Infrastructure and Regional Development: Interlinkages in India

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I. INTRODUCTION

One of the major characteristics 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 imbalances in resource base, a country with 50 years of 'Planned' development ought to have exploited the available resources 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 regional development levels - infrastructure being one of the more important ones among them. In two of the present author's earlier studies the levels of and variation in infrastructural availability in India, and the regional development experience in India at the sate level respectively have been studied. (Majumder, 2003, and Majumder, 2005). In this paper we try to look at the association between regional development levels and regional infrastructural levels. The paper has seven 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 the Objective and Methodology of the study. Next, an overview of the trends in infrastructural availability and development is provided. The sixth section explores the interaction between infrastructure and development using several tools and techniques. A short summary and policy implications then concludes the paper.

II. 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 (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 (1969), and then by Mahajan (1982). Others claiming a narrowing down of regional disparity have been Gupta (1973), Lahiri (1969), and Rao

(1972). Broadly parallel results have been reported by Majumdar (1970), Nair (1982), Ganguli and Gupta (Ganguli, 1976), and Mathur (1983, 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 gaps (Nadkarni, 1969; Rao, 1973; Nair, 1973; Ghaudhri, 1974; Sabhnath, 1977) and 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 an unidimensional factor, captured by income or consumption level alone. 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.

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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 (1970), Shri Prakash (1977), Gulati (1977), Arunkumar & Upendranath (Arunkumar, 1993), and Majumder (2003). The relationship between development and infrastructure has been studied by Tewari (1983, 1984), Amin (1990), Dadibhavi (1991), Gayithri (1997) and Ghosh & De (1998, 2004). 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 (1987) studied various dimensions of infrastructural planning in India using empirical analysis of different models and projects wherein the need to improve the efficiency of these services have been stressed upon.

III. 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. Moreover, since our

country has different types of regions within the states, it has been felt that the study should be based on 'District' level analysis. To have a long-term perspective, the present study covers the 1971-2001 period. This has the added advantage of being able to compare the post-1991 scenario with that of the earlier period which was marked by the beginning of various structural Adjustment Programmes (SAP).

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Also, a diversified view of both development and infrastructure is taken where the multidimensional facet of them are sought to be adequately reflected through multiple and composite indices. Consequently, the following objectives have been framed – (i) to prepare indices of infrastructure and development at the District level; (ii) to examine the trends and patterns in these indices, and (iii) to examine the relationship between infrastructural availability and development using those indices.

IV. METHODOLOGY OF THE PRESENT STUDY

It has been accepted that a region cannot be so easily termed underdeveloped or having 'inadequate' infrastructure based on a single indicator. There are various facets of both of them, and a region, while lacking in one, may be well developed in another. Consequently both Development and Infrastructure have been subdivided into constituent components. Development has been presumed to be consisting of – (a) Agricultural Development - related mainly to the Agricultural sector; (b) Industrial Development - related mainly to the Manufacturing sector; and, (c) Human Development - related to the Social Indicators of literacy, mortality, etc. Similarly, Infrastructure is composed of 3 broad areas of – (a) Physical Infrastructure; (b) Financial Infrastructure; and, (c) Social Infrastructure. Further subdivided, Physical Infrastructure consists of Agro-specific Infrastructure (Irrigation infrastructure and agricultural credit), Transport & Communication Infrastructure (Road, Railway, and Communication networks), and Power Infrastructure. Financial Infrastructure consists mainly of Banking services while Social Infrastructure consists of availability of Educational and Health facilities. Each of these components of development and infrastructure themselves consist of several variables/indicators (see appendix for list of indicators used). Separate indices for each of the three components of development, six sub-sectoral components of infrastructure, and three sectoral components of infrastructure have then been prepared using the Modified Principal Component Analysis (MODPCA) method.[1] Thus, the indices prepared are – AGDEV (representing Agricultural

Development), INDDEV (Industrial Development), HUDEV (Human Development), AGINF (Agricultural Infrastructure), TRINF (Transport Infrastructure), POWINF (Power Infrastructure), PHYINF (Physical Infrastructure), FININF (Financial Infrastructure), EDUINF (Educational Infrastructure), HLTINF (Health Infrastructure) and SOCINF (Social Infrastructure). Single

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Composite indices of Development (DEVT1) and Infrastructure (INFRA1) have also been prepared using MODPCA method from the sectoral indices of development and infrastructure. Two other composite indices of development and infrastructure have also been prepared by simple summation of the sectoral indices.[2] They are DEVT2 and INFRA2 respectively. Further analysis is carried on with the aid of these indices.

V. OVERVIEW AND REGIONAL DISPARITY

A short overview suggests that over the years there have been a substantial improvement in the availability of infrastructural facilities and developmental levels in the districts (Table 1). There has been a phenomenal advancement in agricultural development while least improvement has occurred in human development. In the fields of infrastructure, major expansion has occurred in financial infrastructure while least has happened in the educational sector.

One of the major aspects of sub-regional development experience in India has been wide regional disparity. It is worth exploring the trends in disparity among the districts over the period of study. It is observed that in the first two decades disparity among the districts narrowed down in almost all the indices using both the β-test and the σ-test for convergence (Table 2). However, in the last decade, i.e. the post-SAP era, regional disparity has increased in transport, educational and health infrastructure. This has resulted in divergence in physical and composite scores of infrastructure also. This has been accompanied by widening gaps in agricultural and human development levels, and consequently in the composite development levels too. A major reason behind this experience may be the dwindling public expenditure in the fields of agriculture in the post-SAP period and the gradual withdrawal of State from investment and operation in the educational and transport sectors.[3] This has serious policy implications for balanced regional development of the nation.

VI. DEVELOPMENT-INFRASTRUCTURE INTERDEPENDENCE

In this section we study the nature and magnitude of the association between the development indices and the infrastructural indices for the districts of India and also try to determine the direction of causation in the inter-relationship between development and infrastructure, whether infrastructure precedes or follows development.

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1. Contemporaneous Correlation

It is observed that the association between the development indicators and contemporary infrastructural indices are fairly strong for all the four time points, the association being relatively stronger for industrial development and for physical infrastructure. However, the magnitudes of the correlation coefficients are steadily decreasing over time (Table 3).

2. Causation Analysis

While the contemporaneous correlation measures the association between the indices of development and infrastructure at the same time point, the direction of causation may be examined using lagged correlation. If infrastructure is necessary and precedes development, 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 is true, then the reverse would happen. The above methodology has been applied to each possible combination of infrastructural and development indices for the pairs of time – 1971-81, 1981-91, 1991-2001, and 1971-2001. It is observed that for most of the pairs, I(t) * D(t+1) coefficients are higher compared to I(t+1) * D(t) coefficients. Thus, it can be reasonably argued that the causation seems to run from infrastructural facilities to development. However, financial infrastructure is a major exception to this trend and in the initial years the association is stronger for development indices of past period and financial infrastructure index of present period, indicating that financial facilities were being expanded following a demand determined pattern in the first two decades. The lagged correlation coefficients follow the same temporal and sectoral pattern as that of the simple correlation, with 1981-91 period showing the strongest association and gradual decline in the magnitude of the coefficients over time (Table 4).

3. Regression Analysis

The preceding analysis shows that the causation runs from infrastructure to development, barring a few exceptions. Consequently, we examine how changes in infrastructural facilities affects development levels using Regression Analysis with infrastructural indices as explanatory variables and development indices as dependent variables. Also, accounting for the structural changes in the economy after 1991, we use a recursive-pooled technique where we first use pooled data for the 1971-91 period and then include the 2001 data also and examine how the infrastructure-development relationship has changed in the post-SAP era. The sectoral and composite development indices are regressed on the sub-sectoral, sectoral and composite indices of infrastructure and the results of the estimated models are summarised in Tables 5a and 5b. The following observations may be made.

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It is observed that different infrastructural sectors are important for different development sectors. While power facilities are most important for agricultural development, for industrial development, financial infrastructure is more important. Among the determinants of composite development level, physical infrastructure is most important. We also observe increasing importance of transport infrastructure in the post-SAP era compared to the earlier decades. This has to be seen in conjunction with recent spurts in communication sector in general and business being fuelled by transport and communication facilities.

Another major aspect that emerges from the recursive-pooled model is that the magnitudes of the slope coefficients diminish when we add the 2001 data to the 1971-91 data, while the magnitude and significance of the intercept increases. This indicates that the base value of the development levels are improving over time while the association between infrastructure and development has weakened in the post-SAP period.

4. Discriminant Analysis

One issue of concern in using those 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".[4] Canonical Discriminant Analysis is a prior classification of dependent variable (Y) but groups certain

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"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 predicted classification matches with the initial classification. This technique has been used to test whether predetermined development classes can be sufficiently explained by infrastructural variables. If so, one can argue that levels of infrastructure availability determine development levels.

First, we classify the districts into 3 groups with Lagging, Intermediate and Advanced levels of development using the score of DEVT2 (as it is a simple sum of the three sub-sectoral development indices giving equal weightage to each). This has been done by the method of Cluster Analysis using Squared Euclidean Distance matrix such that Squared Euclidean Distance between groups are maximum compared to average distance between members of a particular group. This means that the clusters are as different as possible from one another but the members within a cluster are very close to one another. It is observed that, as expected, the advanced regions have the highest (average) levels of development and infrastructural availability, and the lagging regions the least, in all the four time points (Table 6). This classification is then sought to be explained using the sectoral infrastructural indices as discriminating variables. These Discriminant functions are then used to reclassify the districts on the basis of the values obtained from the Discriminant functions using values of the infrastructure variables of both current and past years. These classifications are now matched with the initial development classification with the help of the 'Confusion Matrix' (Table 7). It is observed that in all the cases more than 62 per cent of the districts can be correctly classified (compared to 33.3 per cent probability of correct classification under complete randomness). This confirms our findings that both present and past levels 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 across different types of regions or follows any differential pattern is studied next.

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5. 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. Since we have already identified different clusters of regions (districts) in India according to their development levels, it is thought to be an appropriate opportunity to test the validity of Hansen thesis in India. Moreover, it can also throw some light on the declining strength of association between infrastructure and development in recent years.

The association between composite developmental index DEVT2 and sectoral infrastructural indices are looked into, separately for each of the three groups. It is observed that in 1971-81 and 1981-91 periods, the association between Development and Infrastructure were substantial for all the three types of regions (Table 8). However for 1991-2001, the association turns out to be strongest for the Lagging regions and insignificant for the other two regions. Thus, the declining strength of association between infrastructure and development in recent years is mainly due to lack of such association in the relatively improved regions. This phenomenon may be because facilities are already concentrated in the relatively improved regions and so marginal benefits of further expansion of infrastructural facilities are less than the marginal costs of pollution and congestion. On the other hand, in the relatively backward 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. Additionally, it may also be the case that a minimum critical level of infrastructure is necessary to support sustained development. This level being already achieved in the advanced regions, the decade of the nineties witnessed development in these regions even without proportional improvement in infrastructure. Moreover, not only are the impacts different in different regions, the regions are responsive to different components of infrastructure also. While for the lagging regions physical and

social infrastructure are important, for the intermediate and advanced regions, financial infrastructure also exhibits strong association with development. 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. It suggests that infrastructural programs should be directed differently 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; physical infrastructure should be bolstered in the intermediate regions while in the lagging regions both physical and social infrastructure should be strengthened. This sequencing of infrastructural development and proper targeting is a crucial factor in maximising their beneficial effects and is the key to successful regional development planning in India.

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6. Dynamic Aspect of Inter-relationship

The dynamic aspect of the interrelationship between development and infrastructure i.e. the relationship between rate of improvement in development levels and that of infrastructure has also been looked into. From the factor scores that we have used earlier, we determine the Improvement Rates 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). It is 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 rates in development depend upon various factors other than that of infrastructure. This issue therefore needs further exploration and is not attempted herein.

VII. CONCLUSION

The major findings of this paper can be summarized along following lines. Though there has been noticeable rise in levels of infrastructure and development during the study period, regional disparities have increased in the post-SAP period, indicating that perhaps this era has rewarded the better-off regions and neglected the weaker ones. In the transformed regime the State is to play the role of a

facilitator while the expansionary effort is to be taken up mainly by the private players. However, rational private decision makers tend to concentrate around centres where facilities and ready markets are already available and so inequality in infrastructural facilities and market conditions may have led to concentration of private investments in few regions leading to widening of the gap.

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It is also evident that availability of infrastructure – physical, financial, and social – is important determinant of both present and future levels of development of a region. However, over the years, as the base level of development is increasing, the strength of the infrastructure-development causality seems to be weakening. Juxtaposed with the differential nature of this association across different types of regions, it may be inferred that the causality is more prominent at low and medium levels of development. As regions reach a threshold development level, their dependence on infrastructure weakens.[5] This may be due to various factors. It may be that while at lower development levels the causality from infrastructure to development is simple and linear, at progressively higher levels, the relationship is complex, non-proportional, and non-linear. As a result the true magnitude of the interdependence is not being captured by the simple linear correlation and regression analysis. Again, it may well happen that infrastructural availability is a crucial ingredient necessary to cross a critical minimum level of development, beyond which other factors take over the role of 'driving force' of development. An analogy may be drawn with the standard developmental theories where the role of Overhead Capital in escaping 'low level equilibrium trap' and providing a 'Big Push' to the economy is stressed upon.[6] According to these theories, proper infrastructure is a 'pre-condition' for 'Take-Off', while in higher levels we enter the stages of 'Self-Propelled Growth'. The results seem to justify this notion. The changes observed in the post-SAP era may be explained by recalling that in recent times development paradigm has changed and factors like governance, political stability, brand image & attractiveness to investors have emerged as major determinants of development, replacing the simple one-to-one correspondence between infrastructure and development. However, one would be grossly mistaken to conclude that infrastructure is no longer a pre-requisite of development in India. Attractiveness to investors depends crucially on infrastructural facilities and inadequacy or congestion in the later will adversely affect the former in the medium to longer run once the hype of 'brand

image' dies down. Moreover, more than half of our districts are in the 'lagging' group of development in 2001, and for them infrastructural availability is still a crucial determinant of development. There is thus scope for tremendous progress to be made.

These have serious policy implications. Regional inequalities in India (which has often taken the form of social unrest, civic disorder, and fumed by political agitation, secessionist tendencies in some extreme cases) can be narrowed down by focussing on development of the lagging regions, and for which infrastructural development programme will have to play a leading role. Proper identification of regions as regards their development level and then concentrating on the lagging regions for infrastructural upgradation should be a priority area of action. On the other hand, economic activities in the already advanced regions should be monitored, controlled and dispersed so that the infrastructural services therein are decongested and declustered. Given the resource crunch faced by the State and the current macroeconomic standpoint of the authorities on one hand, and the general sluggishness of private entrepreneurs in foraying into infrastructural services on the other, such a targeted approach would pay rich dividends in providing quality and dependable infrastructure all over the country and removing imbalances. This should form the core of regional development planning in India in the new era.

Endnotes

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[1] Researchers have used the simple PCA method to arrive at composite indices. This method suffers from the drawback that heterogeneity due to varied units implies that changes in units may lead to greater value of indices. To solve this problem, Ghosh and De (2004) have divided the original values of the individual variables by their Standard Deviation. This, however, makes the Variance of all the transformed variables equal to unity, thereby

loosing their individual variability. The Modified PCA method (for details see Kundu 1980, 1982) used here standardises the data set by dividing the variables by the respective column-wise means – so that the variables become scale-free, yet retain their individual variances.

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[2] For a detailed discussion on the methodology involved in preparation of the composite indices see Majumder (2003, 2005). In particular, the second set of composite indices as simple sum of sectoral indices are prepared to give equal representation to the sectoral achievements.

[3] This period has also seen major advancement in upgrading of road network and opening up of the educational sector to private enterprises. But those activities have remained concentrated in the already advanced regions leading to accentuating of disparity.

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

[5] International empirical studies support this inference. It is observed that strong infrastructure-development interlinkage is reported from developing economies, while for developed nations the association is reported to be weak. For a detailed survey of related literature, see Majumder, 2002.

[6] These notions are evident in Rosenstein-Rodan (1943), Nurkse (1953), Hirschman (1958), and most prominently in Rostow (1960).