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Abstract

Imbalances in regional infrastructural availability have been a major reason behind lopsided development in India. This paper examines the veracity of this argument in light of empirical results at the district level using a multidimensional approach with sub-sectoral, sectoral and composite indices of development and infrastructural availability. Significant association between infrastructural and development levels of regions is observed, though the magnitude has declined in recent years. This association is different for regions at different stages of development. The findings suggest that identification of specific requirements of different regions, benefit-cost analysis, followed by infrastructural expansion are major planks of balanced regional development.

JEL Classification: *R11, R58, H54, O18;*

Keywords: *Infrastructure, Regional, Planning, India*

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INFRASTRUCTURE AND REGIONAL DEVELOPMENT IN INDIA

One of the major characteristic of development experience in India has been the wide regional disparity in development levels. While the size of the country and the geographical diversity do create some imbalance in resource base, a country with 50 years of Planned development ought to have exploited the available resources of the regions to spark off some sort of development in every region. It is true that efforts have been made in this direction, but wide regional disparity is still a hard reality in India. Economists have identified various factors that have close correspondence with the regional development levels - infrastructure being one of the more important ones among them. In one of the present author's forthcoming studies the levels of and variation in infrastructural availability in India has been studied. [Majumder, 2003]. In this paper we try to look at the association between regional development levels and regional infrastructural levels. The paper has eight sections. In the next section we briefly review some of the studies on regional development and infrastructure in India. The third and fourth sections deal with Objective and Methodology of the study. The fifth and sixth sections explore the Interaction between Infrastructure and Development using Correlation & Regression and Discriminant Analysis. The seventh section tests the validity of Hansen Thesis in India. A short Summary and Conclusion ends the paper.

BRIEF REVIEW

India has experienced wide regional imbalance in achievement of development goals. Whether such imbalances have widened over the years have been studied by various researchers. Their conclusions however, do not match. Williamson [Williamson, 1965, 1968] did the pioneering work in this regard as a part of his international study and concluded that regional inequalities in India increased during the 1950s. This conclusion was refuted first by Dhar and Sastry [Dhar and Sastry, 1969], and then by Mahajan [Mahajan, 1982]. Others claiming a narrowing down of regional disparity have been Gupta [Gupta, 1973], Lahiri [Lahiri, 1969], and Rao [Rao, 1972]. Broadly parallel results have been reported by

Majumdar [Majumdar, 1970], Nair [Nair, 1982], Ganguli and Gupta [Ganguli, 1976], and Mathur [Mathur, 1983, Mathur, 1987]. As against this school, there have been studies that either claim a rise in regional inequality or do not find any evidence to reveal significant narrowing down of the gap. Venkataramiah [Venkataramiah, 1969], Rao [Rao, 1973], Nair [Nair, 1973], Chaudhry [Chaudhry, 1974], Sampath [Sampath, 1977] and Mohapatra [Mohapatra, 1978] belong to this group who argue that regional imbalances in India have increased over the years. Such disagreement has been mainly due to the short span of these studies, and the sensitivity of the conclusion towards choice of initial and terminal years. Also, these studies have mostly used aggregate regional income (or consumption) levels, which means that development has been conceptualised as a unidimensional factor, captured by income or consumption level alone. Mathur [Mathur, 2000] has covered, in one long sweep, the issues of National and Regional Growth experiences in India from 1950-51 to 1996-97, and in some cases up to 2000, using not only overall state per capita income, but also sectoral PCI. He concluded that regional disparities had decreased till mid-sixties but have increased thereafter.

Published studies on infrastructure in the Indian context have been sparse and most of them have been at the national or state level. Researchers who have studied Availability of infrastructural facilities in India and its regional variation include Shah [Shah, 1970], Shri Prakash [Shri Prakash, 1977], Gulati [Gulati, 1977] and Arunkumar & Upendranath [Arunkumar, 1993]. The relationship between development and infrastructure has been studied by Tewari [Tewari, 1983, Tewari, 1984], Amin [Amin, 1990], Dadibhavi [Dadibhavi, 1991], Gayithri [Gayithri, 1997] and Ghosh & De [Ghosh, 1998]. Most of them have concluded that the relation between them is positive and significant and a major part of the regional disparity in development can be attributed to regional imbalance in physical infrastructure. Alagh [Alagh, 1987] studied various dimensions of infrastructural planning in India using empirical analysis of different models and projects. They stressed on the need to improve the efficiency of these services.

OBJECTIVE OF THE PRESENT STUDY

Most of the earlier studies have been at the national or state level, and obviously views the state as a homogeneous unit, which it is not. Further detailed study is required to look at the regional dimension of availability of infrastructural facilities in India and its effect on development. Specially, since our country has different types of regions within the states, it was felt that 'District' must be the level at which the study should be based. To have a long term perspective, the present study uses a 20 year span (from 1971-1991). Also, a diversified view of development and infrastructure is taken where the multidimensional facet of them is sought to be adequately reflected through multiple and composite indices.

Consequently the following objectives were framed.

1. **To prepare indices of infrastructure and indices of development at the District level.**
2. **To examine the relationship between infrastructural availability and development using those indices.**

METHODOLOGY OF THE PRESENT STUDY

The methodology to be adopted in the present study has to be explained in detail.

It was accepted that a region cannot be so easily termed underdeveloped or having 'inadequate' infrastructure. There are various facets of economic 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 both Development and Infrastructure were subdivided into constituent components.

Development has been presumed to be consisting of:-

1. **Agricultural Development - related mainly to the Agricultural sector;**
2. **Industrial Development - related mainly to the Manufacturing sector; and**
3. **Human Development - related to the Social Indicators of literacy, mortality, etc.**

Similarly, Infrastructure is composed of 3 broad areas -

I. Physical Infrastructure;

II. Financial Infrastructure; and

III. Social Infrastructure.

Further subdivided, the following components of Infrastructure are identified:-

(a) Agro-specific Infrastructure - consisting of irrigation infrastructure and agricultural credit;

(b) Transport & Communication Infrastructure - consisting mainly of Roads and Railways;

(c) Power Infrastructure;

(d) Financial Infrastructure - consisting mainly of Banking Services;

(e) Education infrastructure; and

(f) Health infrastructure.

(a), (b) & (c) constitute Physical Infrastructure, and, (e) & (f) constitute Social Infrastructure.

Each of these components of development and infrastructure themselves consist of several variables/indicators. Separate indices for each of the three components of development and six components of infrastructure are prepared (by method explained later) and future analysis is based on those indices.

Any study that attempts to study such a broad aspect of socioeconomic process as infrastructure on one hand and development on the other, over so vast a space as of India must be careful about, and give serious thoughts to, two very important aspects. They are:-

(a) Choice of variables or indicators, and,

(b) The method of combining them into indices.

Both of them must be spelt out.

The choice of indicators and then converting them into composite indices depends primarily on the objective of the study – what specifically is being investigated and which viewpoint it is sought to be looked from. The present study seeks to study the inter-relationship between Infrastructure and Development. Now, both these aspects have serious overlapping. Development of infrastructural facilities is a part of development process proper, and overall development also brings about expansion of infrastructural facilities. Consequently, failure to differentiate between the two will obviously lead to a situation where a significant association will be obtained between them by default - simply due to the overlapping choice of indicators. To obviate this, effort has been made in this study to alienate the indicators so that variables or indicators that measure the availability of social overhead capital or infrastructural facilities are not included as indicators of development proper. An indicator that measures the support system provided, mainly by the State, to the directly productive economic activities or to the process of social capital formation is taken as an indicator of infrastructural facilities. Alternately, an indicator is included on the side of development proper if it is measuring any of the end results of development process, namely - income generation, capital formation, sectoral transition or human capital enhancement. This type of classification has been done with the a-priori ideological standpoint that whereas the infrastructural facilities are the cause, development process is the effect; or, in other words, infrastructure provides the skeleton on which development is built. This somewhat resolves the issue of choice of indicators and their grouping primarily into Infrastructure and Development and then sub-grouping under different components of Infrastructure and Development.

The next issue was regarding the method of deriving Composite Indices. The objective was to prepare composite indices of - Agricultural Development (henceforth AGDEV), Industrial Development (INDDEV), Human Development (HUDEV); Agricultural Infrastructure (AGINF), Transport Infrastructure (TRINF), Power Infrastructure (POWINF), Financial Infrastructure (FININF), Educational Infrastructure (EDUINF), and Health Infrastructure (HLTINF) for the districts of India. Factor Analysis has been the preferred method of preparing Composite Indices under such situations. Consequently, the Modified Principal Component Analysis (MODPCA) technique of Factor Analysis was used to prepare the 9 Composite indices mentioned above.[1] At the second stage AGINF, TRINF and

POWINF were combined to give Physical Infrastructure (PHYINF); while EDUINF and HLTINF were combined to give Social infrastructure (SOCINF).

Composite indices of overall Development level and overall Infrastructural level were also prepared. This was done in 2 ways. The first method used MODPCA on the 3 sectoral indicators of development - AGDEV, INDDEV and HUDEV - to arrive at a composite index of development, represented by DEVT1; and on the 6 sectoral indices of infrastructure - AGINF, TRINF, POWINF, FININF, EDUINF & HLTINF - to arrive at a Composite index of Infrastructure, INF1. Secondly, a simple summation of the sectoral indicators gave us the second composite index of development and infrastructure, represented by DEVT2 and INF2 respectively. It was observed that in almost all the cases, the first principal component had substantially high explanatory power – almost always above 70 per cent.

However a significant result was observed with DEVT1 – the Composite Index of Development obtained by using MODPCA on 3 principal component scores – AGDEV, INDDEV and HUDEV. It was observed that the weightage attached to INDDEV was substantially higher than those attached to AGDEV and HUDEV. In fact, for all the 3 time points (1971, 1981 and 1991), INDDEV had a weightage that was about 30 times as high as that attached to AGDEV. While this is perfectly acceptable if we look at the data matrix alone and follow the statistical principal of attaching higher weightage to variables showing greater variation across space, in the present circumstance certain ideological issue crops up. It can be accepted that a high proportion of diversity among districts can be accounted for by their variation in their Industrial development; but attaching such a high weightage to Industrial development, relative to Agricultural development, while calculating overall development scores would imply that we consider development to be necessarily dependent upon Industrial development. This would significantly make the composite score of development (and our judgement) biased towards Industrial development.

To avoid this dilemma, another composite score of development (DEVT3) was determined which would have equal representation from Agricultural, Industrial and Human Development. To do so, a factor score was evolved by using such a Weight Vector so that the Correlation between the factor score and each of the standardised variables used would be equal. In other words, if $Y_i = \Sigma a_j * X_{ij}$; $j = 1, .., k$; $i = 1, .., n$ gives the factor score of i^{th} observation using the k variables; this Equal Correlation Method would imply that $r_1 = r_2 = \ldots = r_k = R$ where r_j = correlation coefficient between Y (the factor score) and the j^{th} variable (j^{th} X), and where X-s are standardised variables.[2] This method was applied on AGDEV, INDDEV and HUDEV, after standardising them by dividing by their respective mean values, to arrive at DEVT3. Similar procedure was adopted to give us another index of infrastructure - INF3. Thus we now have 3 separate composite indices of development – DEVT1, DEVT2, DEVT3; and 3 composite indices of Infrastructure - INF1, INF2 and INF3. They differ only in the Methodology of their computation but represent the same underlying phenomenon and have close association among themselves. Further analysis is carried on with the aid of these indices.

INTERDEPENDENCE OF DEVELOPMENT AND INFRASTRUCTURAL FACILITIES

The main objective of the study has been to examine the association between the development indices and the infrastructural indices for the districts of India.

The principal intent was :-

(a) To measure the nature and degree of association between the aspects of infrastructure and development, and,

(b) To try to determine whether the relationship is stronger between present infrastructure and future development compared to present development and future infrastructure.

The methodology applied for this was to use the following measures of association and relationship: a) Contemporaneous Correlation, b) Contemporaneous Regression, c) Lagged Correlation with Infrastructure as leader, d) Lagged Correlation with Development as leader, e) Lagged Regression with Infrastructure as leader, and, f) Lagged Regression with Development as leader. The results are summarised below.

Contemporaneous Correlation

It was observed that the correlation between the development indicators and the contemporary infrastructural indices were fairly strong for all the three time points (Table 1a & 1b).

The Correlation Coefficient between INF1 and DEVT1, INF2 and DEVT2, INF3 and DEVT3 were 0.984, 0.679 and 0.424 respectively for 1971. The Correlation Coefficient of the 3 measures of development with Physical Infrastructure were 0.979, 0.840 and 0.551 respectively. For Financial Infrastructure, they were 0.955, 0.849 and 0.573; while for Social Infrastructure the figures were 0.804, 0.773 and 0.592 respectively. Among the components of infrastructure, highest correlation with Development Indicators was observed for Agricultural infrastructure with DEVT1. Insignificant coefficients were observed for Power infrastructure. The association of Agricultural development was strongest with Power infrastructure (0.212), followed by Educational (0.203) and Transport infrastructure (0.173). Industrial development had strongest association with Agricultural infrastructure (0.979), followed by Financial infrastructure (0.954), Health (0.805) and Transport infrastructure (0.752). The association between Human development and all the contemporary indices of Infrastructure are rather weak and insignificant. Also, the association of Agricultural development is stronger with social infrastructure and that of Industrial development is stronger with physical infrastructure.

During 1981 also, the contemporaneous correlation between measures of infrastructure and development were observed to be mostly significant at 1 per cent level. However, the association seems to have weakened marginally compared to 1971, as evident from lower magnitude of the correlation coefficients than before. The association of development indices were strongest with Financial Infrastructure. Industrial development continued to have strong association with Financial (0.952), Transport (0.854), Agriculture

(0.670) and Health infrastructure (0.466), with the last two losing their relatively higher positions of 1971. Agricultural development was found to be strongly associated with Power (0.653) and Educational infrastructure (0.269). The association is surprisingly negative with agricultural infrastructure (- 0.106).

This trend continued, and in 1991 further lower magnitudes were observed for the correlation coefficient between indices of infrastructure and development. But the coefficients were still significant at 1 per cent level. Strongest association was observed between development indices and financial infrastructure. Both Industrial and agricultural development continued to have strong association, as before, with different components of infrastructure.

Lagged Correlation

The contemporaneous correlation measures the association between the indices of development and infrastructure at the same time point. However this does not lead us to any clue regarding the direction of causation or association. Two possibilities may arise regarding the direction of causation. In the first case, we may presume that infrastructure is the leader while development is the follower, i.e. Infrastructure is necessary and precedes development. The alternative may be that development leads to extension of infrastructure and the former is the leader. If the first hypothesis is true then the association between infrastructure of t^{th} period and development of $(t+1)^{th}$ period will be stronger than the association between development of t^{th} period and infrastructure of $(t+1)^{th}$ period. If the alternative hypothesis is true, then the reverse would happen. Consequently, lagged correlation analysis was done and the coefficients were compared. If Infrastructure(t) * Development(t+1) coefficient is greater in magnitude than Infrastructure(t+1) * Development(t) coefficient, then we would conclude that infrastructure precedes development. If however I(t) * D(t+1) is lesser in magnitude than I(t+1) * D(t) then we would conclude that development precedes infrastructural expansion.

The above methodology was applied to each possible combinations of infrastructural index and development index for the 3 pairs of time – 1971- 81, 1981- 91 and 1971- 91. The results are summarised in Table 2a - 2d. The following significant inferences can be drawn from those results.

It is observed that for all the 3 pairs of time, the I(t) * D(t+1) coefficient is higher in magnitude than the I(t+1) * D (t) coefficient for most of the pair of the indices. There were 66 pairs to be compared – 6 measures of development and its components (Agricultural, Industrial, Human development and 3 composite measures of development - DEVT1, DEVT2 and DEVT3) combined with 11 indices of infrastructure and its components (Agricultural, Transport, Power, Financial, Educational and Health infrastructure, 2 other sub components – Physical and Social and 3 composite measures of infrastructure – INF1, INF2 and INF3).

It was observed, that out of those 66 pairs that were compared, association of human development is very low and insignificant for either directions. Out of the remaining 55 pairs, 45 pairs had higher I(t) * D(t+1) coefficients for 1971- 81 period. The same figures for 1981- 91 and 1971- 91 were 36 and 38 respectively. Only 4 pairs in 1971- 81, 8 pairs in 1981- 91 and 7 pairs in 1971- 91 had significantly higher I(t+1) * D (t) coefficient. Thus it can be reasonably argued that the association between infrastructure of present period and development of future period is stronger than the association between development of present period and infrastructure of future period. In other words, the causation seems to run from infrastructural facilities to development. It may be noted that financial infrastructure is a major exception to this trend for all the 3 time-frames. The association is stronger for Development of past period and Financial infrastructure of present period. Another exception has been agricultural development where the association is stronger between development of past and infrastructure of present period. This shows that Agricultural development seems to precede infrastructural expansion.

<u>Regression Analysis</u>

The Correlation Analysis provides us with a fairly good idea regarding the association and interdependence between development and infrastructure. The Lagged Correlation Analysis also shows that the association is stronger between infrastructure of t^{th} period and development of (t + 1) th period rather than the other way round, barring a few exceptions. Consequently, it was sought to examine how changes in infrastructural facilities would affect development levels. To do that, Regression Analysis with infrastructural indices as explanatory variables and development indices as dependent variables were undertaken. Various Regression Equations were formed and estimated. The estimated coefficients would reveal how changes in infrastructural variables would affect development levels.

1. **Production Function in Agriculture:** It was expected that the output in Agriculture would depend on infrastructure among other things. Since Value of Agricultural Output in the districts could be obtained, a production function was formed and estimated. The production function was assumed to be of general log-linear type where log of Value of Agricultural Output (Y1) is expressed as dependent on log of the variables - GCA (X1), Agricultural Worker (X2), Fertiliser Consumption (X3), Tractor-Pumpsets-Diesel Engines (X4), AGINF (X5), POWINF (X6), TRINF (X7) and EDUINF (X8). This equation was named as EQN1.
2. **Manufacturing sector**: The output data on manufacturing sector was not available at the district level. As a proxy to measure the extent of the manufacturing sector, percentage of workers engaged in non-household manufacturing sector was taken. So, a log-linear function expressing log of per cent of workers in non-household manufacturing sector (Y2) as dependent on log of capital availability (represented by per capita bank credit - X9), POWINF (X6), and TRINF (X7), was specified and estimated. This was named EQN2.
3. **Sectoral Development:** The development indices as determined in the present study were also sought to be explained by different explanatory variables including the infrastructure indices. Following regression equations were formed and estimated.
   a) As with production function approach, log of AGDEV (Y3) was used as a dependent variable with the explanatory variables being log of GCA (X1), Agro Worker (X2),

Fertiliser Consumption (X3), Tractors-Pumpsets-Diesel Engines (X4), AGINF (X5), POWINF (X6), TRINF (X7), and EDUINF (X8). This was named EQN3.

b) The Industrial Development index was similarly sought to be explained and the regression equation expressed log of INDDEV (Y4), as dependent on log of POWINF (X6), TRINF (X7), EDUINF (X8) and FININF (X10). This is named as EQN4.

c) Human development was sought to be explained by educational and health infrastructural index and the regression equation expressed log of HUDEV (Y5) as dependent on log of EDUINF (X8) and HLTINF (X11). This is named as EQN5.

4. **Composite Development:** Composite Development indices were regressed on the different components of Infrastructural indices to find out how different components of infrastructure affect Development levels. The following two triplets of equation were formed :–

i) DEVT* = $\alpha + \beta_1$ (AGINF) + β_2 (TRINF) + β_3 (POWINF) + β_4 (FININF) + β_5 (EDUINF) +

β_6 (HLTINF) + U.

ii) DEVT* = $\alpha + \beta_1$ (PHYINF) + β_2 (FININF) + β_3 (SOCINF) + U.

DEVT* = DEVT1, DEVT2 and DEVT3 in successive equations respectively.

These equations were named EQN6, EQN7, EQN8, and EQN9, EQN10 & EQN11 respectively. Thus, 11 regression equations were formed in total. The results are as follows.

Contemporaneous Regression

The regression equations were estimated in 2 ways. Firstly the dependent and explanatory variables were taken of the same time period. This contemporaneous regression would reveal how changes in present period infrastructure (and other explanatory variables) would affect development levels. OLS estimates of these regression equations were determined using Backward Elimination Method. The Final model that was accepted was however not always the last output given by the computational program. Economic logic was used to choose the model to be accepted. If the F-ratio does not increase substantially; or the signs of the regression parameter do not change from unexpected to expected after dropping a variable, then it was retained. The regression results are summarised in Table 3a - 3d. The results indicate the following.

EQN1 reveal that Agricultural output is significantly positively affected by changes in Transport, Agricultural & Power Infrastructure, and Agricultural worker. In later years, GCA and Fertiliser Consumption are also important, signifying the advent of input driven agricultural development.

From EQN2 it is observed that changes in Per Capita Bank Credit, Transport and Power infrastructure positively affect proportion of workers in Non-household Manufacturing sector.

Estimation of EQN3 reveals that Agricultural Development index is significantly positively affected by changes in Agricultural workers, Agricultural & Transport Infrastructure and Tractors, Pumpsets & Diesel Engines in 1971. For 1981, AGINF is replaced by POWINF, and in 1991 Fertiliser Consumption and EDUINF are important, indicating the growing importance of inputs and knowledge.

Industrial development index was found to be significantly positively affected by changes in Financial and Transport Infrastructure for all the three time points, as seen from EQN4.

From EQN5 it was observed that Human development index is positively affected by changes in Health Infrastructure but surprisingly, Educational infrastructure has negative coefficient in this EQN5. Very low ` R^2 reveals that the model is not a very good fit.

EQN6 reveal that composite development index, DEVT1, can be adequately explained by indices of Infrastructure as shown by the high R^2. Significantly positive coefficients were obtained for Financial, Agricultural and Educational infrastructure.

Surprisingly, Transport infrastructure yielded significantly negative coefficient for 1971 and 1981, but positive coefficients for 1991.

Similar results were obtained for EQN7 where DEVT2 was the dependent variable. However in this case the Health infrastructure entered the final equation in 1971 also. The magnitude of the coefficient was highest for Educational infrastructure followed by Health, Finance and Agriculture infrastructure indices.

When DEVT3 was used as the dependent variable, slightly different results were obtained. It was observed that significant positive coefficients were obtained for Health, Educational, Transport and Agricultural infrastructure in 1971. For 1981 and 1991, important variables were Transport, Power and Financial infrastructure. It is to be noted that while DEVT1 and DEVT2 were biased towards Industrial Development, DEVT3 has equal correlation with (standardised) Agricultural, Industrial and Human Development.

EQN9, EQN10 and EQN11 reveal that all three sub-composite components of Infrastructure – Physical, Financial and Social - have significantly positive coefficients. Thus, changes in those components of Infrastructure have significant positive effects on development levels. For DEVT1, Physical Infrastructure has the largest coefficient in 1971, followed by Financial and Social Infrastructure. On the other hand, for both DEVT2 and DEVT3 in 1971, Social Infrastructure has the largest coefficient followed by Financial and Physical Infrastructural indices. For the other six equations, FININF had the highest coefficient followed by SOCINF and PHYINF.

Lagged Regression

It was already found that the lagged correlation coefficients were fairly strong, indicating that a mutual relationship exists between Development level of one period and Infrastructure level of preceding period. It was also concluded that the causality seems to run from infrastructure to development. Consequently, Lagged Regression analysis was also undertaken, where the dependent variables were of the current period while the explanatory variables were of the preceding period. EQN1 was left out as it was a derived production function and logically should contain only current period values.

The general inferences that can be drawn are as follows.

- ♦ Proportion of workers in non-household manufacturing sector is positively affected by financial and power infrastructure of past period.
- ♦ Agricultural development index depends on agricultural worker, transport, agricultural infrastructure and tractors, pumpsets & diesel engines of past period.
- ♦ Industrial development index is positively affected by financial and transport infrastructure of past period.
- ♦ Human development index has no significant explanatory variable in the present system.
- ♦ Development levels, when regressed on different components of infrastructure, revealed that the important components are financial and power infrastructure of past period. Among the sub-composite components, most important is financial infrastructure followed by social and physical infrastructure of past period.

The following inter temporal trends must also be noted.

Development levels in 1991, when regressed on separate components of infrastructure in 1981 showed that apart from financial and power infrastructure, it was also significantly affected by changes in education, health and agricultural infrastructure. Among the sub-composite components, Financial and Social infrastructure seems to dominate over Physical infrastructure, but the importance of the latter has increased over time.

Dynamic Aspect of Inter-relationship

The dynamic aspect of the interrelationship between development and infrastructure was also looked into. Specifically, an effort was made to study the relationship between Rate of improvement in development levels and that of infrastructure and also the relationship between the improvement rates and the base levels of those two aspects. Since the study has been a cross sectional study at 3 time points – 1971, 1981 and 1991, it was checked how the development and infrastructure levels improved during 1971-81 and during 1981-91 period.

To do so, we used MODPCA as before but on a Pooled Data-set where we had the variable values for the districts for each of the 3 time periods. *[This was necessary due to the nature of Factor Analysis. MODPCA or any other factor analysis methods would provide Factor scores for the observations relative to a certain mean or average score. Since this average level is different for the three time points, factor scores derived separately for the three time points are not comparable. So the data are pooled and then factor analysis using MODPCA is applied, so that the factor scores have a common base and become comparable].*

Once the factor scores are derived for the indicators which we had used earlier, we determine the Improvement Rate as the Average Annual Rate of Increase in the Value (score) of an indicator. (Since these are factor scores, the term 'growth rate' is avoided).

An observation of the improvement rates from Table 4 shows that during 1971-81 highest average improvement was observed in Agricultural Infrastructure, followed by Power and Financial Infrastructure. Low average improvement was observed for Educational and Health Infrastructure. Human Development registered a negative improvement during this decade. During 1981-91 also average rate was highest for Agricultural Infrastructure and lowest for Transport Infrastructure. Compared to 1971-81, improvement rates during 1981-91 were lower for INDDEV, TRINF, POWINF, FININF, PHYINF, DEVT1 and INF2, and higher for the rest. However, in this decade, improvement rates of AGDEV and HUDEV increased and surpassed that of INDDEV. An area of concern is the existence of significant variation in the improvement rates across the regions as measured by weighted CV.

To briefly examine whether there is any converging tendency regarding the levels of development and Infrastructure, the improvement rates were regressed on the base year values of the indicators.[3] It was observed from Table 4 that the regression coefficients were negative for all the indicators for each of the 2 time points except Agricultural development during 1981-91 period. This implies that the districts having high base score of any indicator have a lower improvement rate, indicating a catching up by the lagging regions and slowing down by the advanced regions leading to a convergence of the levels of Development and Infrastructure. Only for Agricultural development, divergence is perceived in the eighties.

The relationship between the rates of improvement in development and that in Infrastructure was examined using Correlation method. It was observed that the correlation coefficient between the improvement rates of Development and the improvement rates of Infrastructure has been mostly insignificant. This would imply that the improvement rates are not linearly associated with one another. However, one cannot rule out non-linear association among them. Also, it may well happen that the improvement rate of development (or Infrastructure) depends upon various factors other than that of Infrastructure (or development). This issue requires further research.

DISCRIMINANT ANALYSIS

One issue of concern in using those contemporaneous and lagged regression results in the present environment is the issue of Multicollinearity. Since the explanatory variables used (the infrastructure indices) are correlated among themselves, the regression estimates sometimes give wrong results – which is manifested in the form of wrong signs of the estimated coefficients (relative to what is expected from economic logic), high R^2 but low t-ratio, etc. In fact, a few of the regression results in this analysis do experience such problems.

A method often used to analyse the relative contribution of various associated variables on some other dependent characteristic is the "Discriminant Analysis". Canonical Discriminant Analysis classifies the cases (observations) on the basis of Prior information regarding certain dependent variable.[4] It then tries to build up certain "Discriminant Functions" – linear functions of explanatory variables – so that the disparities between the classes are maximised on these functions. Once those functions are estimated along with the parameters, one can use them to classify a case whose "explanatory variables" are known but not the final outcome/class. Also, they can be used to reclassify the "known" cases and check how far the initial classification matches with the final or predicted classification. A major outcome of the Canonical Discriminant analysis is the "Structure Matrix" that gives us the association between the explanatory variables and the (value of the) functions. By studying those, one can comment on the relative importance of each of the explanatory variables in determining the final classification. Mathematically, this tries to estimate the following equation –

(1)……………………………………………$F_{km} = u_o + u_1X_{1km} + u_2X_{2km} + . . + u_pX_{pkm}$

where, F_{km} = Value (score) of the Canonical Discriminant function for the case m in group k;

X_{ikm} = Value of Discriminating (explanatory) variable X_i for case m in group k; and

u_i= Coefficient of Xi.

The coefficients are estimated so that the estimated "group means" (average score of the groups) are as different as possible. To distinguish between k groups, (k-1) functions are estimated with the added condition that u_i-s of successive functions are uncorrelated among themselves. However, the number of functions to be used for classification depends on the researcher. Statistically, each function has an Eigen value attached to it, which gives the explanatory power of the function. Usually that many functions are used, which, according to the researcher, has sufficient explanatory power. This process is similar to finding out such a coefficient vector so that the values within a group are as similar as possible, while the values of different groups are as different as possible. This is done by maximizing inter-group (between groups) covariance of the explanatory variables relative to within-group (intra-group) covariance.

This technique was used to test whether predetermined Development classes could be sufficiently explained by infrastructural variables. The method of Cluster Analysis using Euclidean distance matrix has often been used to measure the spatial spread of any parameter and for grouping observations. For a certain indicator, the distance between the observations can be presented as a distance-matrix. From that distance-matrix, one can build up 'm' groups of observations such that Squared Euclidean Distance between groups are maximum compared to average distance between members of a particular group. This would mean that the clusters will be as different as possible from one another but the members within a cluster are very close to one another. This method was applied in the present study to prepare 3 clusters of districts with Lagging, Intermediate and Advanced levels of development using the score of DEVT2 (as it is a simple sum of the three subsectoral development indices and captures all three). This classification were then sought to be explained using the sectoral infrastructural indices as discriminating variables.

It was observed that the first structural function explained more than 90 per cent in 1971, and more than 85 per cent in 1981 and 1991. The Structural coefficients were significantly positive for most of the infrastructural indices. While Health, Transport Power and Finance infrastructure dominated the first function, Agriculture and Education dominated the second. This gives us an idea about the role played by each of the Infrastructure variables in determining whether a district would belong to the top, middle or bottom class of development. These Discriminant functions were then used to reclassify the districts on the basis of the values obtained from the Discriminant functions using values of the infrastructure variables. These classifications were then matched with the initial development classification with the help of the 'Confusion Matrix' (Table 5). It was observed that in all the three years more than 61 per cent of the districts were correctly classified (compared to 33.3 per cent probability of correct classification under complete randomness). Significant positive correlation between the "Predicted Cluster of development" and "Actual Cluster of Development" was also observed. This confirms our findings that the level of infrastructure in a district is a significant factor in determining its level of development and a better level of the former is generally associated with a better level of the later. Whether the relationship is consistent or follows any differential pattern is studied next.

VALIDITY OF HANSEN THESIS IN INDIA

One of the possible extensions of the present analysis may be the testing of the validity of 'Hansen Thesis' in case of India. Hansen [1965, 1965a] had theorised that the effects of infrastructural expansion are different in different types of regions. According to him, the effects are substantially positive in intermediate regions but either insignificant or negative in both advanced and lagging regions. He explained such behaviour by pointing out that any marginal benefits of infrastructural investment in advanced regions are less than the marginal social costs of pollution and congestion. On the other hand, the conditions of the lagging regions offer little scope for improvement through infrastructural investment, as other productive activities are very meagre. Contrary to this, in the intermediate regions, the economic situation is conducive to further expansion of directly productive activities, and expansion of overhead capital leads to higher marginal benefits than costs. Since we have already identified different clusters of regions (districts) in India according to their development levels, it was thought to be an appropriate opportunity to test the validity of Hansen thesis in India.

It was observed that, as expected, the Advanced regions had the highest (average) levels of development and infrastructural availability, and the lagging regions the least, in all the three time points (Table 6). Next, the association between different developmental indicators and infrastructural indicators were looked into, separately for each of the three groups. It was observed that in 1971 and 1981, the association between Development and Infrastructure was strongest for the Advanced Regions followed by the Lagging regions (Table 7). However for 1991, interesting results were observed. The association turned out to be strongest for the Intermediate regions and insignificant for the Advanced regions. This supported the Hansen theory that relative to marginal costs, marginal benefits from infrastructural expansion are highest in Intermediate regions.

The second part of Hansen Thesis was that not only are the impacts different in different regions, the regions are responsive to different components of overhead capital also. While for Advanced and Intermediate regions economic overhead capital like transport, power and irrigation facilities are more important, for the Lagging regions social overhead capital like education and health are more important. The empirical findings of this study tend to support this theory. It was observed that in all the 3 time points, for the intermediate and advanced regions, strongest association with development is exhibited by Financial infrastructure. On the other hand, except for 1971, Social infrastructure has the strongest association with development in the lagging regions.

This seems to point out that the Hansen theory regarding differential behaviour of different types of regions is valid for India. This has serious policy implications in the sense that infrastructural programs should be different for different types of regions. The specific type (developmental stage) of a region must be determined at the outset, and then only proper infrastructural expansion programs should be initiated. Specifically, further expansion of infrastructure in the advanced regions should be controlled; economic infrastructure should be bolstered in the intermediate regions while in the lagging regions social infrastructure should be strengthened. This sequencing of infrastructural development is a crucial factor in maximising their beneficial effects.

CONCLUSION

The present study aimed at studying the regional dimension of development and infrastructure and their interactions at the district level. The major findings can be summarised below.

A. **There exists substantial and significant positive association between levels of development and levels of infrastructure. Lagged correlation method seems to show that the direction of causation is stronger from Infrastructure to Development than the other way round.**

B. **The association seems to be weakening over time.**

C. **The importance of Financial Infrastructure seems to have increased considerably over time.**

D. **Agricultural and Industrial development are affected substantially by separate sets of Infrastructural components.**

E. **Agricultural development seems to precede infrastructural expansion while Financial infrastructure seems to follow development.**

F. **Discriminant analysis shows that infrastructural variables can serve as 'discriminating variables' when the districts are classified according to their developments levels.**

G. **In recent years, the association between infrastructure and development are substantially positive in intermediate regions but insignificant in advanced regions, thereby supporting the Hansen Thesis. Also, in lagging regions, social infrastructure is more important, while in advanced and intermediate regions, physical and financial infrastructure are more important.**

The above study thus leads us to believe that the Development level of a region is substantially determined by the level of Infrastructure available therein. Different types of infrastructure affect different facets of development and the interactions between them are such that infrastructure is the leader and development is the follower in most cases. Moreover, specific developmental stage of a region is also a crucial factor that determines the nature and magnitude of the association between different components of infrastructure and development level.

Where does all this lead us to? The outcome of the study seems to highlight the immediate need for infrastructural expansion and development in India. But with State finances dwindling, that is easier said than done. Under such circumstances the regional planning and implementation process must reflect regional priorities in an economic sense and must be decentralised. Sufficient user- and community participation, volunteer labour and local area planning, along with need-based approach should be encouraged. Maintenance and capacity utilisation of existing utilities should be accorded more importance than inauguration of new projects. The size, magnitude or expanse must reflect actual demand. Very often, the Demand is high only because Price is negligible. Demand must be estimated at prices equal to user-charge and costs must be recovered. Commercial management of public utilities with explicit performance goals should be adopted. This will attract private players who will be ensured of fair competition in the market. Such private participation and competition will enhance performance of the sector. Only then can one hope to exploit the potential of the infrastructural sector upto the fullest extent. Proper identification of necessary projects, smooth and quick completion of construction, proper operation and profitable management of the services and regular maintenance would create an efficient infrastructure on which to build up the superstructure of the nation. Expansion of infrastructure is necessary no doubt, but equally crucial is to identify specific projects for specific regions. Serious policy thinking, and appropriate regional planning priorities are needed to fulfil the objective of balanced regional development in India.

Table 1a

Correlation Coefficients between Indices of Infrastructure and Sectoral Indices of Development

Contemporaneous correlation

	1971			1981			1991		
	AGDEV	INDDEV	HUDEV	AGDEV	INDDEV	HUDEV	AGDEV	INDDEV	HUDEV
AGINF	-0.014	0.979**	0.018	-0.106*	0.670**	0.019	-0.095	0.597**	0.001
TRINF	0.173**	0.752**	0.011	-0.029	0.854**	0.015	0.007	0.666**	0.036
POWINF	0.212**	-0.051	-0.026	0.653**	-0.108*	0.075	0.322**	-0.235**	0.001
FININF	0.060	0.954**	0.015	-0.088	0.952**	0.018	-0.073	0.865**	0.009
EDUINF	0.203**	0.144**	-0.059	0.269**	0.068	0.117*	0.184**	-0.002	0.181**
HLTINF	0.153**	0.805**	0.100	0.070	0.466**	0.014	0.019	0.533**	0.004
PHYINF	-0.007	0.980**	0.018	-0.102*	0.684**	0.019	-0.089	0.602**	0.001
SOCINF	0.165**	0.801**	0.094	-0.102*	0.778**	0.020	-0.029	0.812**	0.002
INF1	0.006	0.985**	0.019	0.076	0.466**	0.017	0.024	0.531**	0.009
INF2	0.190**	0.686**	0.000	0.505**	0.433**	0.077	0.248**	0.297**	0.003
INF3	0.240**	0.572**	-0.051	0.190**	0.518**	0.124*	0.162**	0.392**	0.100

** Sig. at 1 percent level * Sig. at 5 percent level

Table 1b

Correlation Coefficients between Indices of Infrastructure and Composite Indices of Development

Contemporaneous correlation

	1971			1981			1991		
	DEVT1	DEVT2	DEVT3	DEVT1	DEVT2	DEVT3	DEVT1	DEVT2	DEVT3
AGINF	0.978**	0.835**	0.547**	0.670**	0.635**	0.342**	0.596**	0.563**	0.310**
TRINF	0.754**	0.728**	0.522**	0.854**	0.831**	0.507**	0.667**	0.660**	0.435**
POWINF	-0.047	0.054	0.076	-0.107*	0.004	0.293**	-0.233**	-0.156**	0.049
FININF	0.955**	0.849**	0.573**	0.952**	0.916**	0.530**	0.865**	0.829**	0.484**
EDUINF	0.148**	0.216**	0.161**	0.068	0.095	0.143**	-0.002	0.013	0.011
HLTINF	0.807**	0.771**	0.591**	0.466**	0.469**	0.326**	0.533**	0.526**	0.338**
PHYINF	0.979**	0.840**	0.551**	0.684**	0.649**	0.353**	0.602**	0.570**	0.318**
SOCINF	0.804**	0.773**	0.592**	0.778**	0.742**	0.412**	0.812**	0.789**	0.484**
INF1	0.984**	0.850**	0.562**	0.466**	0.470**	0.329**	0.531**	0.524**	0.336**
INF2	0.689**	0.679**	0.489**	0.434**	0.507**	0.539**	0.298**	0.347**	0.331**
INF3	0.576**	0.601**	0.424**	0.518**	0.521**	0.371**	0.392**	0.405**	0.285**

** Sig. at 1 percent level * Sig. at 5 percent level

Table 2a

Lagged Correlation Coefficients between Indices of Infrastructure and

Sectoral Indices of Development with Infrastructure as Leader

	1971-1991					
	AGDEV	INDDEV	HUDEV	DEVT1	DEVT2	DEVT3
AGINF	-0.111*	0.683**	-0.005	0.682**	0.642**	0.351**
TRINF	-0.029	0.789**	0.006	0.790**	0.768**	0.472**
POWINF	0.639**	-0.090	-0.020	-0.087	0.056	0.320**
FININF	-0.109*	0.830**	0.000	0.830**	0.788**	0.446**
EDUINF	0.298**	0.067	-0.103*	0.068	0.118*	0.165**
HLTINF	0.178**	0.486**	-0.011	0.487**	0.515**	0.401**
PHYINF	-0.105*	0.656**	0.004	0.655**	0.619**	0.343**
SOCINF	0.032	0.706**	0.017	0.706**	0.701**	0.463**
INF1	-0.105*	0.692**	0.004	0.692**	0.655**	0.365**
INF2	0.352**	0.558**	-0.013	0.560**	0.626**	0.549**
INF3	0.361**	0.381**	-0.042	0.382**	0.449**	0.430**

** Sig. at 1 percent level * Sig. at 5 percent level

Table 2b

Lagged Correlation Coefficients between Indices of Infrastructure and

Sectoral Indices of Development with Infrastructure as Follower

	1971-1991			1971-1991		
	AGDEV	INDDEV	HUDEV	DEVT1	DEVT2	DEVT3
AGINF	-0.096	0.573**	0.023	0.573**	0.541**	0.286**
TRINF	-0.006	0.641**	0.019	0.641**	0.626**	0.386**
POWINF	0.388**	-0.240**	0.106*	-0.240**	-0.183**	0.030
FININF	0.110*	0.847**	0.009	0.848**	0.780**	0.538**
EDUINF	0.183**	0.013	0.145**	0.013	0.019	0.039
HLTINF	0.017	0.477**	0.007	0.477**	0.471**	0.305**
PHYINF	0.012	0.440**	0.006	0.440**	0.383**	0.248**
SOCINF	0.145**	0.349**	0.005	0.352**	0.369**	0.279**
INF1	0.132**	0.718**	0.007	0.720**	0.680**	0.478**
INF2	0.153**	0.233**	0.059	0.235**	0.276**	0.249**
INF3	0.088	0.340**	0.015	0.342**	0.333**	0.230**

** Sig. at 1 percent level * Sig. at 5 percent level

Table 3a

Regression Coefficients - Contemporaneous Regression

Indep Variable	Dependent Variables								
	Y1			Y2			Y3		
	1971	**1981**	**1991**	**1971**	**1981**	**1981**	**1971**	**1981**	**1991**
Const.	1.495**	7.002**	6.029**	-0.963**	-4.983**	-5.616**	-7.437**	-3.516**	2.561**
X1	0.005**	0.432**	0.356**				-1.645**	-0.414**	-0.016**
X2	1.652**	0.199**	0.677**				1.588**	0.328**	-0.743**
X3	-0.491**	0.189**					-0.059*	0.086*	0.453**
X4	-0.194**	0.014	-0.074**				0.148**	0.153**	0.243**
X5	0.639*	-0.038	0.449*				0.596**	0.099*	-0.322**
X6	0.021**	0.099		-0.299*	0.198**	0.286**	-0.188**	0.151**	0.011**
X7	0.648**	0.359*	0.213**	0.017	0.178**	0.179*	0.508**	0.348**	0.075**
X8	-1.406**	0.166	-0.617**				-0.193**		0.438**
X9				0.494**	0.512**	0.528**			
Adj. R^2	0.987	0.737	0.828	0.179	0.514	0.493	0.978	0.662	0.988

** Sig. at 1 percent level * Sig. at 5 percent level

Table 3b

Regression Coefficients - Contemporaneous Regression

Indep Variable	Dependent Variables					
	Y4			Y5		
	1971	**1981**	**1991**	**1971**	**1981**	**1991**
Const.	-0.471**	0.318**	0.349*	0.671**	0.786**	0.722**
X4						
X5						
X6		-0.172**	-0.148*			
X7	0.242**	0.457**	0.475**			
X8			-0.181**	-0.106**	-0.457**	-0.229**
X9						
X10	0.716**	0.784**	0.779*			
X11				0.114**	-0.021	0.101**
Adj. R^2	0.716	0.730	0.694	0.045	0.101	0.119

** Sig. at 1 percent level * Sig. at 5 percent level

Table 3c

Regression Coefficients - Contemporaneous Regression

Indep Variable	**Dependent Variables**								
	DEVT1			**DEVT2**			**DEVT3**		
	1971	**1981**	**1991**	**1971**	**1981**	**1991**	**1971**	**1981**	**1991**
Const.	0.168**	0.647**	0.566**	-0.034**	4.287**	4.196**	0.765**	0.658**	0.707**
AGINF	0.184**	0.254**	-0.19	0.255**	0.185*	-0.369**	0.007*	-0.022*	-0.047**
TRINF	-0.681**	-1.051**	0.297**		-0.741*	1.099*	0.017*	0.096*	0.136**
POWINF	0.004*	0.006	-0.009		0.035**			0.006**	0.003**
FININF	0.985**	0.992**	0.838**	0.523**	1.211**	1.165**		0.016	0.032**
EDUINF	0.156**			1.299**	-0.454	-0.232	0.043	-0.057	-0.069
HLTINF	0.038	0.104**	-0.265**	0.624**	0.169*	-0.358**	0.064**	0.009	
Adj. R^2	0.991	0.921	0.768	0.758	0.853	0.719	0.372	0.405	0.345

** Sig. at 1 percent level * Sig. at 5 percent level

Table 3d

Regression Coefficients - Contemporaneous Regression

Indep Variable	**Dependent Variables**								
	DEVT1			**DEVT2**			**DEVT3**		
	1971	**1981**	**1991**	**1971**	**1981**	**1991**	**1971**	**1981**	**1991**
Const.	0.009**	-0.092**	0.233**	1.864**	4.336**	4.875**	0.815**	0.917**	0.936**
PHYINF	0.374**	0.023	-0.007	0.261**	0.016	-0.026	0.003	-0.002	-0.003
FININF	0.279*	0.704**	0.878**	0.471**	0.989**	1.288**	0.014	0.039**	0.048**
SOCINF	0.214**	0.164**	-0.367**	1.482**	0.339*	-0.436**	0.139*	0.031**	-0.002
Adj. R^2	0.971	0.911	0.763	0.753	0.845	0.696	0.371	0.289	0.230

** Sig. at 1 percent level * Sig. at 5 percent level

Table 4

Dynamic Aspects - Average Improvement Rate, Coeff. Of Variation and

Regression Coefficients of Improvement Rates on Base Year Values

	1971-81			1981-91		
	Average[a]	**CV**	**Regession Coefficient**	**Average**	**CV**	**Regession Coefficient**
Development Indicators						
AGDEV	6.9	309.3	-3.673**	11.0	64.6	0.494*
INDDEV	12.1	232.0	-0.137	5.7	555.7	-0.177
HUDEV	-3.0	79.2	-1.653**	10.2	38.7	-5.787**
DEVT1	9.5	239.2	-0.133	5.9	446.1	-0.193
DEVT2	0.9	456.0	-0.060**	9.6	53.1	-0.192**
DEVT3	-1.2	228.7	-1.548**	10.1	38.2	-5.014**
Infrastructural Indicators						
AGINF	110.8	150.9	-1.052	187.9	691.6	-2.748
TRINF	4.9	130.8	-0.102	2.8	250.0	-0.070
POWINF	42.6	246.5	-1.161**	9.3	143.0	-0.280**
PHYINF	11.8	241.1	-0.096	20.9	757.6	-0.543
FININF	25.8	111.0	-0.382	25.2	371.6	-0.331
EDUINF	0.9	278.2	-1.850**	3.5	89.5	-0.806**
HLTINF	2.2	215.9	-0.804**	3.6	170.0	-0.510**
SOCINF	1.3	221.2	-1.116**	3.6	112.5	-1.041**
INF1	10.5	220.5	-0.070	18.1	525.4	-0.797
INF2	17.5	103.5	-0.288**	8.0	115.1	-0.170**
INF3	4.8	89.8	-4.651**	5.3	76.4	-3.996**

[a] weighted average across the districts of average annual growth rate over the decade
** Sig. at 1 percent level * Sig. at 5 percent level

Table 5

CONFUSION MATRIX

Cross tabulation of Original Group and Predicted Group from Discriminant Analysis

Original Group of DEVT2	**Predicted Group of DEVT2 by Discriminant Analysis**								
	1971			**1981**			**1991**		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
1	9	21	11	29	12	6	31	18	4
2	12	57	57	27	67	38	21	77	61
3	0	40	172	6	46	148	2	41	124

62.8 per cent, 64.4 per cent and 61.2 per cent of original grouped cases correctly classified in 1971, 1981 and 1991 respectively. 1 - Advanced, 2 - Intermediate, 3 - Lagging.

Table 6

Average Level of Composite Indices in Different Types of Districts

	DEVT2	AGDEV	INDDEV	HUDEV	PHYINF	SOCINF	FININF	INF2
1971								
Advanced	16.152	4.879	8.199	3.075	9.601	2.862	7.844	73.873
Intermediate	4.419	1.655	0.593	2.170	0.199	1.401	0.788	45.614
Lagging	2.532	0.651	0.219	1.662	0.102	0.866	0.285	20.778
1981								
Advanced	16.000	5.401	7.973	2.626	7.689	3.366	6.853	101.841
Intermediate	6.311	3.493	0.811	2.007	0.394	1.027	0.742	66.089
Lagging	3.489	1.718	0.305	1.466	0.221	0.720	0.365	43.381
1991								
Advanced	15.215	5.287	7.531	2.398	6.261	3.086	5.932	108.140
Intermediate	6.077	3.303	0.765	2.009	0.578	0.993	0.892	82.419
Lagging	3.485	1.545	0.309	1.630	0.226	0.722	0.578	78.642

Table 7

Correlation Coefficient between DEVT2 and

Indices of Infrastructure in Different Types of Districts

	PHYINF	FININF	SOCINF	INF2
1971				
Advanced	0.842**	0.848**	0.824**	0.831**
Intermediate	0.249**	0.331**	0.172	0.239**
Lagging	0.434*	0.278**	0.372**	0.306**
1981				
Advanced	0.639**	0.931**	0.384*	0.628**
Intermediate	0.195*	0.278**	0.232*	0.229**
Lagging	0.313**	0.429**	0.481**	0.520**
1991				
Advanced	0.567*	0.833**	0.250	0.301
Intermediate	0.313**	0.529**	0.481**	0.520**
Lagging	0.273*	-0.006	0.333**	0.250*

** Sig. at 1 percent level   * Sig. at 5 percent level

Endnotes

[1] This MODPCA method has been evolved by Amitabh Kundu *et al.* Refer to Kundu [Kundu, 1980].

[2] For a study of this and related methods refer to Kundu and Raza [Kundu, 1982]. Other methods include Weighting the Agricultural and Industrial Development Indices by the share of Population in Agriculture and Industry respectively. Refer to Pal [Pal, 1975]. But this will not be able to capture or combine Human Development.

[3] This is usually referred to as the β-test in literature, while the test based on CV is called the σ-test.

[4] For a lucid explanation of Canonical Discriminant Analysis and related techniques, see Klecka [Klecka, 1980].

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Appendix

List of Variables used for creating the Composite Indices

AGDEV - Land productivity - Yield of foodgrains per 1000 hectare GCA; Labour productivity - Yield of foodgrains per 1000 Agricultural Workers; Cropping intensity - GCA as a percentage of NSA; Commercial cropping - Percentage of NSA under commercial crops;

Fertilizer consumption per hectare GCA; Tractors per hectare GCA; Pumpsets and Diesel engines per hectare GCA; Cultivation Extensiveness - NSA as a percentage of Rural Area.

INDDEV - Non-household Manufacturing workers as percentage of total workers; Registered Factories per 1000 sq. km area; Workshops – % of census houses used as workshops; Non-agricultural establishments per 1000 sq. km area.

HUDEV - Literacy %; Infant Survival Rate (1000 - IMR); CDR (transformed)- Inverse of CDR as percentage of Max CDR; CBR (transformed)- Inverse of CBR as percentage of Max CDR.

AGINF - Irrigation intensity - GIA as percentage of GCA; Outstanding Bank Credit to Agriculture per 1000 Agricultural Workers;

TRINF - Road length per 1000 sq. km area; Railway length per 1000 sq. km area; % of villages having Pucca Roads; % of villages having post and Telegraph Offices.

POWINF - % Of Villages Electrified; % of households having electricity.

FININF - Bank branches per 1000 sq. km area; Bank branches per 10000 population; Bank credit per 10000 population; Outstanding Bank Credit to Industries per 1000 Workers in Manufacturing sector.

EDUINF - % of villages having Educational facilities; Primary Schools per 1000 sq. km area; Secondary Schools per 1000 sq. km area; Colleges per 1000 sq. km area

HLTINF - % Of Villages having Medical Facilities; % Of Villages having Facilities of Drinking Water; Urban beds per 1000 urban population; Hospitals and Dispensaries per 1000 sq. km area; Hospitals and Dispensaries per 10000 population; Medical Personnel per 10000 population.