Impact of Infrastructure Availability on Industrial Development- A Micro and Macro Level Analysis for Resource Rich State of Jharkhand, India

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Abstract

Most of the relevant researches conducted so far, have been at national or state level, either to find out the ranking of the states or how these rankings have changed over time. Assumption of the whole state area as a homogeneous unit is not true, and this study feels that the 'District' should be the level at which the research should be based. The paper formulates different composite indices using Principal Component Analysis (PCA) technique. Various development models formulated tries to analyze the impact of various infrastructures on level of industrial development using multivariate OLS regression techniques. The results show that the availability of Physical Infrastructure (PI) and Social Infrastructure (SI) are comparatively in a better condition. However, Banking Infrastructure (BI) needs immediate intervention.

Keywords: Infrastructure, Industrial Development, Principal Component, Regression, Resource Rich State

1. Introduction

Industrialization is widely recognised as the intended shift from agriculture to manufacturing, and is supposed to be the key to development. Hardly any country has developed without considering the industrialisation process. The phenomenon has been so striking to induce some economists to hypothesize that the manufacturing sector is the engine of economic growth, the so called "engine of growth argument" (Kaldor[1]; Cornwall[2]). Infrastructure plays a leading role in industrial development. The causal study by many researchers has established that in long run infrastructure is the leader and the industrial development is the follower.

In Indian context the main characteristics of development has been the wide regional disparity in development levels. Since India is a vast country, the geographical diversity does create some imbalance in resource base. A country with more than sixty years of planned development should have exploited the available resources of the different regions to stimulate some sort of development in every region. No, doubt, the efforts have been made in this direc-

tion, but wide regional disparity is still a ground reality in India (Gulati[3], Ghosh and De[4], Dadibhavi[5]). However, this study goes a step ahead into analysing the districts of a particular state Jharkhand, one of the most mineral rich states of India and with a low level of industrial development.

The study initially reviews the level of industrial development and the availability of the infrastructure facilities at district level. Formulating composite indices for different components of infrastructure, the extent of disparities among the districts are found. Further using the econometric models, it is seen as to how far the infrastructural development in the districts is influencing the industrial development of the districts.

The results show that though physical and social infrastructure influences the level of industrial development of these districts in Jharkhand, banking infrastructure needs an immediate intervention to be developed to influence the industrial development. Results show that, when all the districts as a group is considered, for all the models, the association of the components of infrastructure- Physical Infrastructure (PI), Banking Infrastructure (BI) and

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Social Infrastructure (SI), with level of industrial development is found to be weak -which reflects the low level of infrastructure availability in the state, whereas when the more industrialized districts are considered, for the same set of models, only PI and SI are found to be significant, suggesting a lack of proper synchronization of the industrial development policy for BI at the district level. The paper further tries to turn the findings into useful policy tools, concentrating on the districts of Jharkhand state - one of the most resource rich states in India with low level of industrial development.

Industrial policy in general promoting industry, requires an understanding of the political equilibrium of a society, the actors and their interests, the political institutions, rule of law, and how these pieces all fit together. We need to stop thinking of normative industrial policy. Industrial policy has been successful when those with political power who have implemented the policy have either directly wished for industrialization to succeed or been forced to act in this way by the incentives generated by political institutions (Robinson[6]).

1.1 Objective of the Study

Most of the earlier research works have been either at national level or at state level and assumes the whole state as a homogeneous unit-which is not true. Since our country has different types of regions within the states, it is felt that 'District' should be the level at which the research should be based. A diversified industrial development and different components of infrastructures should be properly and adequately reflected through multiple and composite indices. Consequently, the following objectives were framed-

1. To examine the impact of infrastructure on industrial development of Jharkhand at district level.
2. To utilize the findings as a tool to facilitate, for an efficient policy synchronization, in industrial development of Jharkhand at district level.

2. Data and Methodology

The study is mainly based on the secondary data for the eighteen (old) districts of Jharkhand, which measures the level of industrialisation and the infrastructural availability at state and district level using various variables. Furthermore, this paper has not included the newly created districts in the analysis, because data were not available for the period of study. The data of state level and district level infrastructure facilities for the period 2001-2011 used by the statistical abstract from Director of Economic and Statistics, Government of Jharkhand, whereas demographic statistics of individual districts taken from statistical Abstract, State Census data of various issues, are considered for the analysis.

2.1 Methodology

It is accepted that a region cannot be so easily termed underdeveloped or having 'inadequate' infrastructure. There are various facets of industrial development and a region, while lacking in one, may be well developed in another. Similarly, while it may lack in one or more of the infrastructural services available, it may possess adequate supply of others. Consequently, the selection of the drivers/prime movers of both Industrial Development and Infrastructure is importantly required with a further subdivision into constituent components.

2.2 Drivers of Industrial Development

The socio-economic condition plays a major role in determining the level of industrialization of a region or district. The industrial development depends on how efficiently the economic components and social components are contributing at the district level. The three major components which may play a significant role in determining the levels of industrial development are as follows:

1. The transportation system- which enables the transport of the raw materials from the source to the industries and finished goods to the markets.
2. The financial facility to the industries which gives the financial support for setting up a new unit or for smooth functioning of it.
3. The work force as availability of skilled labors for efficient production.

2.3 Selection of Variables (Based on the Drivers of Industrial Development)

The development can be measured using two types of variables- one is *input variable* and the other is *output variable*. The most preferred and undisputed way to measure the industrial development is using *output variable* in the form of the percentage share of the secondary sector in the State Gross Domestic Product (SGDP), for which, the data is available at state level in Indian context. But for analysing the industrial development at district level,

due to non availability of most of the data under *output variable*, the study focus has been shifted towards measuring the industrial development using some *input variable* which is available at district level. Hence for a rational analysis – both the variables- the dependent variable as well as the independent variables are to be considered from the input variables.

2.3.1 Selection of Independent Variables

Though the variables measuring the availability of different components of infrastructure at district level might be from a wide range of socio-economic aspects, this study since focuses on impact of infrastructure on industrial development, the following input variables are considered:

- The variables covering the transportation system and facilitating the industrial development and denoted by PI are- *Road Length per 100 Square Km, Railway Route Length per 100 Square Km, no. of households having electricity connection per 1000 population.*
- Similarly, the variables contributing at district level to the financial component and denoted by BI are- *no of banks, per capita bank deposit and per capita credit to industry.*
- The third component though not directly related to the industrial development, but has a strong impact and is influenced by quality of education (particularly technological learning) and the availability of health facilities influencing the industrial output. This component denoted by SI may be covered by the following proxies - *number of primary schools per 1000 Sq.Km., number of secondary schools per 1 000 Sq.Km., number of higher secondary schools per 1000 Sq.Km., number of colleges per 1000 Sq.Km., number of primary hospitals and dispensaries per 1000 Sq. Km, number of health sub-center per 1000 population, number of sub divisional hospitals, no. of district hospitals.*

2.3.2 Selection of Dependent Variables

For measuring the industrial development (dependent variable) at district level, which is related mainly to the manufacturing sector, the following proxies are considered which may contribute to the industrial development of the study area-

- *Total no of industries per 1000 sq. km* including SSI (Small Scale Industries), MSME (Micro, Small and Medium Enterprises) and Large Integrated Public Sector Units,

- *Percentage of Industrial Labour*- which is a measure of the actual labours involved in the process of industrial development and
- *Percentage of urban population*- This is the percentage of the population living in urban areas to the total population of the district- which may be considered as a proxy to level of industrial development.

2.4 Research Method

Common problems with cross-section analysis are multicollinearity and dimensionality. PCA is used as a statistical tool to remove these problems. Dimension reduction technique of Factor analysis which uses PCA is applied to those variables/proxies which are highly correlated amongst each other. The study finds number of Sub Divisional Hospitals (SDH) and umber of District level Hospitals (DH), which are at the top in the hierarchy of the hospitals at district level, are weakly associated with the other variables and are also not significant, and hence these two variables are not considered for the further empirical analysis. Since the units of measurement of correlated variables are different, the rotated component matrix using PCA is used in order to obtain the corresponding weights. Since a variable should not have an artificially higher weight due to its higher variance, the data are standardized with variance one (1) and mean zero (0) before applying PCA. Principal components having Eigen values greater than one (1) are selected.

Finally, three principal components are retained which have extracted 88.32 percent of variance of the dataset. The obtained weights are multiplied by the corresponding standardized values of the variables to arrive at the indices.

Since the variable Road Length per 100 Square Kilometre receives the highest weight in the first principal component, after multiplying it with the data on Physical Infrastructure and adding up, the resulting index is named the Index of Physical Infrastructure (Index_PI). Similarly, the second principal component is the Index of the Banking Infrastructure (Index_BI). The third principal component, which has the highest weight to number of primary health center, is the Index of Social Infrastructure (Index_SI). The index of level of industrial development (Index_Industrialisation), is prepared in the same way as discussed above.

The higher numbers of these four indices represent better level of infrastructural availability. The resulting four indices no longer have the problem of multicollinearity

and can be used together in a regression equation. Since all the indices move in one direction, it is expected that economic performances are positively correlated. Hence, it is expected that the coefficient of all the indices would be positive.

3. Models

Since the objective of the study is focussed on policy implication, so for getting a clear picture of the impact of the infrastructure components at district level, analysis focussed at two tiers, first- the individual contribution of each component and second the contribution at a combination level will make the analysis more focussed. Hence the model formulation is based on first- the individual contribution of each component which is studied in Model I, Model II and Model III.

Next level is of combining two (out of the three) of the components and hence next three models –Model IV, Model V and Model VI are formulated to examine the influence when two of the infrastructures are clubbed. The seventh and the last model - Model VII, studies the impact when all the three components are considered simultaneously which may be considered as the inclusive model of industrial development. Hence in total seven models are formulated which are represented below:

$$\text{Model I:} \quad Y_i = \alpha_1 + \beta1\ (PI)_i + \varepsilon_1 \quad (1)$$

$$\text{Model II:} \quad Y_i = \alpha_2 + \beta2\ (BI)_i + \varepsilon_2 \quad (2)$$

$$\text{Model III:} \quad Y_i = \alpha_3 + \beta3\ (SI)_i + \varepsilon_3 \quad (3)$$

$$\text{Model IV:} \quad Y_i = \alpha_4 + \beta4\ (PI)_i + \lambda_4\ (BI)_i + \varepsilon_4 \quad (4)$$

$$\text{Model V:} \quad Y_i = \alpha_5 + \beta5\ (PI)_i + \lambda_5\ (SI)_i + \varepsilon_5 \quad (5)$$

$$\text{Model VI:} \quad Y_i = \alpha_6 + \beta6\ (BI)_i + \lambda_6\ (SI)_i + \varepsilon_6 \quad (6)$$

$$\text{Model VII:} \quad Y_i = \alpha_7 + \beta7\ (PI)_i + \lambda_7\ (BI)_i + \theta_7\ (SI)_i + \varepsilon_7 \quad (7)$$

Here, 'Y_i' represents the Index of level of Industrial Development of ith District; PI represents the Physical Infrastructure index of the districts, BI represents the Banking Infrastructure index of the districts, SI represents the Social Infrastructure index of the districts, α is the intercept, β, λ and θ are the corresponding co-efficient of the different components of infrastructure and ε is the error term. The null hypothesis of level of industrial development (as dependent variable) is tested against the respective indices of the different infrastructure component (as independent variables) of each model separately.

The Index of level of industrial development is considered as a function of Physical Infrastructure Index, Banking Infrastructure Index and Social Infrastructure Index. Here it is hypothesized that, infrastructural development promotes economic growth, in the districts of Jharkhand. But, as all districts are not equally developed an attempt is also made to split the districts of Jharkhand into those above and below the average level of industrialisation.

4. Empirical Results and Analysis

The results are analysed using the different composite indices formulated, which is the base data for studying the inter district disparities, as well as the solutions to the alterative models. The seven alternative equations have been solved for all districts as a group and for districts which are having the level of industrial development, above the district average value, as a second group and for districts below the districts average industrial development 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.

4.1 Pseudo-Code for Different Models for Both Groups

1. START
2. While loop, for any given model 1–7. "9" being to EXIT.
3. Switch model number given by user.
4. Calculate the value of Y obtained from all the seven models considered for the analysis- for both macro level (state as a whole) and micro level (for more industrialized districts).
5. Value of "ε" (as "e" in code) in each case is considered 0.0.
6. Values of "α", "β", "λ" and "θ" are taken from Table 1, for code 1 and Table 2, for code 2. These Greek symbols are represented as "a", "b", "c" and "d" respectively for simplicity.
7. Based on the model selected user enters "PI", "BI" and "SI" values. e.g., if model 2 is selected only "BI" value is asked as Input. Again, if model 6 is selected, only "BI" and "SI" values are asked as Input.

8. After each case, value of "Y" for the respective model is displayed, and User has the liberty to check value of "Y" for another model or EXIT program.

9. END

Table 1. Regression results of OLS for all districts as a group

	Intercept	Index_PI	Index_BI	Index_SI
Model I	2.706 (6.433)	2.086 (11.552)		
AR²	0.8688			
F-Stat	133.457***			
Model II	0.5229 (1.0359)		1.392 (7.528)	
AR²	0.735			
F-Stat	56.68***			
Model III	-0.137 (-0.227)			3.685 (5.780)
AR²	0.618			
F-Stat	33.412***			
Model IV	2.160 (5.01)	1.526 (5.56)	0.497 (2.515)	
AR²	0.897			
F-Stat	88.604***			
Model V	2.12 (4.784)	1.678 (7.147)		1.165 (2.397)
AR²	0.895			
F-Stat	86.28***			
Model VI	0.295 (0.6355)		0.974 (3.97)	1.635 (2.325)
AR²	0.785			
F-Stat	37.614***			
Model VII	1.877 (4.260)	1.37 (4.97)	0.373 (1.856)	0.8403 (1.720)
AR²	0.907			
F-Stat	66.49***			

Notes:
1. *** values significant at 1% level of significance;
2. Figures in parenthesis below the coefficient values are the t-Statistics values.
3. The regression results are based on the data of Table 1.2

Abbreviations:
Independent Variables- Index_PI, Composite Index for Physical Infrastructure; Index_BI, Composite Index for Banking Infrastructure; Index_SI, Composite Index for Social Infrastructure.

Dependent Variable- Index_Industrialisation, Composite Index for Level of Industrialisation

Table 2. Results of OLS for districts having level of industrialisation above average of all districts

	Intercept	Index_PI	Index_BI	Index_SI
Model I	3.841 (6.12)	1.87 (7.033)		
AR²	0.9237			
F-Stat	49.46***			
Model II	3.421 (1.197)		0.849 (1.31)	
AR²	0.1522			
F-Stat	1.7185			
Model III	0.2763 (0.150)			4.970*** (3.832)
AR²	0.7738			
F-Stat	14.6855**			
Model IV	3.872 (3.674)	1.88 (4.501)	-0.0129 (-0.04)	
AR²	0.8857			
F-Stat	16.50**			
Model V	3.23 (1.695)	1.6215 (2.071)		0.769 (0.347)
AR²	0.892			
F-Stat	17.544**			
Model VI	0.161 (0.08)		-0.45 (-0.761)	6.355*** (2.768)
AR²	0.736			
F-Stat	6.60**			
Model VII	2.944 (1.064)	1.486*** (1.284)	-0.1634 (-0.292)	1.623*** (0.387)
AR²	0.8013			
F-Stat	6.3781**			

Notes:
1. *** values significant at 1% level of significance.
2. ** values significant at 5% level of significance.
3. Figures in parenthesis below the coefficient values are the t-Statistics values.
4. The regression results are based on the data of Table 1.5

Abbreviations:
Independent Variables- Index_PI, Composite Index for Physical Infrastructure; Index_BI, Composite Index for Banking Infrastructure; Index_SI, Composite Index for Social Infrastructure.

Dependent Variable- Index_Industrialisation, Composite Index for Level of Industrialisation

4.2 Results of OLS Regression for All Districts as A Group (Refer Table 1.0- Annexure-I)

For measuring the impact of different components individually as well as in various combinations, the indices

of PI, BI and SI are prepared and regressed over level of industrial development and the regression results are presented in the form of seven models in Table 1.0.

The first three models test the individual impact of the three components of infrastructure considered on the level of industrial development at district level. In Model I, II & III, Adjusted R^2 value is maximum for Model I (PI) having value 0.8688, followed by Model II (BI) and Model III (SI) which reflects that the individual priority of impact on the industrial development. Hence the contribution of PI is maximum as compared to other two components.

From Table 1.0, it can further be summarised that for all the models, in all the districts of Jharkhand, initial level of industrial development is significant which is reflected by the highly significant values of the F-Statistics for the intercept. Surprisingly the initial level of industrial development in Model-III is showing negative sign. It might be reflecting that the social infrastructure does not influence the level of industrial development directly.

In models IV, V, & VI, the maximum explanation is observed for model IV (PI and BI) where AR^2 value is maximum 0.897, followed by model V (PI and SI) and VI (BI and SI). Hence it may be noted that when there is a combination of two components, it's again the PI which when combined with BI and SI has more impact. Model VII which might be a good fit model for industrial development is to be noticed for its maximum impact on the industrial development where AR^2 value is highest (0.9070) and it occurs when all the three components are taken together suggesting an inclusive growth model which combines PI, BI and SI simultaneously.

All the insignificant coefficient values, for the index of PI,BI and SI , in all the models are suggesting that the contribution of these components are not significant and hence a policy orientation at district level is highly and immediately required to utilize these infrastructures for achieving a high level of industrial development in Jharkhand as because the current industrial policy – the Jharkhand industrial policy 2012, states about the uniform regional growth, but the approach, priority and phasing is not properly described.

4.3 Results of OLS for Districts having Level of Industrialisation Above Average of All Districts (Table 2)

For measuring the impact of different components individually as well as in various combination, the indices of PI, BI and SI, is regressed over level of industrial development for the districts identified as more industrialised districts and the regression results are presented in the form of seven models in Table 2. The regression is performed here for the same set of models as considered in Table 1.

The results in Table 2 find that the initial level of industrialization is pertinent to all the Models, reflected by the significant F-Statistics values, except Model II (BI). For Model I (PI), AR^2 value is maximum and the F-Statistics value is also highly significant suggesting the maximum contribution of PI in industrial development. Model II (BI) shows the least impact, which is an indicative of the insignificant contribution by the existing BI.

The individual impact is significant for Model-III (SI) only. This is in accord with the present situation as these more industrialised districts are having a good number of schools as well as hospitals, which is due to the existing rich industrial base of the major public sector units in these districts. The insignificant individual contribution in Model I (PI) and Model II (BI) may be due to the lack of policy synchronisation for PI and BI at district level.

The combination impact is tested in model IV onwards. Model V shows that SI in the more industrialised districts is properly linked, while PI is not. Model VI is showing high significance for SI showing its proper linking again but not for BI. The negative coefficient values for BI in models IV&VI again may be a result of failure in policy implication.

Model VII where all the three components are combined together is to be noticed for it being highly significant for PI and SI though here again BI has negative coefficient values, indicating some (or all) factors of BI is not contributing to industrial development and hence intervention in this infrastructure is highly and immediately required to counteract the negative effect for achieving a better level of industrialisation.

The results further find that the minimum coefficient values (under PI_Index column) for all the models is 1.486, indicating that a unit increase in Level of Industrial Development calls for more than 1 unit increase in physical infrastructure indicating the inadequacy in this infrastructure. Similarly, a unit increase in level of industrial development requires at least more than 0.77 units of social infrastructure (under SI_Index column) and one unit increase in level of industrial development calls for more than 0.012 units decrease in BI (under BI_Index

column) which is a clear picture of decreasing per capita income of the people of Jharkhand.

5. Conclusion

In conclusion it could be stated that a high degree of disparity exists within the districts in terms of Physical Infrastructure, Banking Infrastructure and Social Infrastructure resulting into a high variation in the level of industrialisation at district level within the state.

PI, BI, SI are not contributing significantly at the district level is a major concern and is strongly indicating a failure at the level of policy implication. For only five identified districts, though PI and SI are comparatively in a better condition, this shouldn't be misinterpreted as a well placement of this infrastructure in these districts. Results clearly indicate an immediate intervention in BI is required even for the five more industrialised as well as the rest districts parallely. Strengthening of BI will take place only when its components namely, the number of banks and credit facilities to industry by the banks are focussed. Once the retarding effect caused by poor availability in the BI is counterbalanced, all the three components of infrastructure, PI, BI and SI are to be intervened parallely, integrated with the socio-economic conditions of the districts, within the frame of the industrial policy, which will help in achieving the uniform industrial development throughout the state. Proper industrial planning integrated with policy thinking at district level along with set planning priorities are needed to fulfil the objective of balanced regional development in Jharkhand.

6. References

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