INFRASTRUCTURE INVESTMENT AND REGIONAL ECONOMIC GROWTH: A CASE STUDY OF MAHARASHTRA

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India in the recent past has been growing at the rate of 7% and more. If this is to be maintained in the future, then it is expected that there is a balanced regional growth more especially inclusive growth in each state. Five Year Plans of late have been stressing on the states active role in developing their regional infrastructure to see that, their regions also grow along with the state/nation. In this context, a study on the inter-relations between economic activity, growth potential and existing infrastructure facilities is of great importance. There have been number of studies in this direction both at home and abroad. Most of them centre on the point that public infrastructure investment is an important factor promoting economic growth. In the Indian context too we have studies which deal with the role of infrastructure investments in regional development over the different states of the country. However, this study, goes a step further into the districts of a particular state i.e. Maharashtra. The study initially reviews the infrastructure facilities for the 33 districts of Maharashtra for one year i.e.1999-2000. Using this, the extent of disparities between these regions is found. Further using the econometric models it is seen as to how far is the infrastructural development in the districts influencing the per capita income of the districts. The results show that though economic infrastructure influences the per capita income of these districts in Maharashtra, social infrastructure still needs to be developed to influence the per capita income.

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Introduction

India in the recent past has been growing at the rate of 7% and more. If this is to be maintained in the future, then it is expected that there is a balanced regional growth. Both the Ninenth and Tenth, five year Plans have been stressing on the states active role in developing their regional infrastructure to see that, their regions also grow along with the state/nation. In this context, a study on the inter-relations between economic activity, growth potential and existing infrastructure facilities is of great importance. There have been number of studies in this direction both at home and abroad. The study by Aschauer (1989) is said to show that public infrastructure has a significant positive impact on private sector growth and it is one of the works which link infrastructure and economic growth. Besides, there have been others like Mera (1973), Looney and Frederiksen (1981), Biehl (1986), Munnell (1990), Antanio Cutanda & Joaquina Parico (1994) whose works centre around the point that public infrastructure investment is an important factor promoting economic growth. All these studies have been for Japan, Mexico, EEC, USA and Spain. In the Indian context too we have studies like that of Somik V.Lall (1999, 2007), where the author deals with role of infrastructure investments in regional development. This pertains to the different states of the country. However, this study goes a step further into the districts of a particular state i.e Maharashtra. Thus, the study aims at initially reviewing the infrastructure facilities for the 33 districts[1] of Maharashtra i.e regional development of a particular state for one year i.e. 1999-2000. Using this, the extent of disparities between these regions is found. Further using the econometric models it is seen as to how far, is the infrastructural development in the districts influencing the per capita income of the districts. While the extent of disparities show that Pune and Sindhudurgh respectively have the maximum in economic and social infrastructure facilities, the minimum being Thane in both these infrastructure.

Approach to the Study

By infrastructure facilities[2], the study considers the availability of irrigation facilities, godown facilities, public lighting, road length covered, number of post offices, number of commercial and co-operative banks, availability of finance through various sources, number of high

schools, middle schools and primary schools, number of teachers, number of beds in hospitals, number of hospitals/ clinics and number of family welfare centers in a particular district. These were converted into a measure of infrastructure by using Biehl's (1986) method as quoted in Antanio Cutanda & Joaquina Parico (1994). According to this methodology, first these measures are considered in their absolute capacity for each district. For example number of high schools in a district or road length covered per 100 square kilometer. These are then divided by the population or area of the district as the case may be i.e. road length is divided by the area of the district, number of high schools by the population of the district or irrigated area by the cropped area etc. Then by considering the best-equipped district as a reference and assigning it a value of 100, they are further standardized. i.e. by using the following formula

$$I_{i,r} = \frac{X_{i,r}}{X_{i,\max}} * 100$$

Here, $X_{i,r}$ refers to the infrastructure equipment related to the population/area of category 'i' and region 'r'. Where 'i' refers to the particular infrastructure like road length or number of high schools in a district and 'r' refers to the particular district. This helps us in forming infrastructure indices[3] related to irrigation facilities, godowns, public lighting, road length covered, number of post offices, number of commercial and co-operative banks, availability of finance through various sources, number of high schools, middle schools and primary schools, number of teachers, number of beds in hospitals, number of hospitals/ clinics and number of family welfare centers for each of the districts. Since the infrastructure categories are not substitutes, geometric mean is used to calculate the general infrastructure, the economic infrastructure and social infrastructure indicators. All these indicators are standardized at 100 as such we have theses figure in relation to the region with the maximum values. The economic indicator is composed of all the infrastructure categories that directly contribute to production activities. These are irrigation facilities, godowns, public lighting, road length covered, number of post offices, number of commercial and co-operative banks, and availability of finance through various sources. The social indicator, deals with health and education i.e. beds in hospitals & number of hospitals/ clinics and number of high schools, middle schools & primary schools. These are supposed to indirectly help the input efficiency.

Using the coefficient of variation and the maximum minimum ratio between the best and the worst equipped districts as a measure of dispersion, we look into the disparities in each of the

categories along with the general, economic and social indices. Though, correlation between PCY and different variables are looked into, a positive correlation cannot be taken as proof to link relationship between public infrastructure investment and PCY of the region. As mentioned earlier, there are several studies using production functions to show such relationships. Thus, using an econometric model the study estimates income disparities which could be due to employment disparities and infrastructural facilities. Here, in a modified Cobb-Douglas production function, infrastructure investment is considered as an input to production. This is because infrastructure investment influences productive activities as well as social welfare in different regions. While investment on transport and communication, power as an input directly influences the productive process, education facilities like schools and colleges, medical facilities like hospitals, and beds in them influence productive activities indirectly. Besides, these investments also influence the location decisions of individuals for residence, or business firms for increased economic activity. In sum it could be said that the infrastructure investment both, economic/social or direct/indirect influences regional PCY income.

Model

As mentioned above, the econometric model is a modified Cobb-Douglas production function which considers infrastructure investment as an input to production. As such per capita income is considered as a function of Agricultural labour employment, Industrial labour employment, General index of growth, economic index of growth and social index of growth. Here it is hypothesized that, infrastructural investment promotes economic growth, of a region. But, as all regions are not equally developed an attempt is also made to split the 33 districts of Maharashtra into those above and below the average per capita of all districts. As already mentioned the infrastructural facilities are clubbed into general, economic and social infrastructures and employment into agricultural labour and industrial labour. On the basis of this five alternative equations are considered and they are as follows:

$$Y_i = a + bG_i + bAL_i + cIL_i + \varepsilon \qquad \text{I}$$

$$Y_i = a + bS_i + cAL_i + dIL_i + \varepsilon \qquad \text{II}$$

$$Y_i = a + bE_i + cAL_i + dIL_i + \varepsilon \qquad \text{III}$$

$$Y_i = a + bE_i + cS_i + dAL_i + eIL_i + \varepsilon \qquad \text{IV}$$

$$Y_i = a + bG_i + cE_i + dS_i + eAL_i + fIL_i + \varepsilon \qquad \text{V}$$

Here, 'Y' represents the per capita income index of the different districts of Maharashtra; G represents the general infrastructure index of these districts, E the economic infrastructure index, S the social infrastructure index, AL the agriculture labour employment index and IL the industrial labour employment index. The subscript 'i' represents the different districts in the group. ε is the error term.

Data Base

The data for forming the different infrastructure indices used for the different districts of Maharashtra is from the Statistical Abstract of Maharashtra State 1999-2000. This is published by the Directorate of Economics & Statistics, Government of Maharashtra, Mumbai. As already mentioned these are collected in absolute figures from Statistical Abstract of Maharashtra State 1999-2000 and then converted into indices in the way mentioned above and then used in the working of the equations. The population statistics used for calculating per capita is taken from the state census data. The per capita income is taken from District Domestic Product of Maharashtra 1999-2000, 2000-01 and 2001-02, published by the Directorate of Economics & Statistics, Government of Maharashtra, Mumbai.

Empirical Results and Analysis

The results have been analysed using the different indices formed, as well as the solutions to the alterative equations. The five alternative equations have been solved for all districts as a group and for districts above the districts average per capita income level as a second group and for districts below the districts average per capita level as a third group. However, the solutions to the third group did not give significant results as such the study discusses the results of the first two groups only.

i) Analyses of Indices

Analyzing the indices formed it is seen from Table 1 (A) and Table 1 (B), among the different categories, the category on availability of finance through various sources and industrial

employment are most highly dispersed categories. Washim the district with maximum availability credit is 80.59 times more than the minimum available credit district of Gadchiroli. The coefficient of variation is 1.4 between the districts. Similarly Wardha, which employs the maximum industrial labour has 67.52 times more labour than the minimum employing industrial labour district i.e. Gondhiya. Here the coefficient of variation is 1.15 between the districts. The other important infrastructure showing dispersion is fertilizer, irrigation and road length under the economic infrastructure and hospitals/clinics among the social infrastructure. The coefficient of variation between the districts in the case of the above four infrastructures are 0.54, 0.58 0.51 and 0.72. Kholapur with maximum use of fertilizer is 7.33 times more than Ratnagiri which uses the minimum. Satara and Solapur which have the maximum irrigation facilities available is 30 times more than Ratnagiri which has the minimum irrigation available. Similarly, Bhandara which has the maximum road length covered is 9.33 times more than Nandhurbar which has the minimum road length covered. Sindhudurg district which has the maximum number of hospitals is 24.08 times more than Thane.

Observing the dispersion among the general, social and economic infrastructure between districts, dispersion in social infrastructure is the maximum with 0.28 as the coefficient of variation followed by economic and general with 0.21 and 0.17 as the coefficient of variation. Sindhudurg has the maximum in general, education and social infrastructure, the minimum in all these cases being Thane. Pune has the maximum in economic infrastructure, the minimum being Thane again. The paradox being that Thane with a high PCY (second to Pune, which has the highest PCY) has the minimum infrastructure in both economic and social.

ii) Regression Analyses

The OLS results in Table 2 and Table 3 showed that Agriculture labour index through out i.e. i) with PCY as a function of general index of growth, agricultural index and industrial labour index, ii) with PCY as a function of agricultural index, industrial labour index and social index, iii) with PCY as a function of agricultural index, industrial labour index and economic index, iv) with PCY as a function of agricultural index, industrial labour index economic and social index, v) with PCY as a function of general index of growth, agricultural index, industrial labour index, economic and social index; showed negative coefficients indicating that the per capita income index (PCY) and agriculture labour index were inversely related. However, in every case agriculture labour index, ‘t’ stats was always highly significant. A

unit increase in PCY calls for more than .55 units decrease in employment of agriculture labour. It is a clear picture of disguised unemployment / over employment in agriculture sector.

Industrial Labour index showed positive coefficients under OLS for all districts (See table 2) indicating a direct relationship between PCY and industrial labour and of the five equation, 't' stats was significant only for three cases i.e. for ii) with PCY as a function of agricultural index, industrial labour index and social index, iii) with PCY as a function of agricultural index, industrial labour index and economic index, iv) with PCY as a function of agricultural index, industrial labour index economic and social index. But under OLS for districts above average PCY of all districts, only in one case [ii) with PCY as a function of agricultural index, industrial labour index and social index,] was the 't' stats for industrial labour significant and there also the coefficient was negative indicating an inverse relationship. The increase in labour for a unit increase in PCY is very marginal at .16/.18 (see Table 2 showing the amount of employment level needed) and -.25 (see Table 3 showing over employment).

The coefficients of general index in both the equation 1[i) with PCY as a function of general index of growth, agricultural index and industrial labour index], and 5 [(v) with PCY as a function of general index of growth, agricultural index, industrial labour index, economic and social index] of the five Models in Table 2 showed positive coefficients and significant 't' stats. However, under the OLS results for districts above average PCY of all districts (See Table 3), Model 1[i) with PCY as a function of general index of growth, agricultural index and industrial labour index], showed positive coefficient and significant 't' stats but in Model 5 [(v) with PCY as a function of general index of growth, agricultural index, industrial labour index, economic and social index] the coefficient was negative and insignificant 't' stats.

The Economic index in Equations 3,4 and 5 [iii) with PCY as a function of agricultural index, industrial labour index and economic index, iv) with PCY as a function of agricultural index, industrial labour index economic and social index and (v) with PCY as a function of general index of growth, agricultural index, industrial labour index, economic and social index] in both the Tables showed that the 't' stats were significant for both models 3 and 4 and insignificant for model 5 [(v) with PCY as a function of general index of growth, agricultural index, industrial labour index, economic and social index]. Regarding the coefficients, they were positive for all the three in Model i.e. 3, 4 and 5 of Table 3 and in Model 3 and 4 of

Table 2. Here the coefficients indicated that a unit increase in PCY required at least more than .57 units of economic infrastructure

The Social index in Model 4 and 5 [iv) with PCY as a function of agricultural index, industrial labour index economic and social index and (v) with PCY as a function of general index of growth, agricultural index, industrial labour index, economic and social index] in both the Tables showed that the 't' stats were insignificant. However, though Model 2 [ii) with PCY as a function of agricultural index, industrial labour index and social index,] in Table 3 showed significant 't' stats, the same was not repeated in Table 2. Regarding the coefficients, Model 2 in Table 3 it was positive indicating a direct relationship with PCY. But a unit increase in PCY needed more than 1 unit increase in social infrastructure indicating the inadequacy in this infrastructure.

Thus, the overall results indicate that a unit increase in PCY calls for a more than one unit increase in social infrastructure and less than one unit increase in economic infrastructure indicating that economic infrastructure is better placed than social infrastructure so far as its contribution to economic growth is concerned.

Conclusion

In conclusion it could be said that there are wide range of disparities between different districts of Maharashtra indicating the need for inclusive growth. Besides, the lack of development in the social infrastructure in comparison to economic infrastructure calls for addition development both in quantity and quality in schools and hospitals throughout the state.

Notes

1. The study concentrates only on the 33 districts of Maharashtra, except Mumbai and Mumbai suburbs for the latter two districts are far ahead of the other 33 districts
2. These data only reflect the actual number and not the difference in quality of this information.
3. However, as the correlation matrix showed high correlation in some of these variables like, number of teachers, literacy rate, family welfare centres, the final list indices did not include them.

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Table -1(A) District wise index

Districts	yield index	Fertilizer index	irrigation index	godown index	public lighting index	Road length index	post office index
Thane	93.62072	28.49455	16.66667	28.50524	43.48581	25.94318	12.13984
Raigad	71.47575	37.70289	20	70.39853	36.34943	35.05656	46.10517
Ratnagiri	84.09525	13.63933	3.333333	39.00136	23.18837	37.14395	90.82857
Sindhudurg	92.42135	20.34239	80	18.64762	25.12126	76.19712	100
Nashik	61.35929	47.4508	76.66667	63.04781	59.16995	23.39647	31.38293
Dhule	53.24179	19.42341	36.66667	29.6534	33.17402	31.6041	36.17698
Nandurbar	38.27568	19.06371	53.33333	67.43402	43.19515	72.17862	36.45693
Jalgoan	73.71806	63.87144	53.33333	44.07701	59.34614	29.62748	15.29953
Ahmednagar	93.69025	43.8478	93.33333	93.82353	38.85285	17.74948	37.84848
Pune	84.99913	38.34685	90	85.48734	66.49857	23.49444	25.82566
Satara	100	45.01647	100	23.63107	100	33.46223	55.20224
Sangli	85.72918	54.69422	66.66667	29.37076	58.60663	45.63846	37.84459
Solapur	79.76708	35.95089	100	100	42.61218	24.47607	32.65514
Kolhapur	98.59204	100	80	21.59234	48.42099	44.56281	37.09136
Aurangabad	66.71302	38.96312	73.33333	53.34366	61.79199	41.35054	27.04854
Jalna	58.78672	32.35185	46.66667	59.60389	26.63817	24.68973	28.17984
Parbhini	56.23153	15.10709	20	32.96756	40.55368	43.42766	23.70911
Hingoli	53.43299	14.7474	20	25.16285	62.76031	53.51999	36.45208
Beed	67.09543	25.89491	90	79.7067	40.12339	29.50827	35.27095
Nanded	71.05858	62.80488	36.66667	56.33411	38.69024	37.26786	38.27289
Osmanabad	64.1926	19.19308	26.66667	52.68033	40.49058	49.48083	45.54516
Latur	66.5392	42.55734	26.66667	49.29169	32.27529	39.6808	32.09168
Buldana	58.14358	35.22927	20	29.51845	29.37353	18.5887	37.22081
Akola	66.46967	17.26525	16.66667	41.31348	28.90773	42.40396	33.69015
Washim	51.71215	17.26525	13.33333	28.36386	46.19267	38.11476	37.59145
Amravati	76.86424	25.11103	26.66667	45.18824	53.68306	16.86968	40.8612
Yavatmal	67.72119	27.38224	23.33333	52.79319	38.18192	15.67996	35.53553
Wardha	62.2284	33.63709	30	32.52405	49.93686	32.43167	35.41286
Nagpur	72.13628	28.95323	73.33333	94.54621	84.0476	37.55684	20.31185
Bhandara	61.18547	19.06371	76.66667	31.63011	33.20926	100	31.25528
Gondiya	47.99235	19.06371	76.66667	41.8109	31.42362	78.47467	29.57471
Chandrapur	74.08309	26.88201	70	38.71765	42.05887	25.38254	35.43453
Gadchiroli	55.32766	37.26857	96.66667	32.43837	61.2284	10.7221	44.16113
Mean	69.96666	33.5329	52.52525	48.26077	46.04814	38.05096	37.65082
Variance	235.5723	322.8874	944.4655	514.9359	286.2525	389.2222	295.0061
Std D	15.34837	17.96907	30.73216	22.6922	16.919	19.72872	17.17574
Co-eff Var	0.219367	0.535864	0.585093	0.4702	0.36742	0.518481	0.456185

Table -1 (B) District wise index

Districts	Bank index	Credit index	pcy index	general index	Economic index	Social index	Agriculture labour emp index	Industria lab emp index
Thane	45.99867	2.958597	91.60977	23.66597	23.70356	22.16352	20.29917	29.5770
Raigad	58.58243	6.466824	85.26786	42.57175	35.26957	54.83214	48.07058	47.0325
Ratnagiri	70.04948	4.642779	55.3659	35.83816	24.98482	62.10591	70.58716	12.7752
Sindhudurg	80.47268	6.160221	58.61345	49.97886	40.06732	90.24202	73.19817	6.51009
Nashik	41.30209	14.67078	65.04727	41.74158	41.56735	39.80783	64.8328	29.2771
Dhule	40.93609	10.08099	43.78939	31.93376	29.62941	35.10093	72.30612	9.11324
Nandurbar	33.98001	13.12576	37.47374	39.87164	37.09634	43.08028	90.04142	11.8661
Jalgoan	44.37795	16.97362	56.6264	37.32629	39.31273	33.46987	71.42813	13.6406
Ahmednagar	44.77244	17.0373	57.46236	43.86208	44.72621	46.21862	76.04612	14.0261
Pune	72.50205	14.48145	100	39.6885	46.72902	29.13246	38.34813	48.9220
Satara	48.22494	13.70077	61.13883	42.34157	47.78205	34.06622	77.01919	17.4056
Sangli	64.61177	23.05269	69.66036	48.55026	48.12342	53.41909	77.63166	15.1048
Solapur	51.30859	12.41146	55.58473	45.36139	44.0304	52.89871	67.61613	17.1466
Kolhapur	58.54235	27.53206	77.62167	46.16644	50.65783	39.02096	64.60928	28.397
Aurangabad	54.30163	6.585817	64.28134	42.12725	39.81304	45.87265	59.89433	32.2464
Jalna	41.17896	1.746021	39.83281	32.64817	26.76526	42.22085	81.9937	11.6617
Parbhini	41.18897	5.608375	43.8244	28.30736	25.98569	34.26013	74.96554	5.64413
Hingoli	33.64239	8.679027	41.34279	34.94201	28.926	43.68653	91.69417	12.4643
Beed	41.24639	4.551415	47.05882	38.67094	35.84572	48.36331	81.62109	9.22822
Nanded	40.10853	2.731978	39.44328	29.95068	33.67866	30.1875	73.28941	2.34013
Osmanabad	42.91643	14.5071	42.15686	34.45231	35.87094	33.00852	82.09972	7.02241
Latur	41.59136	12.33373	39.58771	37.65273	34.98319	47.62207	70.12347	7.06808
Buldana	40.71332	24.96263	42.31005	32.54958	30.80465	35.31074	87.07372	8.21126
Akola	56.28968	62.58101	48.52066	35.11963	36.49903	44.88309	63.55481	2.79023
Washim	46.25859	100	48.72199	42.24933	36.07094	59.30047	88.76624	12.7916
Amravati	50.28221	5.406745	51.82073	32.47674	30.58197	38.83439	70.25325	6.18097
Yavatmal	41.95107	2.570313	47.73284	31.18305	25.89765	39.89174	83.49144	9.32621
Wardha	52.29323	3.928828	56.76208	41.32161	30.6776	50.24071	72.55394	10
Nagpur	64.88668	6.321011	81.63078	33.04691	41.69443	34.01331	34.70024	2.63877
Bhandara	100	2.436414	51.88638	34.50035	34.6249	46.43921	79.07914	1.56525
Gondiya	94.62308	2.30524	46.57738	33.84496	33.01917	48.6031	77.83442	1.48109
Chandrapur	64.14061	2.286372	62.24615	33.7831	31.43151	35.03535	69.32323	13.6985
Gadchiroli	40.53205	1.240824	34.4888	33.7261	27.64396	53.35468	100	2.31823
Mean	52.84263	13.75994	55.92387	37.3167	35.59074	43.839	71.34382	16.6506
Variance	261.6833	373.8479	265.0095	36.35063	53.17899	153.6979	272.3795	367.302
Std D	16.17663	19.33515	16.27911	6.029148	7.292392	12.3975	16.50392	19.1651
Co-eff Var	0.306128	1.405176	0.291094	0.161567	0.204896	0.282796	0.231329	1.15101

Table -2

Results of OLS for all districts as a group

	Intercept	General Index	Agri lab index	Indus lab index	Economic index	Social Index
Model 1	84.12404 (9.552849)	0.790601 (3.691892)	-0.81765 (-10.2184)	0.08329 (1.137845)		
A R^2	0.82					
F stat	48.748					
Model 2	104.135 (13.0759)		-0.79564 (-8.0326)	0.17736 (2.188)		0.12773 (1.030)
A R^2	0.754					
F stat	32.23					
Model 3	86.96 (9.5669)		-0.74228 (-9.0157)	0.18472 (2.6130)	0.56798 (3.1747)	
A R^2	0.80					
F stat	44.798					
Model 4	80.64204 (8.6426)		-0.7417 (-8.7699)	0.16393 (2.40286)	0.620969 (3.6136)	0.07680 (0.7306)
A R^2	0.82					
F stat	37.489					
Model 5	81.8294 (9.126)	1.1687 (1.941)	-0.8030 (-9.1688)	0.0506 (0.5207)	-0.1388 (-0.3457)	-0.1718 (-1.043)
A R^2	0.8146					
F stat	30.005					

Table -3

Results of OLS for districts having pcy above all district average

	Intercept	General Index	Agri lab index	Indus lab index	Economic index	Social Index
Model 1	92.3258 (7.6038)	0.5306 (1.8727)	-0.642 (-6.0098)	0.06787 (0.8212)		
A R^2	0.749					
F stat	13.937					
Model 2	74.3719 (6.152)		-0.5550 (-8.1839)	-0.2484 (-2.415)		1.0388 (3.402)
A R^2	0.842					
F stat	24.725					
Model 3	84.81 (8.3673)		-0.615 (-8.0978)	0.0994 (1.4299)	0.5777 (3.1521)	
A R^2	0.83					
F stat	22.156					
Model 4	84.0783 (7.5876)		-0.62568 (-6.9416)	0.10012 (1.3694)	0.582717 (3.0081)	0.02691 (0.2393)
A R^2	.812					
F stat	15.06					
Model 5	84.3504 (6.7888)	-0.165 (-0.06736)	-0.62278 (-5.9403)	0.0998 (1.28519)	0.679399 (0.4685)	0.08289 (0.4685)
A R^2	0.788					
F stat	10.72					