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Relationship between Infrastructure and Economic Development: A Case of Indian States

Tasleem Araf Cash[*] and Prakash C Antahal[**]

[*]*Assistant Professor, Department of Economics, Central University of Kashmir, Ganderbal*
[**]*Professor and Head Department of Economics, University of Jammu, Jammu*

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Abstract: In this paper, we compared Indian states in terms of infrastructure development and economic development and identified the states that are lagging behind both in terms of infrastructure and economic development. The study also investigates the role of infrastructure in determining the level of economic development across Indian states. To identify the state level development of infrastructure and economic development, two composite indices namely, composite index of infrastructure development and a composite index of economic development have been estimated using the most commonly used multivariate techniques of factor analysis known as principal components analysis techniques. Our finding shows vast differences among the states both in the level of infrastructure development and economic development. Further, we found that variations in the availability of basic infrastructure facilities across states largely explain the persisting inter-state differences in the level of economic development.

Introduction

Regional imbalances in socio-economic development is a global phenomenon. However, the problem is more acute and glaring in developing and transitions economics than in developed economies. In the Indian context, the issue of regional imbalances attracted particular attention, and special efforts have been made during the planning period to remove existing regional disparities in the level of economic development. However, despite concerted efforts, vast inter-state differences in the level of socio-economic development still persist in the country, which is an important cause of social and political tension in the country. What determines economic growth and economic development is the question that economists and policymakers

keep asking, and there are competing theories about the determinants of economic growth/development. Solow(1956) demonstrates that with a constant return to scale and no technological progress, the rate of growth of output, in the long run, is determined by the rate of growth of the labour force. Kaldor (1957) argued that the main source of economic growth is exogenous technological progress. Endogenous growth theories focus on new knowledge (Romer, 1990) and innovation (Aghion and Howitt, 1992) as important determinant of economic growth. New Economic Geography models assert the role of economic activity, agglomeration, and specialization in economic growth. Recently, institutional economics which underlines the role played by non-economic factors like institutional factors (North,1990), Socio-cultural factors (Knach and Keefer, 1997), Fiscal and Monetary policy volatility (Brunetti, 1997) and demography (Brander and Dowrick, 1994). The growth rates seem to have been associated with infrastructure development, Auscher (1989) Munnell, (1992). World Bank, (1994). In its report, World Bank (1994) argued that a one per cent increase in the stock of infrastructure leads to a one percent increase in the level of output across all countries. Munnell (1990) argued that the absence of infrastructure facilities in any region might lower the population's 'productive efficiency'. Researchers are actively working in this field to explore the possible infrastructure indicators that determine a robust and sustainable growth/development in any region. The improvement in infrastructure could make a real contribution to the region's economic growth and economic development. Stern (1991) argued that infrastructure deficiencies, together with the weakness of management and economic organization, are likely to account for a substantial part of low factor productivity in developing countries. He further argued that it is very hard to run factories and businesses effectively when the electricity and water supplies are unreliable, the telephone and the mail services are weak, and transport is slow and costly.

Infrastructure has been defined as the physical framework of facilities through which goods and services are provided to the public. The term "infrastructure" in its broadest sense covers a wide spectrum of services such as transportation of various types (roadways, railways, airways, and water transportation), generation, transmission, and distribution of power, telecommunication, irrigation, banking, port handling facilities, water supply, sanitation, sewage disposal and provision of education and health facilities. These facilities have been recognized as one of the main factors for existing inter-state differences in the level of socio-economic development. Infrastructural development can be seen as an important policy

instrument for achieving balanced regional development. There are various mechanism through which infrastructure development promotes economic development. Availability of adequate and quality infrastructure facilities increases the productivity of factors inputs, reduces transaction and trade costs, increases the efficiency of production and consumption, opens up new markets, widens the size of the market, increases competitiveness, generates positive externalities, creates employment opportunities, stimulates economic activities, raises productivity, all these effects of infrastructure promotes economic growth. The provision of good quality infrastructure enables a country to modernize its production, generate more non-agricultural activities, accommodate growing urbanization, diversify its economic base, reduce poverty, and improve international competitiveness. Almost all economic activities like production, consumption, distribution, trade, and commerce have been influenced by the availability of adequate and quality infrastructure facilities. Besides this, improvement in infrastructure facilities in any geographical location attracts the flow of resources both from domestic and external sources and further improves their development potential.

Various infrastructure facilities such as rail length, road length, power consumption, irrigation, and banking are considered the key components of infrastructure components contributing to economic development both directly and indirectly.

The benefits a society accrue from infrastructure include higher output levels, higher income levels, higher employment levels, and higher profits. Adequate and quality infrastructure facilities enhance the production and distribution network in the economy and promote overall economic development. The importance of Social Overhead Capital (infrastructure) in promoting economic development has been well recognized by early well-known development economists- Hirschman (1958), Rostow (1960), Nurkse (1955), Myrdal (1964), Hansen (1967). Several empirical studies have been conducted across the world to measure the impact of infrastructure on economic development using cross-sectional, time series and Panel Data (Ashauer, 1989, 1990), Munnell (1990), World Bank (1994), Calderon and Serven (2003), Romp & De Haan (2007), Most of the studies concluded that the impact of infrastructure on development is positive and substantial. In the Indian context, empirical that highlighted the regional differences in the level of infrastructural development include Joshi (1990), Ahluwalia (1991, 1995); Anant *et al.* (1994, 1999); Mitra *et al.* (1998); Das & Beria (1998); Gosh (1998), Majumdar (2005), Sahoo (2011), Paul and Basu (1998), Pradhan (2007) Tiwari (2008), Sahoo and Das (2009), Bajjar (2012). These

studies also examined the contribution of the infrastructure in regional development. Most of the studies conclude infrastructure development has a positive impact on economic development. A number of studies in the existing literature highlighted the existence of inter-state differences in infrastructure development and economic development using composite indices of both infrastructure and development. Sarkar (1994), Majumdar (2005). The present study is different from the existing studies because, in most existing studies, only real per capita net state domestic product is taken as an indicator to measure development which may not be true.

In the present study, we analyze the performance of 27 states of the Indian union in terms of their infrastructural development and economic development. The present study not only highlight the inter-state differences in the level of infrastructure development and economic development, but it also identify the state which are lagging both in terms of infrastructure and economic development and need government intervention to remove defficiencies. The study also explored the association between infrastructure development and economic development to know whether the existing inter-state differences in economic development is reflected by the differences in the availability of basic infrastructure facilities. To fulfil these objectives, we may ask the following research questions (a) What is the levels of infrastructure development in the states of the Indian union, (b) Which states are lagging in terms of infrastructure and what are the reasons for their backwardness. (c) What is the levels of economic development in the states of the Indian union? (d) Which states are lagging in terms of economic development? (e) Is there any linkage between infrastructure development and economic development? The present study is undoubtedly an important contribution to the growing literature on development related to Indian states.

The rest of the paper is organized as follows. Section I discusses the data sources and research methodology used to achieve the objectives of the study. Results of the Principal Components Analysis are presented in Section-II. Empirical findings of the study are given in Section-III. The conclusion and policy suggestions are reported in section IV.

Section-I

Research Methodology

This section provides the methodology used to compute the composite index of infrastructure development and a composite index of economic development for

27 states for 2017-18. In the present study, J&K has been treated as a state and Mizoram is excluded due to the non-availability of reliable data. The study exclusively based on secondary sources of data. State-level secondary data pertaining to various indicators of infrastructure development and economic development has been collected from the following official sources:(a) Ministry of Road Transport and Highways, Government of India, (b) Reserve Bank of India (RBI), (c) National Health Profile, Ministry of Health and Family Welfare (d) National Institute of Educational Planning and Administration. Both infrastructure and economic development are multidimensional in nature. In the present study, an attempt has been made to estimate two composite indices: a composite index of infrastructure development and a composite index of economic development for each state. We have applied the most commonly used multivariate techniques known as Principal Component Analysis PCA) to compute weights for the selected indicators because of their suitability and common application in similar studies. Following indicators for which reliable state-level data is available have been used to estimate the composite index of infrastructure development of each state (a) road density per 100 sq. km of area, (b) rail route length per 100 sq. km of area,(c) annual per capita consumption of electricity, (d) teledensity, (e) commercial bank branches per lakh population (f) gross irrigated area as a percentage of gross cropped area, (g) educational institutions per lakh population and (f) medical institutions per lakh population. Similarly, a composite index of economic development has been estimated using the following indicators (a) real per capita net state domestic product, (b) the number of registered factories per 100 sq. km of area (b) factory workers as a percentage of the total population, (d) life expectancy at birth, and (e) number of children survived per thousand population (inverse of infant mortality rate). Due to data limitations. The unit of measurement of the indicators of infrastructure and development are in a different unit; we made them unit free by divining with column-wise standard deviation. The following formula has been applied to compute weights for the selected indicators

$$Wkj = (\Sigma\ |lij|.\ Ej)\ /\ \Sigma((\Sigma\ |lij|.\ Eij)$$

Where Wkj= weights of the ith indicator of infrastructure at j^{th} time, lij is the factor loadings of ith variables on jth component, Ej is the Eigen value of the jth components. The composite index of infrastructure or development has been developed by multiplying extracted weights with the unit free value of the indicators.

$$CIDIij = \Sigma Wkj\ Xkij$$

Where CIDIij is the composite index of infrastructural development of i^{th} state at J^{th} time, Wk is the weight of the k-th variables, Xkij is the unit free value of k-th indicators at j-th time. Same procedure has been applied to compute composite index of economic development. Based on the composite indices value, states are classified into three development categories- Highly developed, Medium developed and Low developed**.** The states having composite index value equal to or greater than (Mean+0.50*SD) are classified as highly developed, and the states having index value less than or equal to (Mean – 0.50*SD), categorised as low developed. In the same way, states with the composite index value is less than (Mean+0.50*SD) and greater than (Mean –0.50*SD), fall in the category of medium developed.

Section-III

Results of the Principal Components Analysis (Infrastructural Development)

As mentioned earlier, we have applied principal components analysis techniques for assigning weights to the selected indicators of infrastructural development. The results of the principal components analysis like factor loadings, Eigenvalue, communalities, and computed weights are presented in Table 1 below. The Eigenvalue (variance contribution of each component) rule has been applied to decide the number

Table 1*:* Results of the Principal Components Analysis infrastructural Development

	Principal components				
Indicators	*(P1) Loadings*	*(P2) Loadings*	*(P3) Loadings*	h^2	*Weights*
Road length per 100 sq km of area	.793	.307	-.538	.930	0.1495
Length of railways routes per100 sq km of area	.817	-.282	-.214	.920	0.1366
Gross irrigated area as % of gross cropped area	.638	-.327	.405	.677	0.1246
Per capita consumption of electricity	.555	.365	.745	.896	0.1314
Teledensity	.576	.576	-.219	.836	0.1252
Commercial banks per lakh population	.340	.799	.139	.774	0.1061
Educational institutions per lakh population	-.714	.303	-.094	.610	0.1191
Medical institutions per lakh population	-.493	.650	-.121	.681	0.1151
Percentage of variance explained	42.60	22.13	14.32		
Cumulative % of variance	79.05				
Eigen value	**3.41**	**1.77**	**1.15**		

Source: Author's own estimation

of principal components to be retained to extract weights. Only those principal components having an Eigenvalue equal to or greater than 1.0 (unity) have been considered for computation of weights.

As shown in Table 1, two Principal Components with Eigenvalue, more than unity, have appeared. Both the principal components jointly explain a 79.05 percent variation in the combined data. The first and second and components explain 42.60 percent and 22.13 percent variation in the data respectively. It is seen from table 1 that commonalities (h^2) are at a high level and range from 0.610 to 0.910, suggesting that the selected indicators of computing infrastructural development are highly related to each other. The factor loadings reported in Table 1 shows the degree relationship between each of the selected variables with each of the three principal components.

The results reveal that the length of railways routes per100 sq. km of area has the highest loadings (0.817) on the first principal components. Other indicators having the higher loadings with the first principal components are, road length per 100 sq. km of area (0.793). The other indicators having a higher association with the first principal components are educational institutions per lakh population(0.714), gross irrigated area as a percentage of gross cropped area (0.638). The second principal components are represented by teledensity and commercial bank per lakh population and medical institutions per lakh population. The third principal component is represented by the annual per capita consumption of electricity. The computed weights for the indicators of economic development varies between 0.1495 to 0.1061. The road length per 100 sq. Km of area has highest weights (0.1495) and commercial bank per lakh population has the lowest weights (0.1061). From the above-mentioned results of the principal components analysis, it can be inferred that road length per 100 sq. km of area, rail route length per 100 sq. km of area and annual per capita consumption of electricity are the factors of high importance in explaining the inter-states disparities in the level of infrastructure development.

Results of the Principal Components Analysis Economic Development. The results of the principal components like factors loadings, commonalities, percentage of the total variance and extracted weights of the indicators of economic development are presented in below table-1. 2. Results reveals that two Principal Components having an Eigenvalue of more than one and jointly explains 77.22 % of the total variance in the data. First Principal Components is represented by per capita net state domestic product as it has the highest loading (0.831). Other indicators

having higher loading on first components are the number of factor per 100 sq. km of area.(0.82;9), life expectancy at birth (08.25), and the number of children survived per thousand live birth. These are the factors of high importance in explaining the inter-states disparities in the level of economic development. The second principal component is represented by factory workers as a percentage of the total population, and its factor loading is 0.917. The computed weights for the indicators of economic development varies between 0.2177 to 0.1684. The real per capita net state domestic product has the highest weight (0.2177), and factory workers as a percentage of the total population has the lowest weights.

Table 1.2: Results of the Principal Components Analysis Economic Development

Indicators	*Results Principal components*			
	PI	*P2*	h^2	*Weights*
Real per capita net state domestic product	.831	-.277	.767	0.2177
Number of factory per 100 sq. Km or area	.829	.187	.769	0.2090
Factory workers as a percentage of total population	.326	.917	.947	0.1684
Life expectancy at birth	.825	-.290	.764	0.2174
Number of children survived per thousand live birth	-.777	.088	.612	0.188
Eigen value	2.76	1.09		
Percentage of variance explained.	55.36	21.86		
Cumulative percentage of variance	77.22			

Author's own estimation

The extracted weight of the other indicators are number of the factory per 100 sq. km or area (0.209), life expectancy at birth (0.2174), number of children survived per thousand birth (0.188). The results of the principal components clearly indicates that real per capita net state domestic product, number of registered factories per 100 sq. Km of area and life expectancy at birth are the most dominant factor in determining the inter-state disparities in the level of economic development.

Section-III

Empirical Analysis

The estimated composite index of infrastructure development, the estimated composite index of economic development, ascending ranking and classification of

the states into different categories are reported in Table 1.3. It is found that the value of the composite of infrastructural development varies between 2.42 to 0.069. Himachal Pradesh (2.42) has the highest composite index value, followed by Punjab (2.30), Talangana (1.99), Haryana (1.85), and Tamil Nadu (1.85). On the other hand, Manipur (1.069, has the lowest composite index value, proceeded by the states of Nagaland (1.19), Jharkhand (1.22), Bihar (1.28), and Jharkhand (1.23). There are huge variation across the states in terms of infrastructure development. The composite index of Himachal Pradesh (most developed state) is 2.28 times higher than that of Manipur (least developed state). Based on the composite index value, we have divided the states into three categories-highly developed, medium developed and low developed. States having index value equal to or above 1.763 are identified as highly developed. These states are Gujarat, Haryana, Himachal Pradesh, Punjab, Tamil Nadu, Telangana and Uttrakhand. These six states spread over 20.32% area of the country and occupied 18.09 percent of countries total population. Seven states having an index value less than 1.46 are classified as low developed states.

Table 3: State wise Composite Index of Infrastructure Development, Composite Index of Economic Development, Ranking and Categories of States

States	*Composite Index (CI)*	*Ranks*	*Category*	*Composite index of Economic Development*	*Ranks*	*Category*
Andhra Pradesh	1.3572	23	LD	0.9080	9	MD
Arunachal Pradesh	1.5947	12	MD	0.6698	20	LD
Assam	1.5129	19	MD	0.6784	18	LD
Bihar	1.2863	24	LD	0.5681	25	LD
Chhattisgarh	1.5264	18	MD	0.6699	19	LD
Gujarat	1.7386	7	MD	1.2652	2	HD
Haryana	1.8518	4	HD	1.1892	3	HD
Himachal Pradesh	2.4273	1	HD	0.8360	12	MD
J&K	1.5821	14	MD	0.5634	26	LD
Jharkhand	1.2297	25	LD	0.5778	24	LD
Karnataka	1.6522	8	MD	0.8483	11	MD
Kerala	1.6463	10	MD	1.0759	6	HD
Madhya Pradesh	1.4573	22	LD	0.6653	21	LD
Maharashtra	1.5597	15	MD	0.9236	7	MD

contd. table 3

States	*Composite Index (CI)*	*Ranks*	*Category*	*Composite index of Economic Development*	*Ranks*	*Category*
Manipur	1.0690	27	LD	0.4301	27	LD
Meghalaya	1.5276	17	MD	0.6205	23	LD
Nagaland	1.1926	26	LD	0.7444	15	MD
Odisha	1.6055	11	MD	0.7110	16	MD
Punjab	2.3048	2	HD	1.1539	4	HD
Rajasthan	1.5128	20	MD	0.7480	14	MD
Sikkim	1.6509	9	MD	0.8304	13	MD
Tamil Nadu	1.8526	5	HD	1.3265	1	HD
Talengana	1.9937	3	HD	1.0913	5	HD
Tripura	1.4589	21	LD	0.6535	22	LD
Uttar Pradesh	1.5561	16	MD	0.9129	8	MD
Uttarakhand	1.8089	6	HD	0.8934	10	MD
West Bengal	1.5901	13	MD	0.6887	17	LD
Average	1.6113			0.8238		

Author own Calculation Reserve Bank of India

These states are Andhra Pradesh, Bihar, Jharkhand, MP, Manipur, Nagaland, Tripura. These states spread over 21.99 percent geographical area of the country and occupied 24.86 percent countries total population. States namely Arunachal Assam, Chhattisgarh, J&K, Karnataka, Kerala, Maharashtra, Meghalaya, Odisha, Rajasthan, Sikkim,

Uttar Pradesh and West Bengal are identified as medium development. These states spread over 57.67% area of the country and occupy 57.06 percent countries total population. Among the various indicators of infrastructural development, the inter-state disparities are highest in rail route length per 100 sq. km of area as its coefficient of variation is 108%, whereas disparities across the state are lowest in teledensity (38.71 per cent). The value the coefficient of variation of other indicators of infrastructural such as road length per 100 sq. Km of area (106%), Gross irrigated area as percentage of gross cropped area 61.75 percent, annual per capita consumption of electricity 53.69 percent, commercial bank per lakh population(63.81 percent), educational institutions per lakh population 55.67 percent and medical institutions per lakh population 80.06 percent.

Table 1.3 State-wise composite Index of economic Development, Ranking, NSDP per capita at factor cost and constant price. The value of the composite index of economic development varies between 1.32 to 0.43.

Tamil Nadu, with the composite index value of 1.32, is the most developed state in the country, followed by Gujarat (1.26), Haryana (1.19), Punjab (1.15) and Talangana (1.09). On the other hand, Manipur (0.43) is the least developed state in the country, preceded by the state of Jammu and Kashmir (0.56), Jharkhand (0.57), Meghalaya (0. 62). There are huge variation across the states in each parameter of infrastructural development.

Based on the composite index, value states have been classified into three different categories. States with composite index value equal to or more than 0.94 have been identified as highly developed states. These states are Gujarat, Haryana, Kerala, Punjab, Tamil Nadu and, Talangana. These states spread over 18 percent of the total geographical area and occupied around 19 percent of the country's total population. Andhra Pradesh, Karnataka, Maharashtra, Nagaland, Rajasthan, Sikkim, Uttar Pradesh, and Uttrakhand have been identified as medium developed states. These states spread over 42% of the geographical area and occupied around 43 percent of the country's total population. All other states, namely, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Jammu and Kashmir, Jharkhand, Madhya Pradesh, Manipur, Meghalaya, Tripura Pura and West Bengal, have been identified as low developed states in term of economic development. These states spread over 40% of the geographical area and occupy 38% of countries total population.

Next, the paper examined the linkages between infrastructure and economic development to see whether the states possessing better infrastructure facilities are higher level of economic development. We compute Person's rank correlation coefficient. We found that the value of the Pearson's rank correlation coefficient is high and positive (0.69), indicating that states which are infrastructurally sound have a high level of economic development. The states with a relatively high Composite infrastructure development value, Gujarat, Haryana, Punjab, Tamil Nadu, Kerala, Talangana, and Karnataka, have a relatively high value of the composite index of economic development as well. On the other hand, states with the low value of the composite index of infrastructural development, Manipur, Jharkhand, Bihar, MP, Chhattisgarh, and Tripura, have a low level of economic development. In other words, infrastructural development and economic development are going hand in hand. These results are in line with the finding of Majumdar 2005. However, there are certain

inconsistencies. Himachal Pradesh, J&K, Arunachal Pradesh, and Uttar Pradesh have a relatively better-developed infrastructure, but these states are relatively poor in terms of economic development. Whereas Maharashtra, Rajashtan, Nagaland, these states have a relatively low value of the composite index of infrastructure development but a relatively higher value of the composite index of economic development, indicating that these states fall behind on infrastructure but have a higher level of economic development. It is found from the above analysis that all the infrastructurally poor states are also at a relatively low level of economic development.

In contrast, rich states had relatively better infrastructural facilities. The results indicate a positive association between infrastructure and economic development. Our results are in line with the economic exception and theory.

Section-III

Conclusion and Policy Suggestions

In the study, we compared Indian states in terms of their infrastructure development and economic development. The state-level development of infrastructure and economic development has been assessed by estimating two composite indices- a composite index of infrastructure development and a composite index of economic development. We have applied Principal component analysis techniques to compute weights for the selected indicators. Twenty-seven states have been classified into three development categories. We found that huge differences exist among the states both in the level of infrastructural development and level of economic development. Among the various indicators of infrastructure development, the inter-state disparities are highest in rail route length per 100 sq. km of area and lowest in teledensity. Seven states, Andhra Pradesh, Bihar, Jharkhand, Madhya Pradesh Manipur, Nagaland, Tripura, have been identified as low developed states in terms of infrastructural development. These states are lagging in all dimensions of infrastructure. Improvement in basic infrastructural facilities like health, education, power, irrigation and transport in the low developed state is a prerequisite to improve the quality-of-life of the people and to usher in sustainable socio-economic development in the lagging states. We found eleven states: Arunachal Pradesh Assam, Bihar, Chhattisgarh, Jammu and Kashmir, Jharkhand, Madhya Pradesh Manipur, Meghalaya, Tripura, West Bengal are lagging behind in terms of economic development and identified as low developed. The study found that the unequal distribution of infrastructure across the state has largely been responsible for inter-state differences in the level of

economic development. An increase in infrastructure will have a greater impact on these states. At the state level, this study provides an empirical foundation for an argument in favour of allocating more funds for the development of infrastructure, particularly in the low developed states. Our analysis shows that poorer states need to invest extensively in transportation, communication, Power, Irrigation, banking, education, and health facilities. One way of doing so would be to increase fiscal transfers from the centre to these lagging states so that they can achieve the growth needed to attract investment. Such transfers should be connected to any sector-specific investment and policy initiatives already running in these states. Focused investment to expand health and education and improve transport, communication, and power infrastructure will expedite the overall development prospects of the Indian states, especially the poorer ones.

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