq. Dev.	324.84	125.14	193.32	151.24	61.00	122.55
Observations	34	34	34	34	34	34

Source: Authors' calculation.

Thus, we estimate equation (3) using the method of ordinary least squares:

$$\ln Confirm_i = \beta_0 + \beta_1 \ln Urban_i + \beta_2 \ln Rural_i + \beta_3 \ln Age_i + \beta_4 \ln Density_i + \beta_5 \ln Poverty_i \qquad (3)$$

A summary of the statistics and regression results are presented in Tables 2 and 3, respectively.

Table 3. OLS Estimation Results.

Dependent variable: Confirm
Estimation Method: OLS

Variable	*Coefficient*	*Sth. Error*	*T-statistic*	*Prob.*
Constant	2.88*	1.68	1.72	0.10
Urban	1.61***	0.35	4.54	0.00
Rural	−0.33	0.31	−1.06	0.30
Age	−0.03	0.15	−0.23	0.82
Density	0.07	0.27	0.25	0.81
Poverty	0.25	0.26	0.98	0.34
R-squared	0.84			
F-statistic	30.16 (0.00)			

*Significant at 10% level of significance.***Significant at 1% level of significance.
Source: Authors' calculation.

The regression result shows that out of the selected variables, only the urban population in the Indian states and union territories significantly affects the total number of patients tested positive for COVID-19. The estimated coefficient is significant at a 1% level of significance. An increase in the urban population by 1%, on average, leads to a 1.66% increase in the total number of COVID-19 cases. Thus, the total number of COVID-19 cases is very responsive to changes in the urban population. Hence, it can be said that states having higher urban populations face a greater risk of COVID-19. All other variables, such as rural population, age structure, population density, and poverty, have no significant impact on the dependent variable. An R-squared value of 0.84 shows that the model is a good fit, and 84% of the variations in the total number of patients tested positive for COVID-19 is explained by the independent variables. The F-statistic is significant at a 1% level of significance, which means the overall model is significant. The regression results are presented in Table 3.

In the next step, the estimated β_0 and β_1 coefficients (because only these 2 are significant) were used to create a COVID-19 threat index. The COVID-19 threat index ranks the states such that states having sizable urban populations and consequently facing a greater risk of

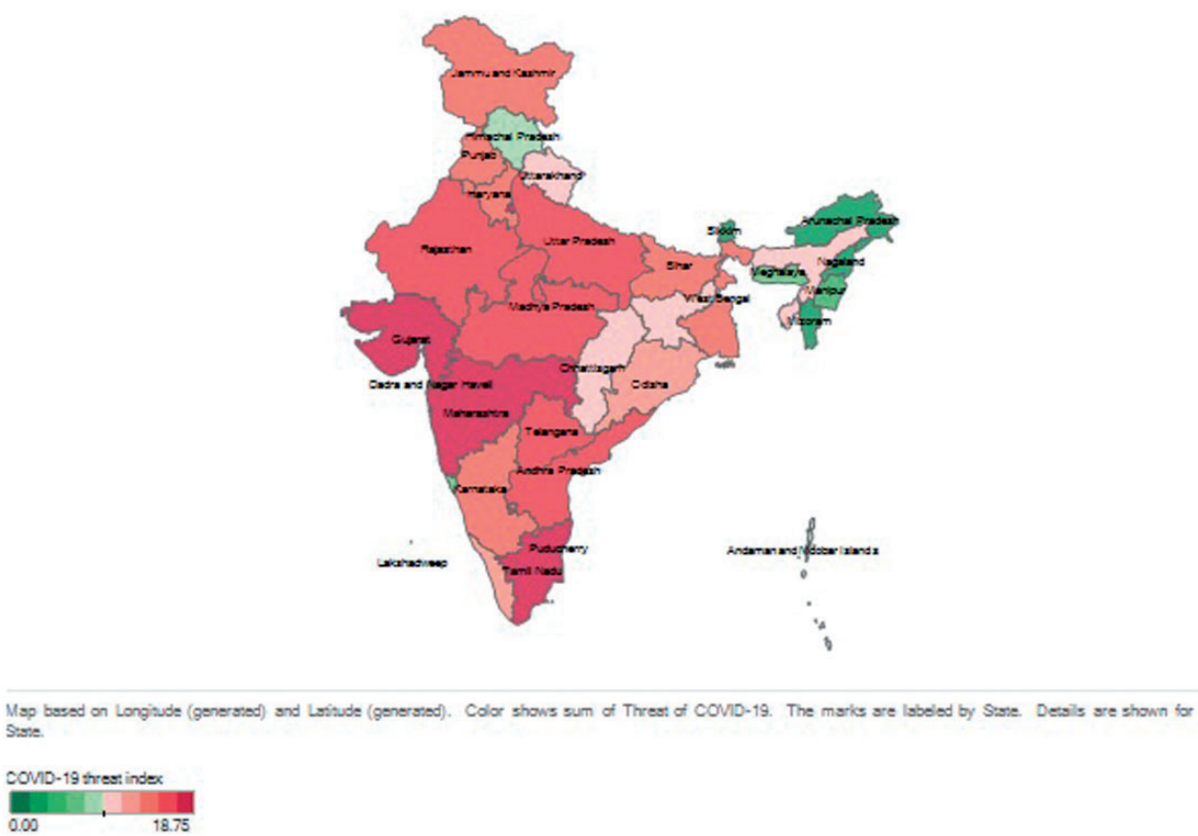
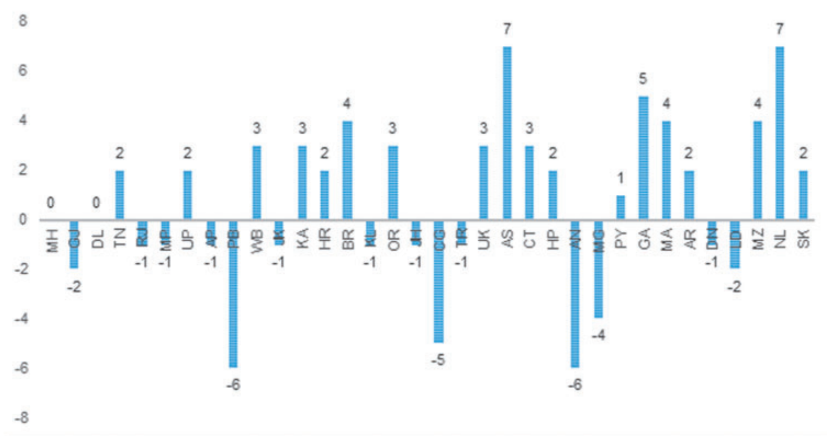


Figure 2. Mapping of predicted cases of COVID-19 in the Indian states.



Source: Authors' calculation

Figure 3. Policy effectiveness indicator of Indian states.

Table 4. COVID Rank of Indian States and Union Territories.

State	COVID Rank Predicted	COVID Rank (as of June 8, 2020)	Policy Effectiveness Indicator
MAHARASHTRA (MH)	1	1	0
GUJARAT (GJ)	2	4	−2
DELHI (DL)	3	3	0
TAMIL NADU (TN)	4	2	2
RAJASTHAN (RJ)	5	6	−1
MADHYA PRADESH (MP)	6	7	−1
UTTAR PRADESH (UP)	7	5	2
ANDHRA PRADESH & TELANGANA (AP)	8	9	−1
PUNJAB (PB)	10	16	−6
WEST BENGAL (WB)	11	8	3
JAMMU AND KASHMIR (JK)	12	13	−1
KARNATAKA (KA)	13	10	3
HARYANA (HR)	14	12	2
BIHAR (BR)	15	11	4
KERALA (KL)	16	17	−1
ODISHA (OR)	17	14	3
JHARKHAND (JH)	18	19	−1
CHANDIGARH (CG)	19	24	−5
TRIPURA (TR)	20	21	−1
UTTARAKHAND (UK)	21	18	3
ASSAM (AS)	22	15	7
CHHATTISGARH (CT)	23	20	3
HIMACHAL PRADESH (HP)	24	22	2
ANDAMAN AND NICOBAR ISLANDS (AN)	25	31	−6
MEGHALAYA (MG)	26	30	−4
PUDUCHERRY (PY)	27	26	1
GOA (GA)	28	23	5
MANIPUR (MA)	29	25	4
ARUNACHAL PRADESH (AR)	30	28	2
DADRA AND NAGAR HAVELI (DN)	31	32	−1
LAKSHADWEEP (LD)	32	34	−2
MIZORAM (MZ)	33	29	4
NAGALAND (NL)	34	27	7
SIKKIM (SK)	35	33	2

Source: Authors' calculation.

COVID-19 appear at the top, while states with a lower risk appear at the bottom. The estimated threat value of COVID-19 for each state was obtained by substituting the actual values of the estimated β_0 and β_1 coefficients and urban population in the model. The estimated values for each state were then ranked in descending order, with states facing the highest threat of COVID-19 appearing on the top of the list. The resulting index was plotted on the political map of India using a color code. The states and union territories in dark red have the highest threat of COVID-19, and the dark green states have the lowest threat of COVID-19. A color-coded threat mapping of COVID-19 in Indian states is given in Figure 2.

The calculated threat index was further used to rank the Indian states and union territories. Then, we ranked states based on the cumulative number of confirmed cases on June 9, 2020, as shown in Table 4.

The higher COVID rank shows the higher threat of COVID-19 in the respective state and union territory. The top 5 states facing the highest threat of COVID-19 are Maharashtra, Gujarat, Delhi, Tamil Nadu, and Rajasthan. The states and union territories facing the lowest threat of COVID-19 are Daman and Diu, Sikkim, Nagaland, and Mizoram and Lakshadweep. All the northeastern states and hilly states face a lesser threat of COVID-19.

The policy effectiveness indicator was calculated and is shown in Figure 3. It shows that the response of government policies has been effective in controlling COVID-19 cases in Andaman and Nicobar Islands, Punjab and Chandigarh, among others. The northeastern states that face a lesser threat of COVID-19 have not been able to control COVID-19 effectively.

Conclusion and Policy Implications

India is the second-most populous country in the world, with 376 million Indians residing in urban areas. Our study finds that the urban population significantly affects the spread of COVID-19 in Indian states. In contrast, demographic factors such as rural population, density, and age structure do not have a significant impact on the spread of the disease. Thus, our study contradicts existing studies that argue that age structure and population density are key determinants of the COVID-19 pandemic.

The majority of the Indian population resides in rural areas. The insignificant impact of rural populations on COVID-19 cases might be due to the successful implementation of lockdowns, which restricted the movement of people from urban to rural areas. In addition, people in rural areas have a healthier lifestyle, cleaner air to breathe, and a lower prevalence of diseases such as diabetes and high blood pressure, which would have reduced the number of COVID-19 cases. However, it can also be argued that the underreporting of COVID-19 cases due to inadequate data collection in rural areas could be a reason behind the insignificant impact. Apart from the demographic factors analyzed in the study, social and living conditions could also play a dominant role in explaining the spread of COVID-19. Thus, the study calls for future research in this direction.

The ranking of states based on the threat of COVID-19 indicates that states such as Maharashtra, Gujarat, Delhi, Tamil Nadu, Rajasthan, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Telangana, Punjab, and West Bengal face a more significant threat of COVID-19. Thus, the governments of these states should design pandemic control policies with a greater focus on urban areas. A considerable number of migrant workers moved from the urban areas of states such as Maharashtra and Gujarat to Uttar Pradesh, Bihar, and Madhya Pradesh. Hence, that might be one of the factors behind the lesser effectiveness of lockdown and government policies in these states. The northeastern states should improve the effectiveness of public policies directed toward the control of the pandemic.

Declaration of Conflicting Interests

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