DISPARITIES IN PRODUCTIVE CAPACITIES AND DEVELOPMENT IN UTTAR PRADESH: A DISTRICT-LEVEL STUDY

Padma Suresh Mandala *

1. Introduction

In recent years, development economics literature has focused on strengthening productive capacities of economies especially in developing countries as the key to achieving sustained growth, poverty reduction and employment creation.In 2021, UNCTAD launched a new multidimensional index of country level productive capacities(UNCTAD, 2021) called the productive capacities index (PCI). This has led to growing literature examining the role of productive capacities in promoting economic growth and resilience of economies and reducing economic vulnerability to shocks besides country specific studies that assess gaps in productive capacities to identify comparative advantages as well as key binding constraints to socio-economic development(Gnangnon, 2021, 2022; UNCTAD, 2020; UNCTAD, 2022).

The present study aims to construct a measure of productive capacities at the district level in Uttar Pradesh (UP)to assess the relative position and gaps among districts in their productive capacities.

The state of UP is the most populous state in India and shows significant intra-regional variations in income, poverty, population, urbanization, and structural features (Agarwal et al, 2014; Diwakar, 2009; World Bank, 2016). The theoretical and methodological foundations for constructing a composite index of productive capacities provide policy makers with a useful measure to benchmark productive capabilities.Identifying the relative strengths and vulnerabilities of districts in terms of their productive capacities can help in aligning policies aimed at achieving economic growth and balanced regional development in the state.

2. Literature Review

UNCTAD (2021) defined productive capacities as "the productive resources, entrepreneurial capabilities and production linkages which together determine the capacity of a country to produce goods and services and enable it to grow and develop".Instead of focusing on output, the approach gives a multidimensional measure of economic inputs

* Associate Professor, Department of Economics, Sri Venkateswara College, University of Delhi

and potential.The Productive Capacities Index (PCI) of UNCTAD maps productive capacities across 46 indicators covering eight categories namely Information and Communication Technologies (ICTs), structural change, natural capital, human capital, energy, transport, the private sector, and institutions. UNCTAD (2021) reports PCI results for 193 countries for the period 2000-2018. The scores that range between 0 to 100 shows that least developed countries lag significantly with respect to productive capacities in the categories of structural change, human capital, energy, institutions, and ICTs. The index makes a valuable contribution in identifying lagging regions and countries besides proving useful for comparisons of progress over time.

The theoretical foundations of PCI explain the high degree of correlation observed between PCI and per capita GDP, human development, and sustainable development goals. Low per capita GDP is directly related to low levels of productive capacities while fostering productive capacities can spur structural transformation, economic growth, and sustainable development outcomes (UNCTAD,2021).

The focus of this paper is on assessing district-level productive capacities in Uttar Pradesh through construction of a district productive capacities index (DCI) based on five dimensions that capture district level capacities in sectoral resources and infrastructural linkages and an analysis of the performance of districts to identify the relative strengths and the dimensions in which districts are deficit.The results from such an analysis can help policy makers to identify lagging districts and plan for broad-based growth and structural transformation.

3. Data and Methods

Data for 75 districts of UP is obtained from the official state publication-District Wise Development Indicators (2021).The reported data for the indicators cover the years between 2017-18 to 2020-21.The composite district capacity index (DCI) is constructed using a two-step methodology and is based on 32 variables covering five dimensions that are given in Table 1.For each of the dimensions, a sub index is first constructed using the method of principal component analysis (PCA) and the composite DCI is then obtained as the geometric mean of the five sub indices. The choice of variables included in the index is based on theoretical and policy relevance as well as availability of district-level data.We estimate IND-Index that is a measure of productive capacities in industry, BFC-Index for Banking Finance and Cooperation, HED-Index that measures health and education, INF-Index that measures infrastructure and AGR-Index that measures agricultural and livestock resources.

Table 1.Dimensions and variables in the construction of sub indices used to estimate the District Capacity Index (DCI)

Dimension and Subindex	Variables
Industry IND-Index	No. of small-scale industries per lakh population No. of registered working factories per lakh population Average workers per registered working factories Share of secondary sector in net district domestic product Percentage of electricity consumption in industries to total consumption
Banking Finance and Cooperation BFC-Index	No. of scheduled commercial banks per lakh population Per capita credits in Rupees Per capita deposits in Rupees No. of PACS per lakh rural population No. of cooperative agricultural marketing centres per lakh population
Health and Education HED-Index	No. of Allopathic hospitals/dispensaries per lakh population No. of beds in Allopathic hospitals/dispensaries per lakh population No. of Ayurvedic/Homeopathic/Unani hospitals/dispensaries per lakh population No. of beds in Ayurvedic/Homeopathic/Unani hospitals/dispensaries per lakh population No. of CHCs/PHCs per lakh population No. of family welfare clinics/centres per lakh population No. of ITIs per lakh population No. of polytechnics per lakh population No. of schools per lakh population (HSS)
Infrastructure INF-Index	Total length of pucca roads per thousand sq km Per capita electricity consumption (KWH) No. of LPG consumers per lakh population No. of post offices per lakh population Per capita district plan expenditure in Rupees
Agriculture, Animal Husbandry and Livestock AGR-Index	Percentage of gross irrigated area to gross area sown District wise percentage of private pumping sets/tubewells District wise percentage of government tubewells Distribution of total fertilizer per hectare of gross area sown No. of regulated mandis per lakh hectare of net area sown Veterinary hospitals per lakh of livestock Population per milch cattle AI centres/subcentres per lakh of milch cattle

Source: Author's classification based on secondary data

To construct each sub index, the method of PCA (Anderson,1958; Jolliffe 2002) is used for dimensionality reduction to transform a larger set of correlated variables in the data set into a smaller set of uncorrelated factors or principal components. The principal components are linear combinations of the variables in the data set and are ordered to successively maximize variance.For better interpretation of the components; varimax rotation with Kaiser Normalization was used. KMO test and Bartlett's test of sphericity are conducted to examine the suitability of data for structure detection. The results from these tests for

the five subindices are given in Table 2 and validate the use of PCA as a tool for dimensionality reduction. Table 2 also gives the number of retained factors for construction of sub indices as determined by applying Eigenvalue criterion and cumulative percentage of variation of the retained factors.

Table 2.Summary statistics for validity of principal component analysis of component subindices in the construction of District Capacity Index (DCI)

Subindex	IND Index	BFC Index	HED Index	INF Index	AGR Index
KMO test value	0.725	0.6814	0.767	0.698	0.599
Bartletts test Chi-square value (p-value)	213.710 (0.000)	405.519 (0.000)	463.08 (0.000)	82.761 (0.000)	290.849 (0.000)
Number of components with eigenvalue greater than one	2	2	3	2	3
Cumulative proportion of variance explained by components with eigenvalue greater than one	0.8003	0.8622	0.7930	0.6662	0.6636

Source: Author's estimation based on secondary data

For each dimension, factor scores of extracted components RC_i, ($i = 1 \ldots p$), are used to obtain weighted rotated factor scores (F_i) using the proportion of variance explained by the rotated component(w_i)to total variance of extracted components as weights as given in equation (1).

$$F_i = \sum_{i=1}^{p} w_i RC_i \quad \ldots\ldots\ldots(1)$$

The weighted factor scores are then standardized as given in equation (2) to give the sub index score for each district on a scale of 0 to 100 (excluding lower boundary value).

$$I_i = \frac{F_{i0} \ \min\ (F_i)}{\max\ (F_i) \ \min\ (F_i)} \ldots\ldots\ldots(2)$$

F_{i0} is the weighted factor score for a particular district, min (F_i) and max(F_i) are the minimum and maximum values of weighted factor scores over all districts for that dimension. For each district, the composite DCI index is obtained as the geometric mean (GM) of all the sub indices (i = 1… j) as given in equation (3).The GM is used in aggregation as it reduces substitutability between dimensions and because it is less sensitive to outliers that can skew certain categories (UNCTAD, 2021). The estimated DCI scores range from 0 to 100 with a higher DCI score indicating better performance of the district in terms of its productive capacities.

$$\text{District Capacity Index (DCI)} = \left(\prod_{i=1}^{j} I_i\right)^{1/j} \ldots\ldots\ldots(3)$$

4. Results

The 75 districts of UP are ranked in descending order of DCI scores and classified into quintile groups in Table 3. For each district, scores on the five sub indices are also reported. The region to which the district belongs-Western, Eastern, Central or Bundelkhand is given in the first column of Table 3.Western region districts have on average higher DCI

scores with 16 out of the 30 districts in the region in the top two quintiles.Western region district-G.B. Nagar which lies in the NCR region of Delhi leads in terms of productive capacities with the highest overall score and is the top performer in three dimensions of industry, banking and finance and infrastructure. Surprisingly, Ghaziabad which is also in the Delhi NCR region ranks in the lowest quintile. While the district scores high on IND-Index, BFC-Index and AGR-Index, its poor performance in Health and Education sub index combined with the methodology of obtaining the composite index through use of geometric mean gives the district a low overall score. Rapid population growth in the district, and the pressure on infrastructure and civic amenities as well as the emergence of G.B.Nagar as a major destination for investment has put this district at a relative disadvantage in the last decade so that the district has lagged behind G.B.Nagar (Das and Vaibhav, 2021). Lucknow and Kanpur Nagar and Kanpur Dehat from the Central region are in the top quintile. The top two quintiles have only nine of the 28 Eastern districts and no district from the Bundelkhand region. Four of the seven districts in Bundelkhand region are in the bottom quintile of DCI rankings. Western districts of Mainpuri, Budaun, Kasganj and Sambhal along with Ghaziabad are in the bottommost quintile. Banda and Chitrakoot in Bundelkhand and Bahraich in the Eastern region are among the districts performing the worst in DCI score. These districts rank at the bottom in one or more of the subindices. The subindices reveal gaps in all five dimensions with especially large gaps in IND-Index and BFC-Index outlining the need to incentivize private investments and promote entrepreneurial resources. G.B. Nagar, Ghaziabad, Moradabad, Auraiya, Meerut, Hapur, Amroha, Rampur in the Western region, Lucknow and Kanpur Nagar, Kanpur Dehat in Central region, and Eastern districts of Sonbhadra and Varanasi are in the top quintile in IND-Index. Western region districts like Baghpat, Hapur, Muzaffarnagar, Meerut, Hapur etc., perform well in agriculture as do Gorakhpur, Mau, Basti, Ballia in the Eastern region while all seven districts in Bundelkhand are at the bottom in AGR-Index. In HED-Index, all seven Bundelkhand districts besides Ballia, Shravasti, Amethi, Pratapgarh, Deoria in Eastern region and Western districts like Etah, Mainpuri, Etawah and Kannauj perform well. A few Eastern region districts like Varanasi, Prayagraj, Amethi, Deoria and Gorakhpur perform well in BFC-Index while Ayodhya, Varanasi and Amethi rank at the top quintile in INF-Index.

Table3.Classification of districts into quintile groups based on District Capacity Index (DCI) scores along with district scores on subindices

Region	District	IND Index	BFC Index	HED Index	INF Index	AGR Index	DCI score	DCI Rank
Quintile 1								
Western	G.B.Nagar	100	100	30.43	100	66.98	72.75	1
Central	Lucknow	28.19	62.27	32.62	73.10	78.12	50.46	2
Central	Kanpur Nagar	32.61	35.80	28.90	44..37	70.91	40.29	3
Western	Meerut	27.09	26.39	27.34	45.46	80.56	37.23	4
Eastern	Amethi	12.84	21.59	69.79	92.33	39.02	37.04	5
Western	Hapur	24.98	13.25	36.83	52.44	73.80	34.26	6
Central	Kanpur Dehat	18.10	17.54	47.39	72.43	35.94	33.01	7
Eastern	Gorakhpur	11.17	17.90	37.77	44.83	100	32.06	8
Western	Auraiya	21.82	18.30	49.91	54.65	31.04	32.05	9
Western	Etah	4.33	21.21	81.68	66.53	57.92	31.06	10
Eastern	Varanasi	17.30	26.28	21.24	56.58	50.33	30.75	11
Western	Agra	27.61	21.24	24.41	47.52	39.26	30.57	12
Western	Bulandshahr	16.98	14.62	40.74	28.15	54.64	27.44	13
Western	Mathura	18.24	16.80	33.02	31.23	48.96	27.41	14
Eastern	Mau	9.33	13.02	35.79	45.89	75.05	27.23	15
Quintile 2								
Western	Muzaffarnagar	16.76	10.74	35.35	26.91	85.85	27.13	16
Western	Hathras	13.10	20.65	39.28	31.10	44.18	27.09	17
Western	Baghpat	7.02	11.59	44.19	44.42	90.53	27.04	18
Eastern	Prayagraj	12.65	15.75	25.46	44.88	61.77	26.89	19
Western	Etawah	8.12	13.05	56.87	48.90	46.63	26.77	20
Central	Rae Bareli	8.31	20.95	39.48	34.74	56.78	26.70	21
Central	Unnao	15.33	18.56	42.77	24.07	44.00	26.43	22
Western	Bareilly	16.35	14.78	29.53	29.15	55.97	25.89	23
Western	Aligarh	16.41	13.15	21.92	35.81	61.02	25.28	24
Eastern	Basti	3.93	13.21	43.43	48.27	78.93	24.37	25
Western	Amroha	18.31	9.01	34.78	28.56	47.43	23.88	26
Eastern	Ghazipur	4.74	13.94	37.18	46.02	66.50	23.73	27
Eastern	Ambedkar Nagar	9.17	11.14	36.04	48.87	41.43	23.69	28
Eastern	Chandauli	15.74	12.53	38.93	31.64	30.41	23.64	29
Western	Moradabad	22.62	9.52	24.64	18.55	74.77	23.62	30
Quintile 3								
Eastern	Jaunpur	8.48	13.60	36.27	45.56	37.42	23.48	31
Western	Firozabad	16.05	9.23	34.52	31.92	40.85	23.16	32
Bundelkhand	Jhansi	11.51	21.03	51.46	39.83	11.32	22.38	33
Eastern	SantKabir Nagar	6.76	12.97	35.39	33.52	53.49	22.33	34
Central	Barabanki	8.72	12.76	38.67	20.76	60.31	22.20	35
Eastern	Ayodhya	4.98	9.46	39.52	59.34	47.57	22.08	36
Eastern	Azamgarh	4.48	13.53	39.32	36.34	60.22	22.05	37
Eastern	Ballia	2.56	13.98	58.26	32.43	74.47	21.90	38
Central	Fatehpur	8.12	11.69	43.80	32.57	35.43	21.69	39
Western	Shahjahanpur	9.41	11.14	38.05	23.09	51.59	21.65	40
Eastern	SantRavidas Nagar	16.30	8.64	31.08	33.01	30.35	21.30	41
Western	Rampur	18.15	8.54	29.45	15.81	60.64	21.29	42
Eastern	Pratapgarh	2.86	15.14	56.88	44.57	39.56	21.26	43
Bundelkhand	Hamirpur	3.52	17.69	100	33.07	20.65	21.17	44
Bundelkhand	Jalaun	3.96	13.79	64.51	47.33	25.42	21.16	45

Quintile 4								
Western	Saharanpur	10.24	12.67	28.17	16.05	72.31	21.15	46
Eastern	Deoria	1.80	19.00	54.66	33.97	66.63	21.14	47
Western	Shamli	8.42	5.31	38.26	27.22	75.42	20.38	48
Eastern	Mirzapur	9.43	8.33	50.08	31.80	27.24	20.28	49
Western	Kannauj	11.20	5.63	51.89	33.60	29.36	20.03	50
Western	Pilibhit	9.81	9.01	40.71	11.85	73.93	19.94	51
Eastern	Sultanpur	5.39	7.93	45.82	26.36	58.20	19.75	52
Eastern	Kaushambi	8.33	8.15	41.40	39.12	24.64	19.35	53
Eastern	Gonda	5.57	10.41	30.71	32.52	45.47	19.24	54
Western	Bijnor	8.54	8.77	25.06	21.66	51.53	18.38	55
Eastern	Sonbhadra	28.14	9.53	42.88	22.99	7.79	18.32	56
Western	Farrukhabad	5.31	10.02	34.83	19.69	54.15	18.16	57
Central	Hardoi	7.05	8.97	31.47	16.66	45.19	17.18	58
Eastern	Siddharth Nagar	2.84	9.06	45.88	18.56	67.97	17.16	59
Western	Budaun	6.48	11.87	26.37	15.13	37.59	16.31	60
Quintile 5								
Eastern	Kushi Nagar	5.96	5.43	33.69	13.65	68.03	15.89	61
Central	Sitapur	3.72	9.90	29.56	19.64	46.10	15.81	62
Western	Mainpuri	2.41	5.26	57.38	17.96	52.22	14.69	63
Bundelkhand	Lalitpur	8.79	7.33	65.06	19.02	8.22	14.57	64
Eastern	Maharajganj	4.62	3.01	30.52	20.03	69.89	14.28	65
Central	Kheri	3.54	4.57	26.44	9.24	38.20	10.86	66
Bundelkhand	Mahoba	7.28	15.20	64.17	11.52	1.67	10.65	67
Western	Kasganj	7.39	1.44	39.61	12.15	26.70	10.64	68
Western	Sambhal	10.27	1.19	16.67	14.23	27.24	9.53	69
Eastern	Shravasti	1.09	8.56	57.76	27.59	3.09	8.56	70
Eastern	Balrampur	2.42	0.82	27.34	7.41	24.15	6.28	71
Western	Ghaziabad	43.03	21.59	0.01	83.27	91.68	6.07	72
Bundelkhand	Banda	0.01	4.97	64.76	23.17	13.64	2.54	73
Bundelkhand	Chitrakoot	0.88	9.04	58.61	15.26	0.01	1.73	74
Eastern	Bahraich	4.29	0.01	19.42	0.01	26.59	0.37	75

Source: Author's estimation based on secondary data

To examine whether observed disparities across districts and regions are statistically significant, a one-way ANOVA test was conducted. Table 4 gives the summary statistics and tests for means of DCI scores by quintile groups and regions. The reported F-values show that differences in mean DCI score across quintile groups is highly significant with a p-value of 0.000 while differences across the four regions is significant at 3% level of significance.

Table 4.Summary statistics and tests for means and variances of DCIscoresby quintile groups and regions

By Quintile Groups				By Regions			
Quintile	Mean DCI score	Standard deviation	Frequency	Region	Mean DCI score	Standard deviation	Frequency
1	36.241	11.74	15	Western	24.696	11.527	30
2	25.478	1.486	15	Central	26.461	11.990	10
3	21.939	0.705	15	Bundelkhand	13.455	8.796	7

4	19.118	1.480	15	Eastern	20.872	7.429	28
5	9.496	5.10	15	Total	22.455	10.430	75
Total	22.455	10.430	75				
F=41.88 with p-value = 0.000				F=31.16 with p-value=0.0298			

Source:Author's estimation based on secondary data

5. Discussion

Larger productive capacities enhance the capacity of a region to produce more goods and services. The high degree of correlation observed between PCI and per capita GDP, human development, and other sustainable development goals (UNCTAD, 2021) reinforces the importance of assessing and identifying gaps in productive capacities. We examine the association between district-level productive capacities and levels of development in the state of Uttar Pradesh.The estimated correlations between DCI and per capita NDP (pcNDP) and DCI and percentage share of district in NDP are 0.601 and 0.657 respectively (data for NDP and pcNDP are for 2018-19 at constant 2011-12 prices). The correlations are positive and statistically significant thereby indicating that higher productive capacities are associated with higher per capita income and a larger share in state NDP while lower productive capacities are associated with lower levels of development. Figure 1 gives the relation between DCI and district per capita NDP (pcNDP) and Figure 2 gives the relation between DCI and percentage share of district in NDP. The scatter plot of districts in Figures 1 and 2 show that Western and Central districts like G.B. Nagar, Lucknow, Meerut, Kanpur Nagar, Hapur, Hathras have high DCI scores and high pcNDP and larger share in NDP while there is a bunching of Eastern districts at lower end with Eastern region accounting for 17 of the bottom 20 districts in pcNDP. The bottom ten districts in pcNDP are all from Eastern region with an average pcNDP which is half of the state's average. In pcNDP the top quintile has all Western region districts except Lucknow and Kanpur Nagar from Central region and Hamirpur and Jhansi from Bundelkhand while no district from the Eastern region is in the top quintile in pcNDP.

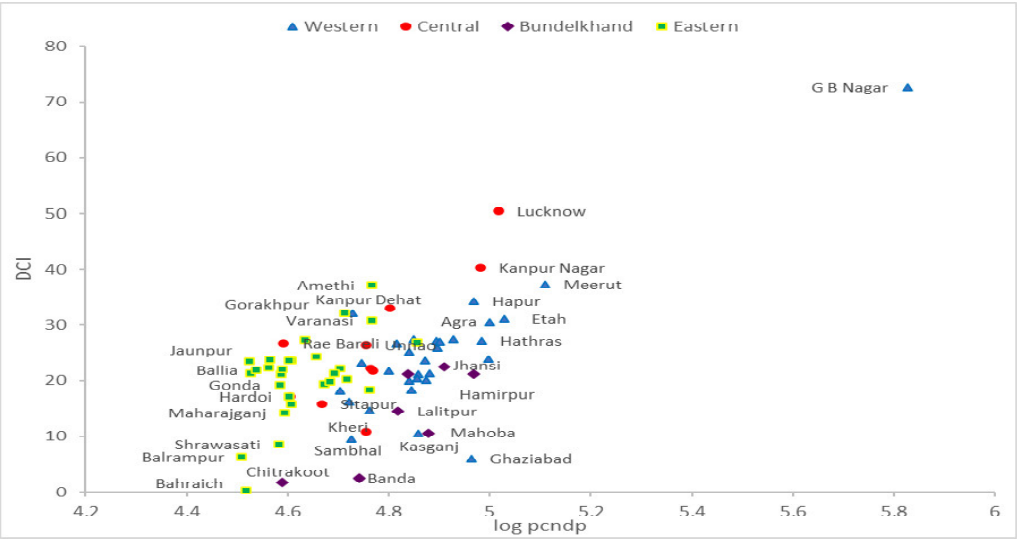

Figure 1. District Capacity Index (DCI) and log pcndp

G.B. Nagar has a disproportionately large share of the state's NDP and its performance on DCI and pcNDP is significantly ahead of next ranked districts like Meerut, Lucknow, Kanpur Nagar, Agra, Hapur, Etah etc. The district's pcNDP is seven times that of Ghaziabad, and ten times the state's average pcNDP. Ghaziabad district has a mere 2.6 per cent of state NDP compared to G.B. Nagar's share of 8.42 per cent and ranks eleventh in pcNDP. Bundelkhand region districts have a lower share of state NDP but the region's higher pcNDP is attributed to the sparse population in the region (Chaturvedi, 2015).Eastern region districts of Bahraich, Balrampur, Shravasti and Bundelkhand district of Chitrakoot are the poorest in per capita income and have the lowest scores on DCI. Some Eastern districts like Gorakhpur, Basti, Mau and Ballia rank at the top in AGR-Index but are in the middle in pcNDP.

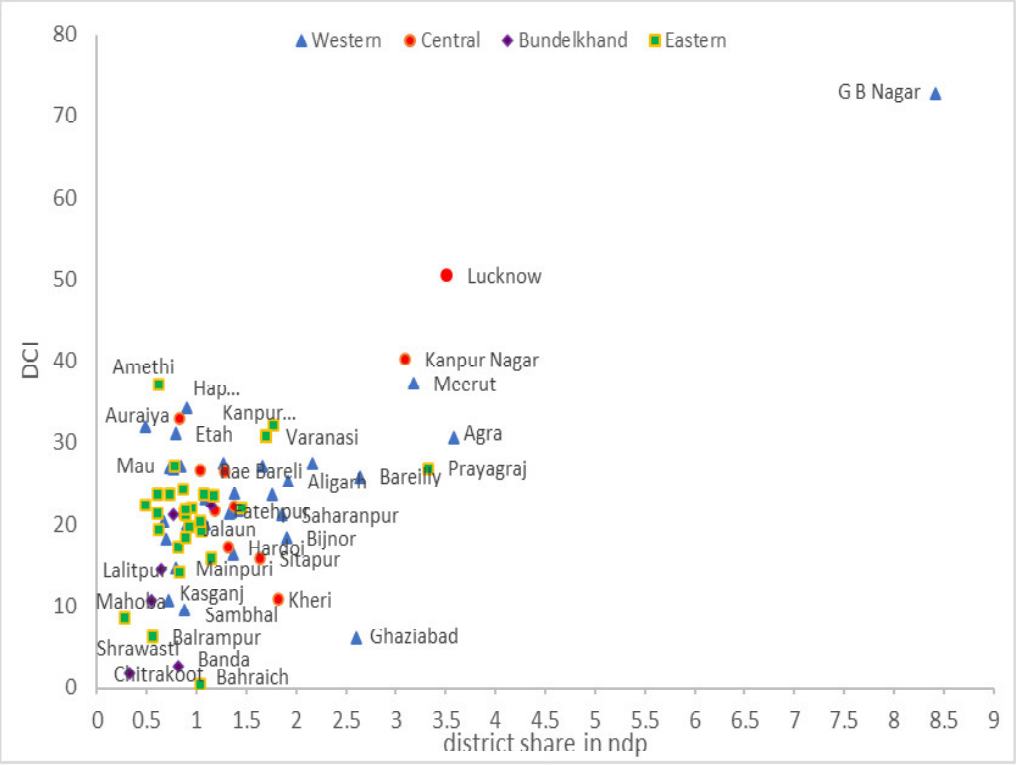

Figure 2. District Capacity Index (DCI) and district share in ndp (per cent)

Improving productivity of agricultural resources and diversification can help these districts do better. The results also show significant within region differences in productive capacities and development. Districts like Rae Bareli, Kheri, Sitapur and Hardoi lag significantly behind best performing districts in the Central region like Lucknow and Kanpur

Nagar while a few districts like Sambhal, Kasganj, Budaun and Mainpuri lag significantly behind other districts in the Western region like G. B. Nagar, Meerut, Etah, Hapur and Agra.

6. Conclusion

Based on the concept of productive capacities of UNCTAD(2021), the paper shows the prevalence of wide disparities in productive capacities across districts and regions of UP. More importantly, districts differ vastly in terms of their productive capacities across the five dimensions of industry, agriculture and livestock, banking, finance and cooperation, infrastructure and health and development. Overall, the paper demonstrates the significance of measuring and benchmarking productive capacities. The composite measure of DCI helps in over come binding constraints to development by identifying a district's vulnerability. District and region-specific policies can map the strengths and weaknesses of districts and focus on diversifying capacities and improving productivity of resources to achieve faster economic growth and balanced regional development.

References

1. Agarwal, A., Agarwala, P., Basu, R., Cheon, S. H., Choi, S., Dowall, D. E., ...& Asia, S. (2014).Leveraging spatial development options for Uttar Pradesh (English). Working Paper. Report Number 88967. World Bank Group. Washington, D.C.
2. Anderson, T. W. (1958). An Introduction to Multivariate Statistical Analysis. New York:
3. John Wiley & Sons, xii+374pp; Reprinted: New Delhi: Wiley Eastern Private Limited; 1972.
4. Chaturvedi, Sumit. (2015). Comparing Western UP and Bundelkhand. Human Development, Gender and Deprivation. Economic and Political Weekly. Vol.50. Issue No. 20.
5. Das, V.K., &Vaibhav, V. (2021). Noida is growing, Ghaziabad is fading. The story of Uttar Pradesh's two boom towns. The Print.Dated 06 August 2021.
6. District Wise Development Indicators (2021). Economics and Statistics Division of the State Planning Institute, Planning Department, Government of Uttar Pradesh.
7. Diwakar, D. M. (2009). Intra-regional disparities, inequality and poverty in Uttar Pradesh. Economic and Political Weekly, Vol. 44. No. 46/47. 264-273.
8. Gnangnon, S. K. (2021). Productive capacities, economic growth and economic growth volatility in developing countries: Does structural economic vulnerability matter? Journal of International Commerce, Economics and Policy, 255001.

9. Gnangnon, S. K. (2022). Effect of Productive Capacities on Economic Resilience in Developing Countries. Asian Development Perspectives, 13(1), 1-35.

10. Jolliffe, I. T. (2002). Principal Component Analysis (2nd ed.). Springer-Verlag New York.

11. UNCTAD (2020). UNCTAD Productive Capacities Index. Focus on Landlocked Developing Countries. United Nations. eISBN: 978-92-1-005435-5

12. UNCTAD (2021). UNCTAD Productive Capacities Index. Methodological Approach and Results. United Nations. Geneva. eISBN: 978-92-1-005409-6

13. UNCTAD(2022).National Productive Capacities Gap Assessments. Zambia. United Nations. Geneva.eISBN: 978-92-1-001967-5

14. World Bank. (2016). Uttar Pradesh - Poverty, Growth, and Inequality (English). India State Briefs. Washington, D.C.: World Bank Group.