Has COVID-19 Distorted the State-Wise Convergence in India? An Empirical Analysis

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Abstract

The study attempted to analyze the economic performance of Indian States with quarterly data from April 2018 to December 2021 by selecting high-frequency indicators. The majority of the States appeared to have reached their respective pre-pandemic levels, as indicated by trends in electricity generation, labor-force participation rate (LFPR), bank credit, and tax revenues, by the end of December 2021. However, in terms of indicators such as vehicle registrations and consumer sentiments, most States had not reached their pre-pandemic levels. We found that Sigma (unconditional) convergence among States was not evident for most of the indicators except bank credit, while beta (conditional) convergence slowed down in the aftermath of the coronavirus disease 2019 (COVID-19) pandemic based on indicators such as tax revenue, exports, and capital expenditure. In terms of bank credit, there was an indication of the convergence process coming to a standstill in the aftermath of COVID-19-induced disruptions.

Keywords : convergence, COVID, growth

JEL Classification Codes : A19, O13, O47

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I n the aftermath of the coronavirus disease 2019 (COVID-19) contagion, the global economy has widely observed the short-term phase of de-globalization, wherein countries closed their borders along with movements of people across countries and within the country. The disturbed supply chain and migration of unorganized sector workers took a heavy toll on the economy during the COVID-19 pandemic. As a result, India joined the global economy in an unprecedented economic contraction in 2020–2021. Though the fiscal and monetary authorities have necessarily and rightly provided policy support to prevent the COVID-19 crisis from destroying livelihoods, businesses, and production capacity, the academic circle and researchers have raised concerns over the alarming economic disparities among Indian States during COVID-19.

The COVID-19 pandemic had a significant negative impact on the global economy through disruptions at an unprecedented scale. The lockdowns created disruptions in economic activity, supply chains, nature of work, migration patterns, and existing economic trajectories worldwide. Such global changes are bound to have local repercussions. From a regional perspective, massive economic shocks caused by the pandemic are expected to

have a heterogeneous impact across the regions. This is due to structural variations of the regional economies, the differential impact of the pandemic, and numerous local policy responses to address the pandemic.

In India, the fight against the virus is fought at multiple levels. With the Union Government giving broad direction and policy support, STATEs and local governments took the lead in adopting and implementing policies according to specific local conditions. While some States were experiencing a peak number of cases, other States were still in the early stage of the virus transmission. This warranted local responses where some States were still under lockdown while others were gradually easing the restrictions. Such localized responses that have turned effective in addressing the pandemic are bound to lead to differential economic recovery from the COVID-19-induced disruption across States. Hence, the economic recovery trajectory is expected to vary across the States. Persisting regional inequities across the country have sustained interest in the convergence and divergence patterns across the States as an important economic question. Therefore, monitoring regional economic activity through high-frequency indicators has become paramount for proactive public policy, which helps in sustainable, balanced, and inclusive regional economic development.

To this end, the study attempts to analyze the economic performance of Indian States with quarterly data from April 2018 to December 2021 by selecting high-frequency indicators, namely, consumer sentiment, *Kharif* foodgrains production, vehicle registration, electricity generation, tax revenues, labor-force participation rate (LFPR), Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) 2005 work demanded, and the bank credit. The authors find a mixed trend. This article also tries to identify the impact of COVID-19 on existing patterns of convergence or divergence across Indian States. The authors find convergence among States slowing down in the aftermath of COVID-19 based on indicators such as per capita tax revenues, per capita exports, and per capita capital expenditure. However, the conditional convergence process in per capita bank credit came to a halt in the aftermath of COVID-19. These are worrying trends and need reinvigorated public policy measures to make course corrections.

Motivation and Objectives

Many countries are characterized by significant regional disparities in economic performance and living standards, as reflected in income, education, and health outcomes. This study aims to understand and analyze the State-wise economic performance, which has occupied considerable socioeconomic attention, with explanations varying from the nature of the States to planning their health management, economic development, employment, tax system, and infrastructure. This is the first article analyzing economic development (using quarterly data) in Indian States during pre- and post-COVID-19.

Thus, the following are two specific objectives of this study:

(1) To analyze how States have performed till end-December 2021 *vis-à-vis* their pre-pandemic levels based on selected indicators,[1] and

(2) To gauge the convergence path of States to analyze the impact of COVID-19 on the convergence trend among States.

The quarterly data on the selected economic indicators have been sourced from various ministries and agencies of the Government of India and data agencies such as CMIE.

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[1] Consumer sentiment, vehicle registration, labor-force participation rate (LFPR), electricity generation, employment rate, bank credit, Kharif foodgrain production, tax revenue, and Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) work demanded.

Literature Survey

The notion of convergence among multiple regions within a larger economic unit has its origins in the Solow – Swan growth model, which says convergence between poor and rich countries continues till capital and output per worker converge across countries (Solow, 1956). Barro et al. (1991) applied this to subregional units and found convergence in the per capita income (PCI) of the States in the United States of America. Islam (2003) further qualified this "unconditional convergence," stating That a country converges to its own single steady state because a steady state differs from country to country, thus suggesting the concept of "conditional convergence." Over time, several studies were conducted at the global level that differed in their results due to the period considered, the distinct group of economic units considered for analysis, and the methodology adopted (Li et al., 2016; Próchniak & Witkowski, 2013; Völlmecke et al., 2016). However, persistent regional inequities across the globe make the question of economic convergence even more relevant. For instance, IMF researchers, Floerkemeier et al. (2021) found that many countries are characterized by significant regional disparities in economic performance and living standards, as reflected in income, education, and health outcomes.

In advanced economies, regional disparities have broadly increased since the late 1980s as affluent places, particularly large and well-connected cities, pulled away from poorer ones. In developing economies, regional disparities in the gross domestic product (GDP) per capita are even larger.

The studies on convergence[2] within India have also diverged in their findings. Cashin and Sahay (1996) examined data for the period 1961–1991 and found some evidence for unconditional convergence in the analysis period, with the strongest effect being identified in the 1961–1971 decade. Agarwalla and Pangotra (2011) tried to examine the trends in disparities across the regions in India over 26 years (1980–2006). They found a convergent trend in regional incomes, conditional upon growth rates of inputs, and technological growth rate. Kumar (2015) examined the convergence in seven sister states in the Northeastern region of India and found that they experienced a degree of convergence in the PCIs during the 1990s and divergence during the first decade of the twenty-first century. Mishra and Mishra (2018) found that the PCIs of all BIMAROU states, except Uttar Pradesh, are found to be stochastically converging in the long run.

In contrast, many studies found evidence for divergence across the regions. Kalra and Sodsriwiboon (2010) examined the convergence and spillover across the Indian states using nonstationary panel data techniques. The finding suggested the existence of divergence over the entire sample period, convergence during subperiods corresponding to structural breaks, and club convergence. Swarup et al. (2021) tested for stochastic convergence hypothesis by employing State-level data for 19 Indian States (from 2001 to 2015) and concluded that total factor productivity, as well as the factor inputs (i.e., labor and capital), exhibited divergence, implying persistence in income inequality across Indian States. Misra et al. (2022) studied income convergence at the district level in India and did not find any evidence for convergence of the per capita district income. Many empirical studies on the Indian States indicated that the impact of growth on socioeconomic development has not been uniform across all Indian States.

Against this backdrop, given the differences in the findings of these studies, there is a pertinent need for further research into the questions of convergence within India, especially after the COVID-19 pandemic-induced disruptions. The COVID-19 pandemic has impacted economic activity across the world along with a significant impact on regional economic development. Martinho (2021) studied the impact of the COVID-19 pandemic on the convergence of per capita GDP across OECD countries. However, such an assessment in the Indian context

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[2] In literature, there are broadly two types of convergence, namely, unconditional/absolute convergence and conditional/beta convergence. Unconditional convergence refers to where the economic growth among countries/States/regions is convergent at the same steady state ; whereas, conditional convergence refers to where nations do not converge at the same steady state but different steady states conditioned by the specific peculiarities of the various countries, States, and regions.

was considered inadequate. In this context, this study analyzes a pertinent question, whether COVID-19 has distorted the State-wise convergence in India, using State-level quarterly data from April 2018 to December 2021 along with an analysis of the State-wise economic developments in pre- and post-COVID-19.

State - Level Data Analysis and Empirical Findings

The pandemic began with a gradual spurt in new cases from March 2020 onwards, leading to a nationwide lockdown impacting economic activity. A second wave of the pandemic from April 2021 had a severe impact on both lives and livelihoods. Regional variations in the incidence of COVID-19 can be mapped with differing fatality rates across the States. While Punjab and Maharashtra were among the States with the highest fatality rates till end-March 2022, Telangana and Andhra Pradesh had the lowest fatality rates among the major States (Figure 1a). By the end of March 2022, more than 182 crore vaccine doses were administered to the public in India. Most States reported near-universal vaccination of the first dose along with precautionary dose and vaccine for the age group of 15–18 years. In terms of the second dose also, most States reported more than 90% of the eligible population getting vaccinated. Jharkhand had the lowest share of its eligible population getting both doses of vaccine. However, many large States like Andhra Pradesh, Karnataka, and Madhya Pradesh reported more than 99% of coverage of vaccines for eligible populations (Figure 1b).

Given the differential incidence of COVID-19 and varied vaccination progress across States, it becomes crucial and pertinent to understand and analyze how COVID-19 has impacted various economic activities in different States so far. In this regard, the quarterly[3] data on selected economic indicators have been used in this study.

Figure 1. *COVID-19 Fatality Rates and Vaccination Status*
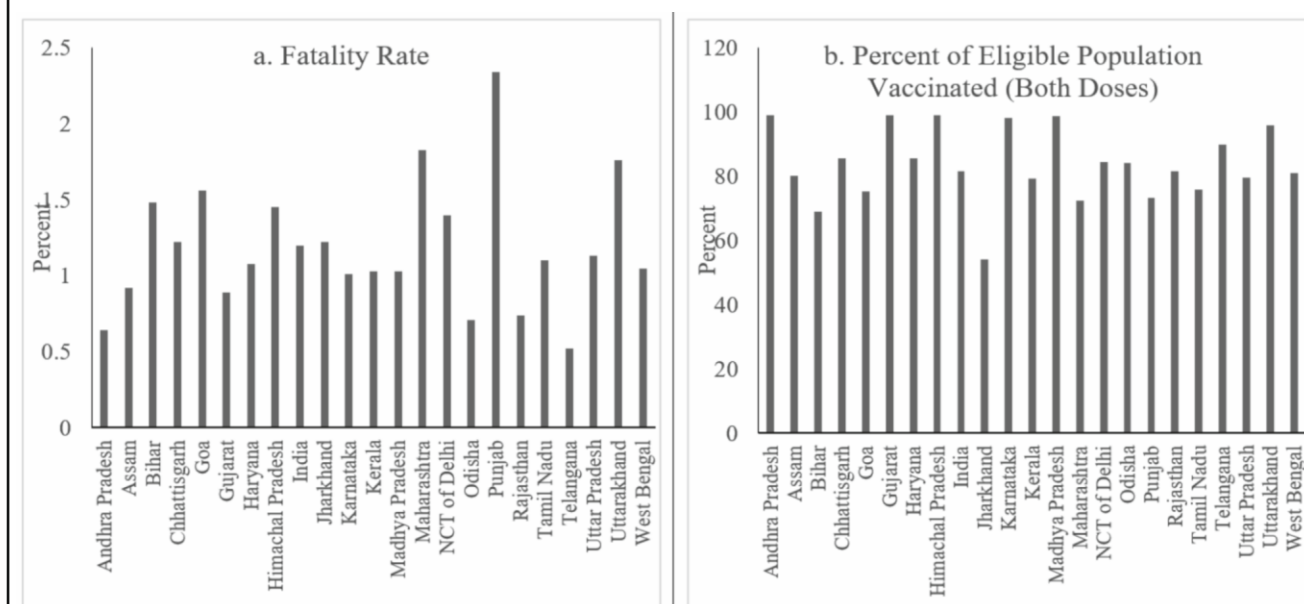
Source : Ministry of Health and Family Welfare, Government of India, and The Hindu COVID-19 Tracker (as on March 30, 2022).

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[3] This study compares Q3 data across States for each selected year to avoid seasonality. Q3: 2021–2022 is taken because it is the latest quarter for which data are available for all States.

Consumer Sentiment

The link between consumer confidence indicators and economic activity is found to be more relevant during crisis periods, such as recession or depression, or during big political and economic upheavals. The consumer sentiment index[4] is an economic indicator that measures how optimistic consumers feel about their finances and the State of the economy. States continued with a high level of consumer sentiment until it was disrupted by the pandemic, which led to a sharp downfall in Q1: 2020–2021 for almost all the States. The lowest level was seen in Chhattisgarh. However, the States soon steered on a recovery path, which was again impacted by the second wave of COVID-19. With continued efforts toward vaccination, it was made possible for the States to go for quicker unlockdowns, which was reflected in improved consumer sentiment for the majority of States in Q3: 2021–2022. Himachal Pradesh, Rajasthan, Uttar Pradesh, and Gujarat were the States with high consumer sentiment in Q3: 2021–2022 (Table 1). This has been possible mainly due to increased mobility and the swifter reopening of market areas to a greater extent in these States. Moreover, proactive measures undertaken by States have been noteworthy. Specifically, effective door-to-door surveillance in Himachal Pradesh and self-proclaimed

Table 1. *Consumer Sentiment Index*

State	Q1: 2019–2020	Q2: 2019–2020	Q3: 2019–2020	Q4: 2019–2020	Q1: 2020–2021	Q2: 2020–2021	Q3: 2020–2021	Q4: 2020–2021	Q1: 2021–2022	Q2: 2021–2022	Q3: 2021–2022
Andhra Pradesh	111.6	108.2	104.5	101.3	24.3	38.6	47.2	59.6	46.2	45.6	52.4
Assam	100.4	107.2	114.4	113.9	55.8	59.2	71.9	76.4	65.5	64.8	71.9
Bihar	99.4	98.3	102.1	91.4	58.3	55.5	62	63.2	52.9	52.3	51.5
Chhattisgarh	90.3	93.8	102.4	97.6	6.4	5.1	18.5	24.3	39.5	55	67.5
Gujarat	150.7	131.1	139.8	128.8	41.2	32.5	77	99.7	93.7	115.3	87.6
Haryana	99.8	105.4	92.1	85.5	20.2	16.7	36.1	22.9	13	17.6	11.5
Himachal Pradesh	113.1	114.5	119.7	112.3	71	57.2	46.5	54.6	78.7	81.7	96.1
Jharkhand	87.2	85.3	83.8	85.7	25	37	64.8	72.3	63.5	80.5	84.2
Karnataka	122.4	125.5	132.4	114.9	48.4	68.1	58.3	42.9	31	40.3	58.3
Kerala	69.2	74.9	69.7	69.5	14.6	16.8	13.3	25.9	31.1	21.1	24.1
Madhya Pradesh	149.6	150.4	118.4	130.8	66.7	56.5	60.9	69.3	68.8	68.4	74.5
Maharashtra	91.9	92.2	89.7	87.9	26.9	32.6	39	48.8	42.4	46.7	50.3
NCT of Delhi	114.5	105	102.4	107.6	26.7	36	57.2	53.5	39.6	46.8	46.3
Odisha	102.4	104.9	113.3	116.9	43.3	36.5	41	39.4	44.5	54.3	48
Punjab	117.1	110.5	123.7	119.3	38.3	45.5	61.7	52.1	42.2	52.3	75.1
Rajasthan	110.2	103	109.8	114.4	51.2	70	78.5	78.8	66	65.6	94.4
Tamil Nadu	90.1	84.4	85.9	88.7	29.4	15.6	8	8.5	13.8	14.7	9.4
Telangana	117.5	122.1	124.4	124.6	38.9	48	64	56.2	52.9	46.6	54.2
Uttar Pradesh	118.2	124.3	123.9	121.4	66.2	68.3	80.1	78	78.6	80.3	91.6
Uttarakhand	104.9	103.7	98	95	47.8	57.9	69.7	72.8	75.3	69.3	71
West Bengal	94.1	99	93.1	75.2	46	37.1	37.6	42.2	35	55.2	39.4

Source : CMIE.

[4] Refer to https://consumerpyramidsdx.cmie.com/kommon/bin/sr.php?kall=wkb for methodology.

lockdowns imposed by the Panchayati Raj Institutions (PRIs) in Gujarat have contributed to improved sentiments and optimism in these States.

However, consumer sentiment across the States is still below their pre-pandemic levels in Q3: 2020–2021 *vis-à-vis* Q3: 2019–2020, indicating the need for continued fiscal and monetary policy support to revive the States completely. The not-so-dampening effect of omicron-led economic disruptions has also kept the spirits high. This indicates that consumers have understood the need to adapt and develop resilience against recurring COVID-19 waves in a better way. Moreover, there have been growing optimistic expectations about the rise in income.

Vehicle Registration

With regard to the automobile sector, Telangana and Madhya Pradesh were the top two States in vehicle registrations in Q3: 2021–2022 (Figure 2a). However, most States continue to witness a decline in the q-o-q term except for Gujarat and Telangana. Moreover, all the States are below their pre-pandemic levels in terms of vehicle registrations in Q3: 2021–2022, which requires policy attention. Odisha was the State with the lowest number below its pre-pandemic level (Figure 2b). However, with the ebbing of COVID-19 cases along with proactive trade policy, government support to address semi-conductor chips shortage, and emerging pent-up demand associated with complete unlockdowns across States, vehicle sales may grow manifold in the coming months.

Figure 2. *Vehicle Registrations*

Source : Vahan.
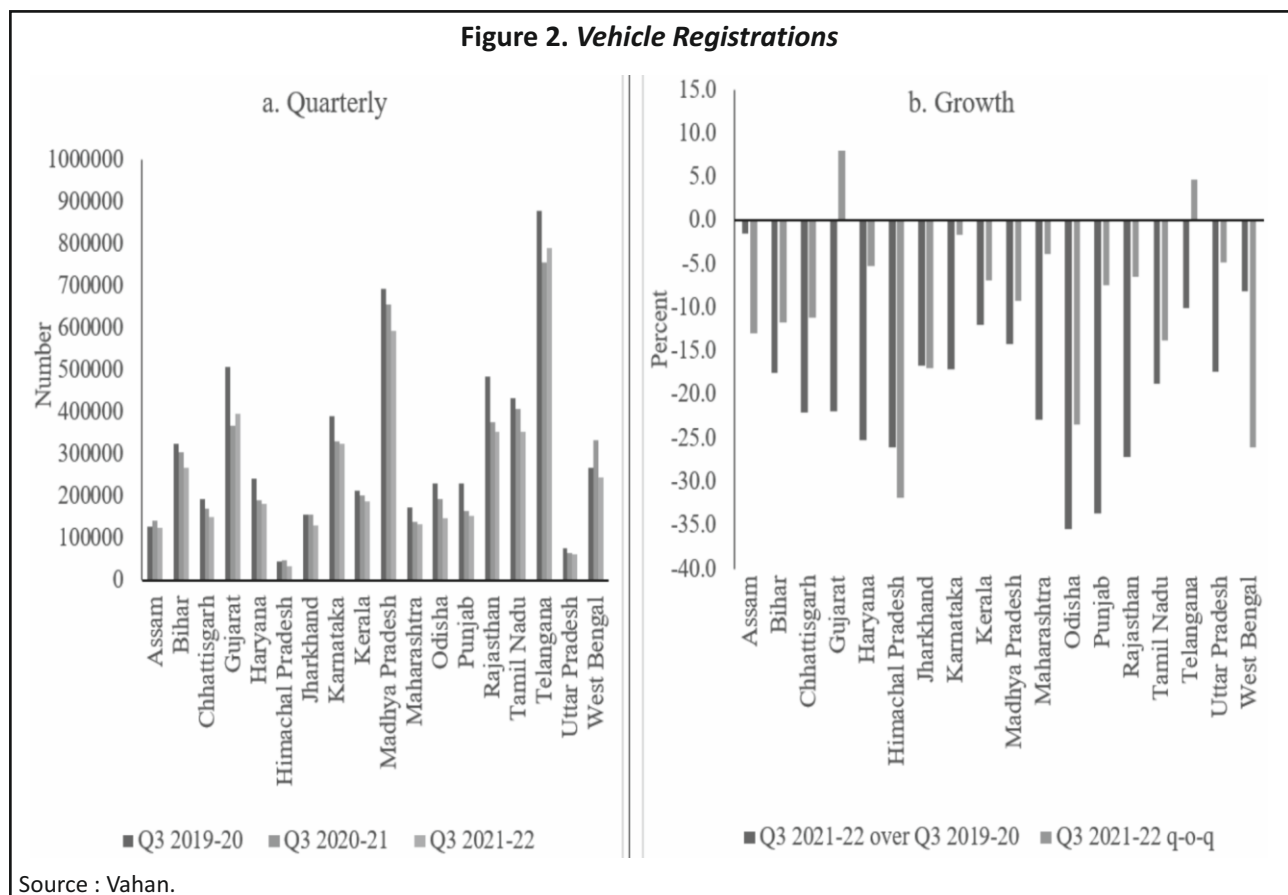
LFPR

The LFPR based on the CMIE household survey indicated significant disruption in the labor market caused by the pandemic. The LFPR, which was already lower for many States in the pre-pandemic period, was further reduced by the pandemic-induced economic shock.
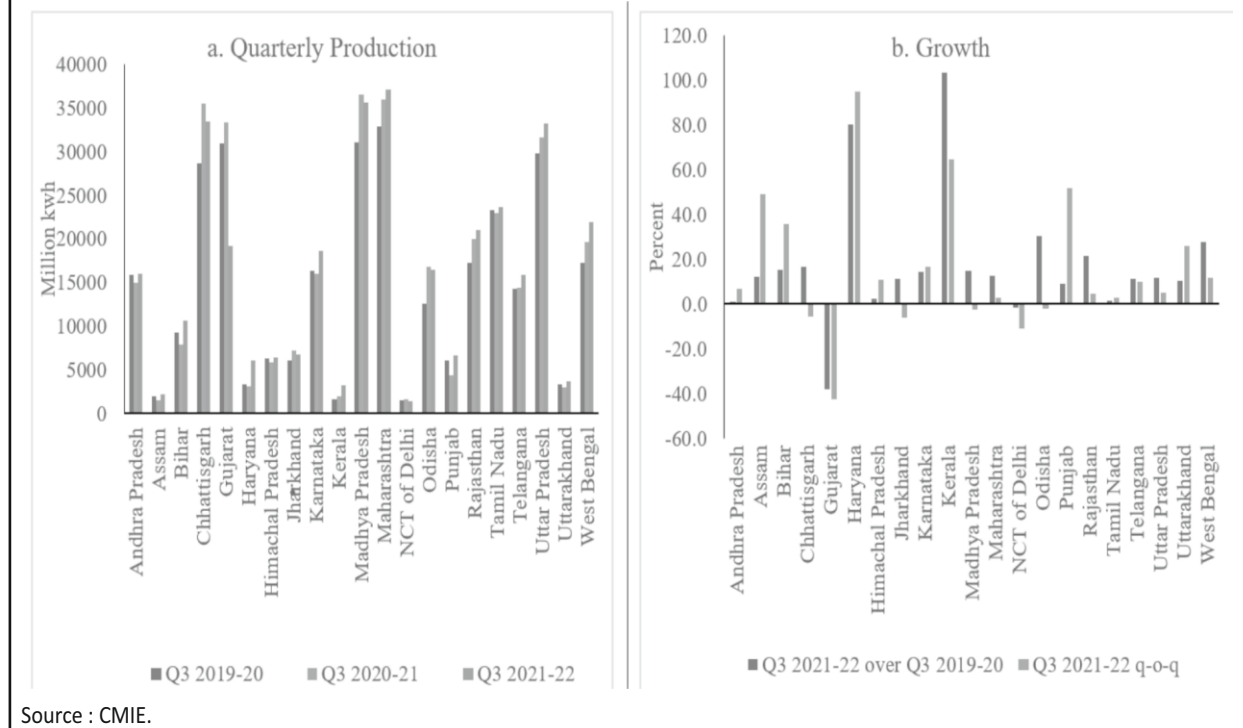
However, with the return of gradual normalcy and unlockdowns implemented across States, LFPR is indicated to have returned closer to the pre-pandemic level across many States in Q3: 2021–2022, signaling a movement toward a faster recovery. States like Haryana, Jharkhand, Maharashtra, and Rajasthan have even surpassed their pre-pandemic levels. Moreover, in the q-o-q term, many States have witnessed higher labor participation. Telangana and Gujarat recorded the highest LFPR in Q3: 2021–22 (Table 2). The high LFPR in Telangana is on account of higher women labor-force participation in the State, which is significantly higher than overall India's women LFPR.

Table 2. *Labor-Force Participation Rate*

State	Q1: 2019–2020	Q2: 2019–2020	Q3: 2019–2020	Q4: 2019–2020	Q1: 2020–2021	Q2: 2020–2021	Q3: 2020–2021	Q4: 2020–2021	Q1: 2021–2022	Q2: 2021–2022	Q3: 2021–2022
Andhra Pradesh	41.7	41.6	41.0	40.3	39.2	38.0	37.9	39.2	38.6	39.4	38.9
Assam	49.1	48.5	44.5	46.9	39.8	45.7	43.6	45.0	47.3	49.9	41.6
Bihar	38.8	38.3	38.4	37.8	37.6	36.7	35.6	37.3	35.5	35.5	35.0
Chhattisgarh	43.1	44.0	44.6	44.5	36.5	42.9	40.4	41.1	43.0	39.8	41.2
Gujarat	47.6	47.7	48.7	48.9	40.3	46.1	46.1	46.1	46.0	46.1	47.2
Haryana	44.4	43.3	43.4	42.9	41.8	42.0	41.9	41.2	42.3	42.5	43.7
Himachal Pradesh	44.0	45.3	45.6	43.8	35.3	42.5	39.0	39.3	37.4	36.3	34.8
Jharkhand	41.3	41.4	41.8	42.6	39.1	38.7	41.0	41.6	42.4	41.6	42.4
Karnataka	41.8	40.0	39.4	41.3	43.8	40.1	39.9	39.8	42.3	40.0	39.3
Kerala	38.4	36.6	36.0	36.0	31.7	35.3	33.7	33.7	34.9	34.2	35.1
Madhya Pradesh	39.4	40.1	40.0	39.0	38.4	40.0	39.8	38.4	36.6	39.0	38.2
Maharashtra	43.1	44.5	44.2	43.5	38.0	42.3	42.4	43.2	41.9	44.2	45.2
Meghalaya	59.1	62.0	62.5	63.4	52.3	62.2	60.7	61.3	58.6	63.8	58.4
NCT of Delhi	42.4	44.3	43.5	45.2	28.6	35.1	34.1	35.6	34.0	36.1	34.8
Odisha	40.4	41.7	42.0	40.4	32.8	39.0	40.3	39.5	39.2	39.9	40.8
Punjab	43.0	43.8	43.0	42.8	36.6	41.1	39.4	39.4	38.4	39.5	39.6
Rajasthan	40.3	40.0	41.7	40.7	39.2	41.0	44.6	44.1	45.5	44.3	45.4
Tamil Nadu	43.9	45.3	44.3	43.0	29.5	39.3	37.4	37.4	34.2	37.5	36.8
Telangana	53.7	55.9	55.8	58.7	51.7	54.3	53.1	52.8	49.4	52.6	52.7
Tripura	64.0	61.7	64.3	68.6	54.0	52.9	52.8	53.7	53.3	52.9	54.4
Uttar Pradesh	40.2	39.6	39.3	39.2	38.3	35.9	37.1	35.0	35.5	34.9	34.8
Uttarakhand	34.6	34.7	35.2	35.2	33.4	37.4	32.1	30.8	32.3	31.2	31.9
West Bengal	47.4	47.6	47.3	47.5	40.7	47.3	45.7	46.7	45.1	45.6	45.4

Source : CMIE.

Figure 3. *Electricity Generation*

a. Quarterly Production

Million kwh

Q3 2019-20   Q3 2020-21   Q3 2021-22

b. Growth

Percent

Q3 2021-22 over Q3 2019-20   Q3 2021-22 q-o-q

Source : CMIE.
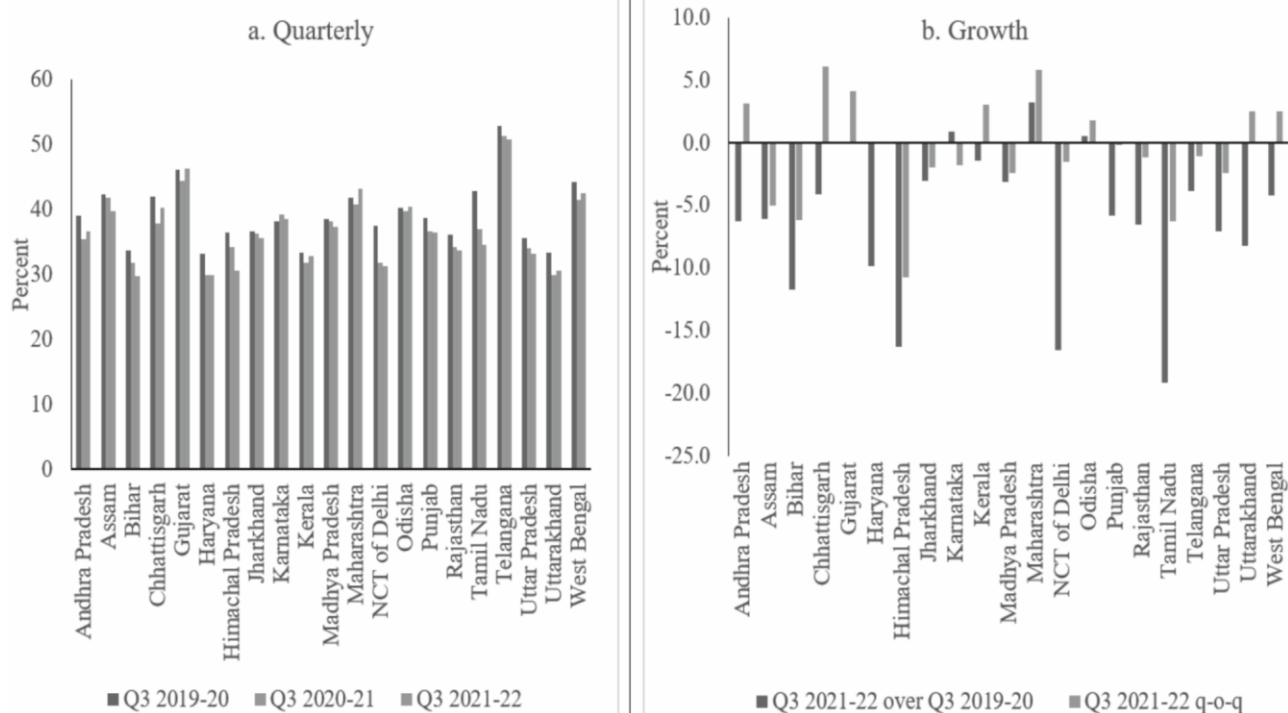
Electricity Generation

In India, the recovery of electricity generation was discernible in Q3: 2021–2022. Madhya Pradesh and Maharashtra were the leading States in electricity generation (Figure 3a). Moreover, it has improved significantly across the States in the q-o-q term, implying a sustained recovery in the economy as the pandemic recedes. Compared to the pre-pandemic levels, many States except Gujarat and the National Capital Territory (NCT) of Delhi have witnessed higher electricity generation than their pre-pandemic levels in Q3: 2021–2022 *vis-à-vis* Q3: 2019–2020 (Figure 3b). This indicates explicitly toward better recovery in industrial growth and bodes well for the future growth path of the country as a whole.

Employment Rate

In terms of employment rate (as published by CMIE), States have witnessed a significant surge in Q3: 2021–2022. Gujarat and Telangana were the top States in terms of employment rate (Figure 4a). In q-o-q term, Chhattisgarh, Gujarat, and Maharashtra were the leading States. This was because of proactive, strong, and supportive measures, such as encouraging MSMEs, faster clearances to industries, prompt credit support, and suitable labor reforms adopted by these States. However, in the q-o-q term, Tamil Nadu, Bihar, and Himachal Pradesh witnessed sharper declines in the employment rate.
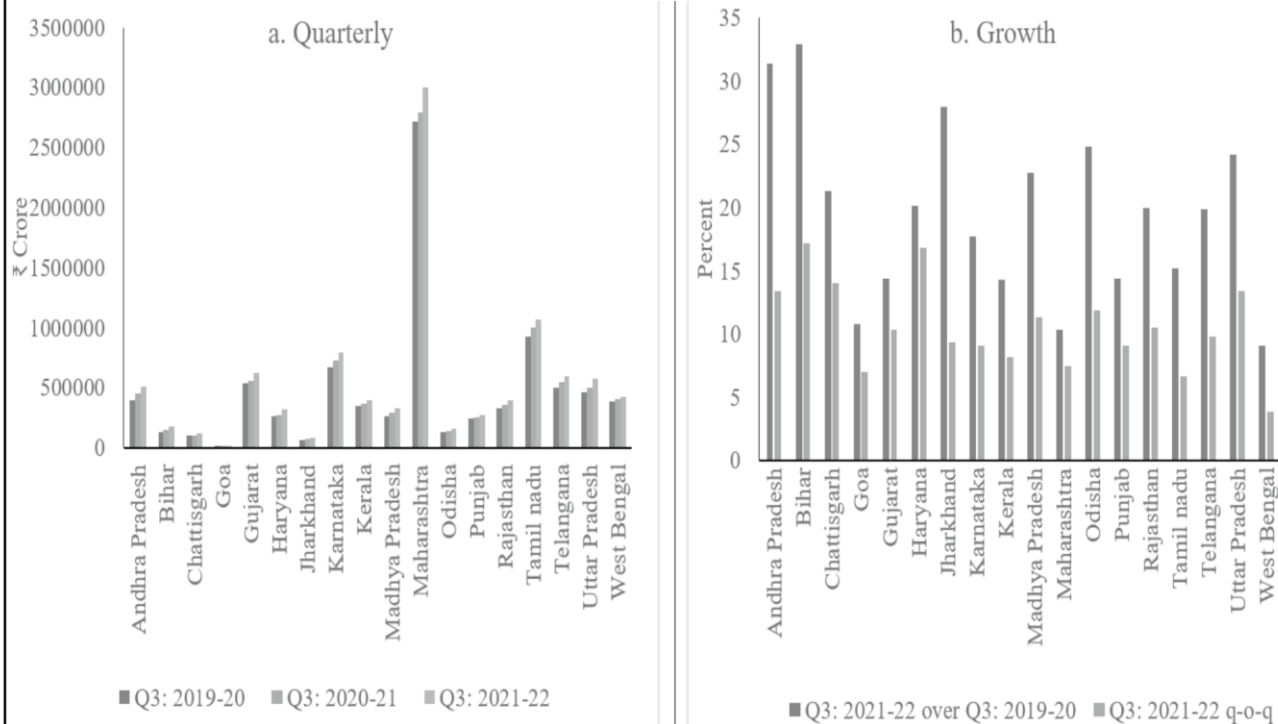
When compared to the pre-pandemic levels, Gujarat and Karnataka were the States that even witnessed a higher employment rate. Tamil Nadu, Bihar, Himachal Pradesh, and NCT of Delhi witnessed a significant reduction *vis-à-vis* their pre-pandemic level (Figure 4b). This requires taking significant measures in these States to address the issue holistically for faster and more inclusive growth in these States.

Figure 4. *Employment Rate*

a. Quarterly

b. Growth

■ Q3 2019-20 ■ Q3 2020-21 ■ Q3 2021-22

■ Q3 2021-22 over Q3 2019-20 ■ Q3 2021-22 q-o-q

Source : CMIE.

Figure 5. *Credit by SCBs*

a. Quarterly

b. Growth

■ Q3: 2019-20 ■ Q3: 2020-21 ■ Q3: 2021-22

■ Q3: 2021-22 over Q3: 2019-20 ■ Q3: 2021-22 q-o-q

Source : RBI.

Credit by Scheduled Commercial Banks (SCBs)

Credit by SCBs can be taken as an indicator to reflect the pace of economic activity across States. The bank credit growth has recovered across the States in Q3: 2021–2022. The total credit by SCBs in Q3: 2021–2022 was higher in all the States compared to their respective pre-pandemic level, indicating a strong surge in credit demand (Figure 5a). Bihar and Andhra Pradesh saw more than 30% growth in Q3: 2021–2022 compared to Q3: 2019–2020, whereas credit growth in Maharashtra and West Bengal was the lowest at 10% and 9%, respectively. Compared to the previous year, that is, Q3: 2020–2021, credit growth in Bihar and Haryana grew the highest at 17%, whereas it was the lowest in West Bengal at 4% (Figure 5b).

Foodgrain Production During Kharif

The economic implications of the COVID-19 pandemic have brought the agricultural sector into sharp focus and heightened its responsibility to feed and employ thousands of people who might have lost livelihoods. At this time, when most sectors of the economy are reported to be under significant stress, the agricultural sector continues to be promising and cushioning the economy.

For our purpose, foodgrain production refers to the performance of the agriculture sector across States. The impact of the pandemic on agriculture output was almost negligible, as reflected in foodgrain production during the *Kharif* season, which was a silver lining and acted as a cushion against pandemic-induced economic shock. Maharashtra and Telangana have registered the highest growth rate of 31% and 21%, respectively, during the *Kharif* season of 2021–2022 compared to the *Kharif* season of 2019–2020. Compared to 2020–2021, Telangana and Madhya Pradesh are top performers in foodgrain production in 2021–2022, with over 20% growth. Compared to the 2019–2020 *Kharif* season, the output has contracted in Gujarat and Kerala and registered a lower growth than the *Kharif* season of the previous year, 2020–2021 (Figures 6a and 6b).
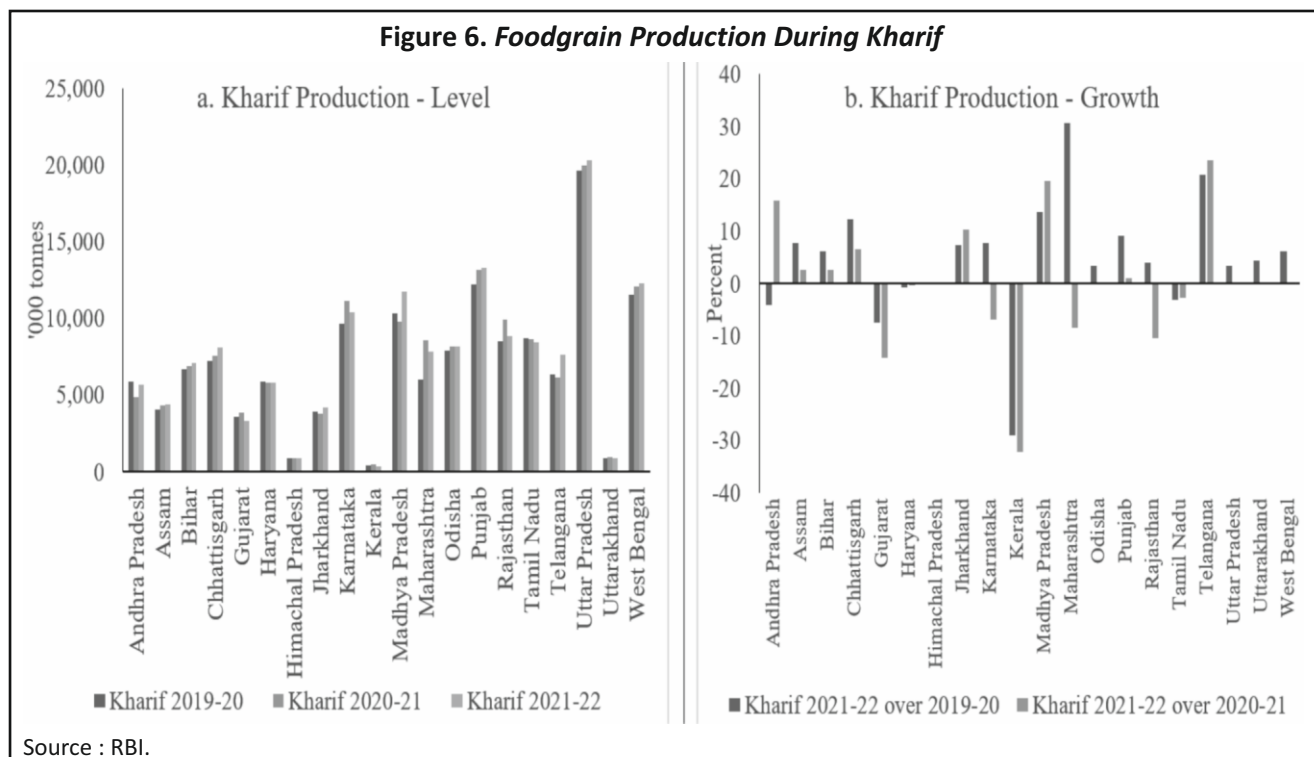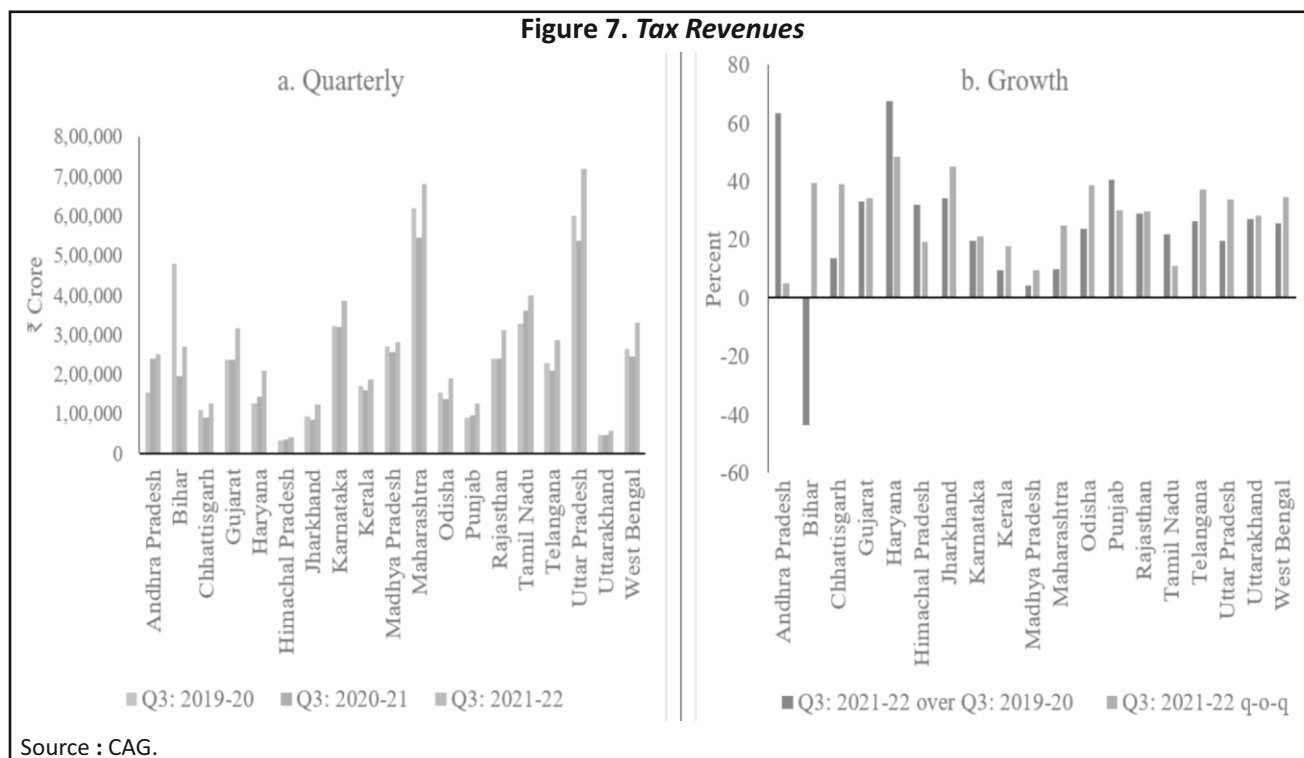

Figure 6. *Foodgrain Production During Kharif*

Source : RBI.

Figure 7. *Tax Revenues*
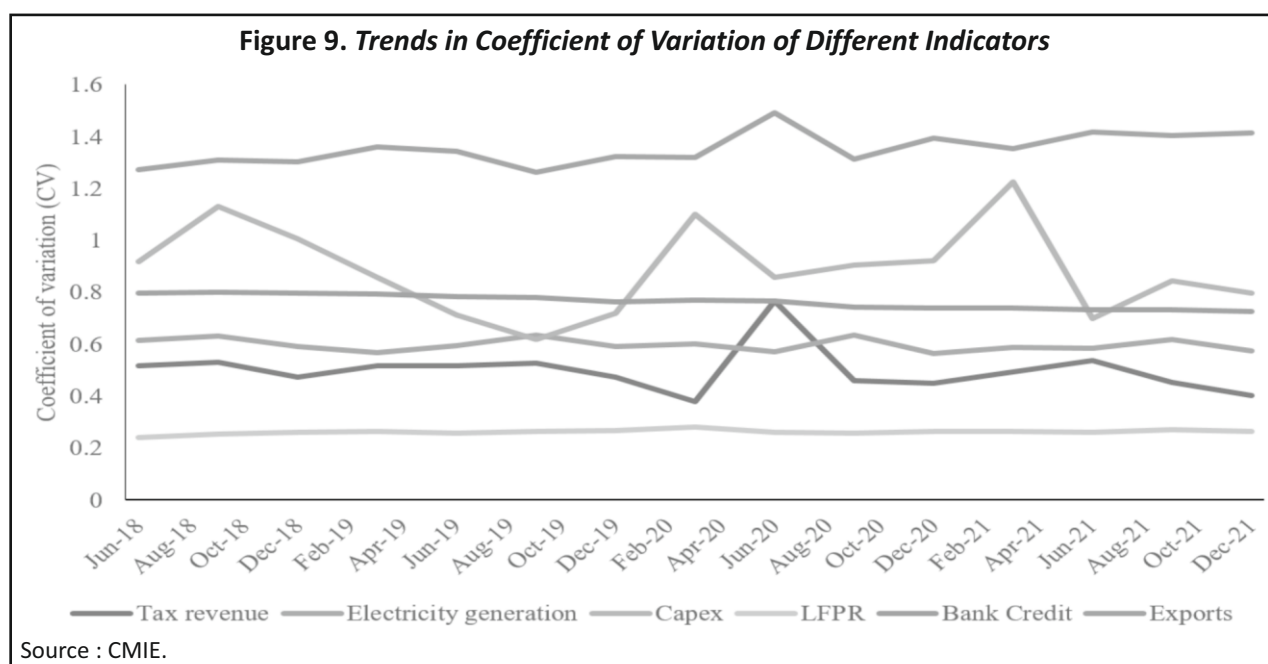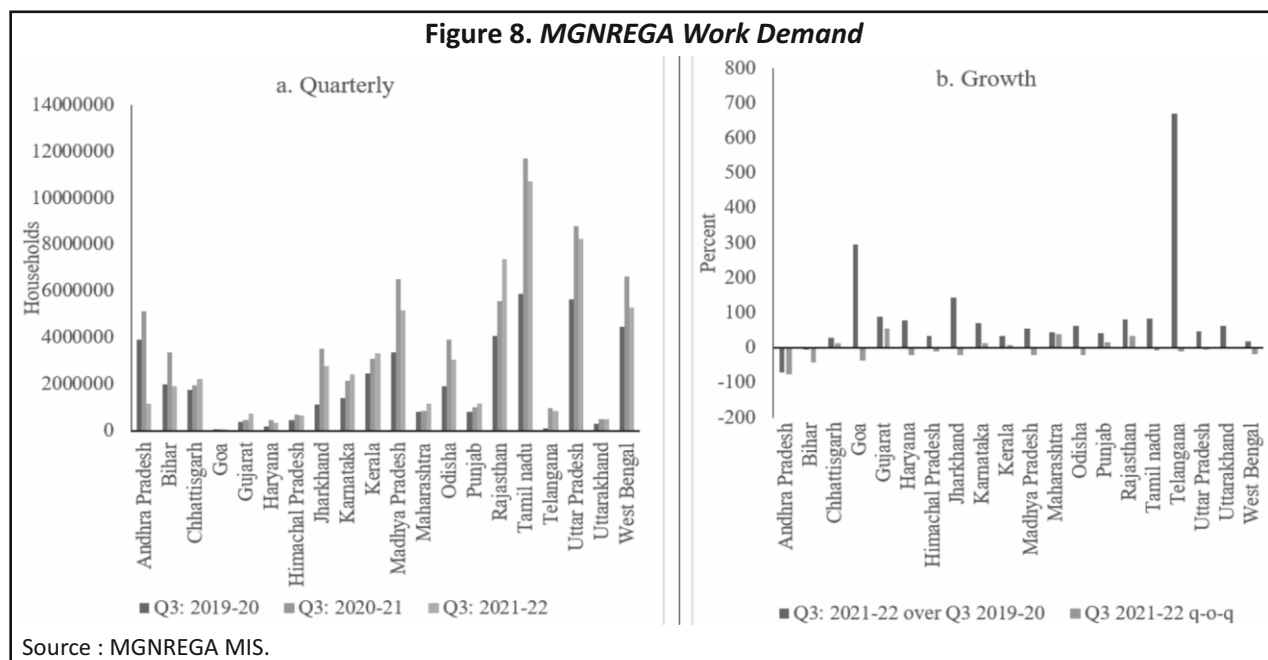

Source **:** CAG.

Tax Revenues

The growth in tax revenues reflects the status of economic activity in the respective States. In most States, tax revenues have recovered to the pre-pandemic level in absolute terms. During Q3: 2020–2021, tax revenues in most States fell below the corresponding period in the previous year (Figure 7a). Haryana and Telangana have recorded 67% and 64% growth rates, respectively, in Q3: 2021–2022 over Q3: 2019–2020. During Q3: 2021–2022, Bihar has seen a contraction of 44% compared to the pre-pandemic period of Q3: 2019–2020 and Madhya Pradesh has registered a modest growth of 4% in Q3: 2021–2022 over Q3:2019–2020. Compared to the previous year of Q3: 2020–2021 during Q3: 2021–2022, Haryana registered the highest growth, while Andhra Pradesh registered a growth of only 5% (Figure 7b).

MGNREGA Work Demand

The work demand under MGNREGA may be considered an indicator of the rural job scenario. In absolute terms, Tamil Nadu and Uttar Pradesh have the highest number of households demanding work under the MGNREGA scheme. Compared to Q3: 2020–2021, a decrease in work demand can be seen during Q3: 2021–2022, indicating an improvement in the availability of jobs and migration to cities for better economic prospects.

However, the work demand in Q3: 2021–2022 remains higher than the corresponding period in the pre-pandemic year of 2019–2020 (Figure 8a). The work demand in Telangana is highest in Q3: 2021–2022 compared to the pre-pandemic period of Q3: 2019–2020. It remains higher in most States except Andhra Pradesh, Bihar, Goa, and Haryana, indicating persistent demand for work under MGNREGA across the States (Figure 8b).

Figure 8. *MGNREGA Work Demand*

Source : MGNREGA MIS.

Figure 9. *Trends in Coefficient of Variation of Different Indicators*

Source : CMIE.

Sigma Convergence

The sigma convergence is one of the methods to gauge the convergence among cross-sectional units. It is also called unconditional or absolute convergence as it does not control for underlying differences in characteristics of different cross-sectional units. It is used to measure the reduction/increase in disparity across cross-sections over time. It is generally analyzed by comparing the standard deviation or coefficient of variation (CV) across cross-sections over a period. If the standard deviation or CV of the indicator is declining over time, it indicates

sigma convergence. In this study, sigma convergence is analyzed, but no definite declining pattern was obtained for the selected indicators, except bank credit (Figure 9). However, it can be observed that there was sigma convergence among states in terms of tax revenue in the pre-COVID-19 period that got disturbed by the pandemic-led disruptions.

Beta Convergence and Empirical Methodology

The models where the economic growth among countries, States, and regions is convergent at the same steady state have been associated with the convergence conceptions related to the neoclassical theory within the economic literature (absolute convergence) (Solow, 1956). In these cases, the poorer regions have grown faster than the richer ones. With constant or decreasing returns to scale, these processes are characterized by having input supply and technical progress that are exogenous and freely available in poorer countries, allowing for catching up to happen.

However, recently, the concept of conditional convergence has been gaining more attention, being closely associated with the endogenous growth theory, where nations do not converge at the same steady state but different steady states conditioned by the stock of different factors, say, human capital, for example (Barro, 1991). The convergence for different steady states is dependent on the specific peculiarities of the various countries, States, and regions (Chatterji, 1992). The concepts of sigma and beta convergence are mainly used in research related to convergence aspects. Sigma convergence quantifies the level of dispersion of the GDP per capita or productivity, and beta convergence is obtained through regression estimating a relationship between the growth rates and the starting level of the variable of interest, which is expected to be negative (Barro et al., 1991).

Beta convergence is said to occur if the countries, States, and regions having initially low PCI grow at a faster rate than those having higher PCI (in this study, due to the unavailability of State-wise quarterly data on PCI, selected indicators are taken, which are per capita tax revenues, per capita bank credit, per capita exports, and per capita capital expenditure). To obtain evidence with regard to beta convergence, the growth in these selected indicators is regressed upon their respective initial level based on econometric modeling. As per this method, convergence is confirmed if the coefficient of the initial level is negative and statistically significant.

In this study, fixed-effect panel-data estimation has been applied to 25 States[5] of India to obtain empirical evidence on beta convergence. The period used for regression analysis is quarterly data from April 2018 to December 2021, with April 2018 to March 2020 being the pre-COVID period. The panel data set is used for the analysis as it has more advantages over the cross-section and time-series data. The States or regions are heterogeneous units. Thus, the panel data estimation procedure allows for each individual and various time periods to be considered for the analysis at the same time. The panel data model has both fixed effects and random effects. Random effects are correlated with other explanatory variables and are generally biased. The authors conducted the Hausman test, which supported the fixed-effect model estimation. Panel data regression for the fixed-effect model is summarized in Table 3. The growth rate of selected individual indicators is regressed on their respective logarithm of per capita initial value. The convergence holds if there exists a statistically significant negative relationship between the current period growth and the logarithm of per capita initial value, that is, ($\beta > 0$ or ($-\beta$) < 0). Suitable control variables have been included in the model based on relevancy to the dependent variable.

The model specification is as follows:

Following Islam's (1995) and Sala-i-Martin's (1996) methodology, the authors have used β-convergence as in equation 1:

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[5] These states account for around 97% of India's GDP.

$$\ln (y_{it}) = \alpha + (1-\beta) \ln (y_{i,t-1}) + \gamma \ln (X_{it}) + \mu_{it}, \tag{1}$$

where, $0 < \beta < 1$ and μ_{it} have mean zero, finite variance, $\sigma^2 u$, and is independent over t and i.

Manipulating equation (1) yields,

$$\ln y_{it}/y_{i,t-1} = \alpha - \beta \ln (y_{i,t-1}) + \gamma \ln (X_{it}) + \mu_{it} \tag{2}$$

Thus, $\beta > 0$ implies a negative correlation between growth and the initial log value of a selected variable.

The hypotheses in this study are as follows:

↳ **H01 :** The conditional convergence among States based on per capita tax revenue is not affected after the pandemic-induced shock.
↳ **Ha1 :** The conditional convergence among States based on per capita tax revenue is affected after the pandemic-induced shock.

↳ **H02 :** The conditional convergence among States based on per capita exports is not affected after the pandemic-induced shock.
↳ **Ha2 :** The conditional convergence among States based on per capita exports is affected after the pandemic-induced shock.

↳ **H03 :** The conditional convergence among States based on per capita bank credit is not affected after the pandemic-induced shock.
↳ **Ha3 :** The conditional convergence among States based on per capita bank credit is affected after the pandemic-induced shock.

↳ **H04 :** The conditional convergence among States based on per capita capital expenditure is not affected after the pandemic-induced shock.
↳ **Ha4 :** The conditional convergence among States based on per capita capital expenditure is affected after the pandemic-induced shock.

Results

The results presented in Tables 3 to 6 pertain to the fixed-effect panel estimation model. The Hausman test favored the fixed-effect model compared to the random-effect model. Broadly, they confirm that the process of convergence, which was underway until the final quarter of 2019–2020, slowed down with the arrival of the COVID-19 pandemic. This happened in the case of tax revenues, exports, and capital expenditure, as the magnitude of the coefficient indicated that the initial value was reduced in the period, including COVID. In the case of bank credit, the undergoing convergence process came to a standstill in the aftermath of the COVID-19 pandemic.

There is evidence of conditional convergence among States in these aggregate variables. The States are converging toward their respective steady state in terms of tax revenues, exports, and capital expenditure, but their convergence speed has been slowed down by the pandemic-induced disruptions. With regard to bank credit, the coefficient is statistically insignificant, and signifying convergence process has been halted in the post-COVID-19 period, which was witnessing conditional convergence in pre-COVID time. LFPR and electricity generation are found to have statistically significant positive coefficients with respect to bank credit.

Table 3. *Fixed-Effect Panel Estimation*

Indicator	Pre-COVID (April 2018 – March 2020)					Interpretation
	Initial value	Capital Expenditure	CPI	LFPR	Electricity Generation	
	–113.4***	16.7	–0.53	–1.89	10.3	Convergence slowed
	[0.001]	[0.174]	[0.642]	[0.57]	[0.834]	down due to the impact
	Including COVID (April 2018 – December 2021)					of COVID-19
Tax Revenue	–62.8***	10.02	0.16	–1.37	8.8	(H01 is rejected)
Per Capita	[0.004]	[0.149]	[0.656]	[0.337]	[0.76]	

Table 4. *Fixed-Effect Panel Estimation*

Indicator	Pre-COVID (April 2018 – March 2020)			Interpretation
	Initial value	CPI	Electricity Generation	
	–889.8***	1.35	70.1	Convergence slowed
	[0.000]	[0.688]	[0.583]	down due to the
	Including COVID (April 2018 – December 2021)			impact of COVID-19
Exports Per	–811.02***	2.23**	86.59	(H02 is rejected)
Capita	[0.000]	[0.039]	[0.308]	

Table 5. *Fixed-Effect Panel Estimation*

Indicator	Pre-COVID (April 2018 – March 2020)				Interpretation
	Initial value	Capital Expenditure	LFPR	Electricity Generation	
	–66.8**	1.22	1.64***	12.16**	Convergence slowed
	[0.016]	[0.410]	[0.000]	[0.031]	down due to the
	Including COVID (April 2018 – December 2021)				impact of COVID-19
Bank Credit	–17.02	2.51**	0.57***	23.4***	H03 is rejected)
Per Capita	[0.480]	[0.024]	[0.005]	[0.000]	

Table 6. *Fixed-Effect Panel Estimation*

Indicator	Pre-COVID (April 2018 – March 2020)					Interpretation
	Initial value	CPI	LFPR	Electricity Generation	Tax Revenue	
	–2327.1***	79.3	–145.2	–1302.9	3423*	Convergence slowed down
	[0.000]	[0.134]	[0.346]	[0.57]	[0.057]	due to the impact of COVID-19
	Including COVID (April 2018 – December 2021)					(H04 is rejected)
Capital Expenditure	–1481.5***	–7.4	–8.9	–721.3	2667**	
Per Capita	[0.000]	[0.640]	[0.888]	[0.576]	[0.026]	

Notes.

1. Figures in the parentheses are the *p* - values.

2. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

3. CPI refers to consumer price inflation, and LFPR refers to the labor-force participation rate.

Moreover, capital expenditure significantly relates to bank credit in the post-COVID period. Higher tax revenue leads to higher capital expenditure and *vice-versa,* as reflected by the statistically significant positive coefficient of tax revenue coefficient.

Limitations of the Study

The period used in this study to analyze the impact of COVID-19 shock on the convergence pattern among Indian States is not relatively longer. Since COVID-19 struck India in March 2020, this study has to rely on fewer data points due to the shorter period available. A longer period would have led to the study being more robust. Also, as quarterly income data are not available for States, the convergence pattern could not be analyzed directly in terms of income, which would have enriched the analysis significantly. The income inequality aspect could have been analyzed, which is not possible at this stage due to the paucity of data. Furthermore, more broad-based and representative indicators, if available, could be included in the analysis, which would further enhance the usability, robustness, and scope of the study in the future.

Conclusion and Policy Implications

COVID-19 has left a lasting imprint on the State economies, causing permanent changes and teaching important lessons. A fixed-effect panel estimation model confirms that the process of convergence, which was underway until the final quarter of 2019–2020, slowed down with the arrival of the COVID-19 pandemic. The convergence process of States toward their respective steady state in the case of tax revenues, exports, and capital expenditure has been slowed down in the post-COVID world. Regarding bank credit, the convergence process, which was happening in the pre-COVID period, has shown signs of withering. Conditional convergence in the case of bank credit is no more evident.

The speedy and inclusive immunization drive against COVID-19 helped in engendering confidence and aided in rejuvenating various economic activities among States in a broad-based manner. However, to move further, what will remain critical is the need for more close policy and operational coordination, data/information sharing monitoring and evaluation, and consultative actions to shape the State economies that would deliver strong, sustainable, and balanced growth and be equally pivotal in the safety of human capital forever. The pandemic has revealed that policy choices made during such catastrophes would shape the Indian States and, ultimately, the Indian economy for decades to come.

Authors' Contribution

This research work is a collective contribution of all three authors – Sudhanshu Goyal, Akash Kovuri, and Ramesh Golait from the Department of Economic and Policy Research of RBI. The views expressed in this article are those of the authors and strictly do not represent the views of the Reserve Bank of India.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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