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# What explains Regional Imbalances in Infrastructure?: Evidence from Indian States

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# What explains Regional Imbalances in Infrastructure? Evidence from Indian States[1]

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## ABSTRACT

The literature on regional growth suggests that divergences in infrastructure is a major factor behind the wide and persistent regional growth imbalances in India. Using a state infrastructure-expenditure function, the paper examines the possible factors that determine infrastructure expenditure and its implication for regional imbalance in infrastructure creation across 14 major Indian states. We, in the present study, find that factors such as resource mobilization, per capita income, and population density may result in unequal infrastructure expenditure across states. We also find that factors such as more spending by the infrastructure-deficit states, political stability, and positive spatial dependence in infrastructure expenditure among states have a balancing effect on infrastructure creation across regions. These results suggest the need for augmenting the financial capacity of the infrastructure-deficit states and strengthening the positive spatial dependence among states through creation of interstate infrastructure networks (railways, national highways etc.) and conducive investment climate, which could boost competition among states for better infrastructure creation.

**Keywords:** infrastructure, regional imbalance, spatial dependence, Indian states

**JEL Classification codes:** H54, R11, R12, C31

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# 1. INTRODUCTION

A fairly large literature has emphasized the role of infrastructure as a crucial factor for economic growth, both at the national as well as at the regional level.[2] Given that the process of economic growth at the national level depends on growth of the regions it consists of, distribution of infrastructure facilities across different regions within an economy assumes importance in the context of achieving balanced regional growth. The issue has a special relevance in the case of India as a number of studies on regional development and growth in India ascribe to regional imbalance in infrastructure as a major factor behind wide and persistent regional disparity in India.[3] A key question here is why is there such a regional imbalance in infrastructure? The answer to this may imply interesting aspects for infrastructure policy of the national and sub-national governments.

What drives infrastructure provision across different regions within an economy? As most of the infrastructure services are non-excludable, non-rival and prone to market failure, their provision occurs, mainly, through the public policy decision. Broadly, the literature identifies three groups of factors, viz. economic, political and spatial factors that are behind the regional infrastructure provision. Economic factors comprise of equity and/or efficiency considerations, resource constraints, demography, temporal persistence and financial capacity of the government.

It has long been recognized that efficiency and equity considerations are major elements in government's preferences behind the allocation of infrastructure expenditure across regions (Mera, 1967, 1973; Behrman & Craig, 1987 and Anderstig & Mattson, 1989). While efficiency in the allocation of infrastructure spending means incurring more expenditure for the region where the marginal productivity of the expenditure is highest, the element of equity implies undertaking more infrastructure investment in the poorer regions as well. The empirical findings suggest that the government preferences in regional allocation of infrastructure expenditure diverge, with evidences of only equity (Yamano & Ohkawara, 2000), only efficiency (Mizutani & Tanaka, 2008) and of both equity and efficiency (Zheng et al., 2013; Kemmerling & Stephan, 2002; Castells & Sole-Olle, 2005). Further, the absence of equity motive in case of developing countries may be due to reasons such as lack of financial resources (Arimah, 2005). As regards the influence of demography, certain categories of infrastructure (hospital, schools, etc.) are population serving i.e. expenditure on them increases with increase in population. However, other infrastructures such as roads, pipelines, waterways are space serving i.e. expenditure on them decrease with increase in population size or urbanization (Biehl, 1989). While Hansen (1965) finds positive relationship between infrastructure expenditure and population size, Randolph et al. (1996) and Yu et al. (2011) find that infrastructure expenditure declines with higher urbanization and population size, pointing to existence of economies of scale in infrastructure provision.

Public expenditure on infrastructure projects could also show the phenomenon of temporal persistence. That is once some expenditure is incurred on an infrastructure project, successive expenditures take place in subsequent years till its completion (Castells & Sole-Olle, 2005; Zheng et al., 2013) or sometimes for maintenance. Moreover, the ability of the government to finance infrastructure depends on their revenue generation capacity (Arimah, 2005; Kemmerling & Stephan, 2002; Yu et al., 2011; Randolph et al., 1996; Mizutani & Tanaka, 2008 and Painter & Bae, 2001). In addition, higher economic

[2] See Romp & De Haan (2007) for a critical survey of the literature.

[3] Shah (1970), Das & Barua (1996), and Ghosh & De (2005).

status of a region can also lead to higher infrastructure spending, partly because of higher level of public revenue, and also as a response to higher demand for infrastructure from the well-off citizens (Randolph et al., 1996; and Arimah, 2005).

Besides economic factors, political motives such as possibility of electoral gains and political affiliation of the incumbent government (Costa-I-Font et al., 2003; Joanis, 2011; Zheng et al., 2013; Castells & Sole-Olle, 2005; Sole-Olle, 2011 and Crain & Oakley, 1995), government's sensitiveness to the existence of lobbying from large business firms (Crain & Oakley, 1995; Mizutani & Tanaka, 2008 and Cadot et al., 1999), to voters' preferences for more infrastructure (Ghate, 2007), and majority or stability of the government (Kimberling & Stephan, 2002; Crain & Oakley, 1995 and Mizutani & Tanaka, 2008) can influence the regional allocation of infrastructure investment.

Apart from economic and political factors, spatial factors may also influence infrastructure expenditure across regions. This refers to the dependence in the level of public expenditure among neighbouring regions, which is explained by the existence of spillover effects,[4] yardstick competition[5] and tax competition[6] (Brueckner, 2003; Revelli, 2005, 2006). Yu et al. (2011) finds positive spillover effects among city governments' infrastructure expenditure. The spatial dependence in fiscal choices may also result from a common policy environment (Mundlak et al., 2007) or the lower-tier (municipal) governments, in a federal set-up, reacting in a similar fashion to higher-tier (provincial) authority's policies (Revelli, 2003). Zheng et al. (2013) finds evidence of significant spatial dependence in central government investments across Chinese regions, resulting in two or more neighbouring jurisdictions receiving higher investment from the central government simultaneously.

The literature on determinants of infrastructure expenditure at the regional or sub-national level are mostly directed towards developed countries. Further, the findings about the relative importance of factors influencing infrastructure expenditure vary across studies. While some studies reveal the importance of economic factors, others discover the role of political and institutional factors and a few others find the role of spatial interaction among regions in influencing infrastructure expenditure. The difference in findings across studies is not surprising given the fact that each of them pertain to different region and time period. While the form of governments, geographical size and conditions, demographic, economic and institutional features vary from region to region, the impact of some factors may vary over time as well. The diverse findings may also be due to different category of infrastructure services considered as well as adoption of different methodologies. Moreover, data deficiencies create constraints in considering all factors in case of all economies or regions. In view of these, the study of determinants of interregional expenditure on infrastructure is an empirical issue and the finding is likely to be case/time-specific to some extent.

Empirical literature on the determinants of infrastructure expenditure across states is rather sparse in case of India. The studies in India are either concerned with the behaviour of public expenditure in general or with specific infrastructure expenditure such as health and education. The existing

[4] The expenditure by the government of a region could create beneficial or unfavourable effects on its neighbouring regions, reducing or increasing the need for spending on infrastructure in the latter region.

[5] The imperfectly informed voters in a jurisdiction look at public services and taxes in neighbouring jurisdiction as yardsticks to judge the quality and efficiency of the same provided by their own government. Hence, governments are likely to mimic the behaviour (decisions on public expenditure) of their neighbours so as not to lose confidence of their voters.

[6] Tax competition hypothesis suggests that fiscal policy (with regard to tax rate and/or public spending) in one region elicits similar policy responses from other surrounding regions leading to fiscal competition among governments of different regions for attracting people and businesses.

studies are also less comprehensive in respect of different possible factors, mostly focusing on political and, to some extent, on economic factors. For example, Khemani (2010) provides evidence of disproportionately more budget spending of state governments going to social programmes such as employment and welfare transfers, which is more suitable to ensure electoral gains than capital spending in infrastructure. Other studies demonstrate the association between coalition government and public expenditure (Dutta, 1996; Lalvani, 2005; Dash & Raja, 2013 and Chaudhuri & Dasgupta, 2006). A few studies highlight the role of economic factors such as per capita income and population size (Dash & Raja, 2013). Studies such as Rahman (2008) and Chatterji et al. (2014), which explore the determinant of health and education expenditure, find that per capita income and sources of revenue are significant determinants of expenditure.

However, the studies in India have not explored the role of spatial interaction effect and the existence of equity or efficiency motive. They have also not examined the implications of infrastructure expenditure across states for regional imbalance in infrastructure endowments, which matters the most for balanced regional growth. The present study tries to fill the void in the literature by addressing all such issues. Using a panel data set of 14 major states during the period from 1991 to 2010, the paper explores the determinants of infrastructure expenditure. The study contributes to the existing literature in several directions. First, it compares the status of different states in infrastructure expenditure and actual infrastructure creation to find out whether imbalance in the latter corresponds to imbalance in the former. Second, it splits up total expenditure on infrastructure into economic and social and investigates whether there are differences in determinants of two kinds of infrastructure. Third, it is more comprehensive than existing studies as it takes into account economic, political, as well as spatial factors. Fourth, the study looks at implication of these factors for regional balance in infrastructure.

## 2. EMPIRICAL MODEL AND METHODOLOGY

### 2.1. Empirical model

The empirical model consists of an infrastructure expenditure function in which infrastructure expenditure of states[7] are explained by the three possible groups of factors: economic, political, and spatial interaction. Economic factors comprise of efficiency and/or equity motive of the government, demography, per capita income of a region, financial capacity of the government, temporal persistence effect (lagged dependent variable). However, infrastructure expenditure may also be influenced by political motives (for example, to have majority/ stable government). Above all, spatial factors may play a role in the form of spatial dependence in infrastructure expenditure of states. Keeping in view these three factors and the way these are measured in the empirical studies, we set up the state level infrastructure expenditure function as follows:

$$PCINFEXP_{it} = \alpha_i + ß_1 PCINFEXP_{it-1} + ß_2 W.\ PCINFEXP_{it} + ß_3 PCRESMOB_{it} + ß_4 PCSDP_{it} + ß_5 POLSTAB_{it} + ß_6 POPDEN_{it} + ß_7 INFINDEX_{it} + \mu_{it} \quad (1)$$

Here, $PCINFEXP_{it}$ is infrastructure expenditure per capita, $PCINFEXP_{it-1}$ is past per capita infrastructure expenditure, $PCRESMOB_{it}$ stands for resource mobility, $PCSDP_{it}$ is per capita income, $POLSTAB_{it}$ is political stability, $POPDEN_{it}$ is population density and $INFINDEX_{it}$ represents infrastructure index. Subscript $i$ =

[7] The determinant of regional distribution of central government's infrastructure-expenditure function is not explored as data on state-wise allocation of such expenditure is not available.

1...14 refers to states and $t = 1...20$ represents time. $\alpha_i$ is the fixed effect for $i^{th}$ state, which is included to capture the unobserved state-specific traits. The description of the dependent variable and the independent variables of equation (1) are as follows:

**Infrastructure expenditure per capita ($PCINFEXP_{it}$)**

The dependent variable in earlier studies is usually investment expenditure on infrastructure. However, the quality of infrastructure is more crucial than the quantity of infrastructure stock, and new infrastructure construction by diverting scarce domestic resources away from maintenance and operation of existing stock may have a perverse effect on economic growth (Hulten, 1996). Hence, the maintenance of existing infrastructure facilities is as much important as expenditure on new infrastructure facilities. Accordingly, we have taken the total expenditure on infrastructure per capita, comprising of revenue as well as capital expenditure. The dependent variable has three variants. First, per capita expenditure on total infrastructure (the sum of economic and social infrastructure); second, per capita expenditure on economic infrastructure (irrigation, power, transport and communications); and third, per capita expenditure on social infrastructure (education, medical & public health, water supply and sanitation).

**Past per capita infrastructure expenditure ($PCINFEXP_{it-1}$)**

As infrastructure projects usually take several years to complete necessitating continuous spending, public expenditure on infrastructure usually shows the phenomenon of temporal persistence. Hence, the effect of temporal persistence on expenditure per capita in the time period *t* ($PCINFEXP_{it}$) is measured by the lagged per capita expenditure in the time period *t-1*, i.e. $PCINFEXP_{it-1}$.

**Spatial interaction effect (W. $PCINFEXP_{it}$)**

As explained in the earlier section, spatial auto-correlation or spatial dependence in infrastructure expenditure of the states may exist due to elements such as competition, cooperation, and spillover effect manifesting in policy interdependence among the state governments. Further, the so-called spatial dependence observed may be the result of some spatially auto-correlated shocks among the state governments. The existence of spatial dependence is measured by the variable, W. $PCINFEXP_{it-1}$. This is the spatial counter part of the dependent variable, which is calculated as the spatially weighted average of per capita infrastructure expenditure of the $i^{th}$ state's neighbouring states. The criteria for defining neighbours of a state and the weights (*W*) used are described in the next section.

**Resource mobilization ($PCRESMOB_{it}$)**

As in the case of all expenditures, government revenues put limits on the infrastructure expenditure as well. The variable $PCRESMOB_{it}$ is used as a measure of financial capacity of the government. This is calculated as the ratio of total receipts, i.e., both revenue and capital receipts, to population. Several other measures of fiscal situation and budget constraint of the government such as budget balance, composition of budget, budget cycle (the frequency with which budgeting exercise is conducted) and grants from higher-tier of government, debt burden are found in empirical studies. While some of the variables such as central grants for state governments' infrastructure expenditure could not be included because of unavailability of data, an additional reason is that including all of the variables would reduce the degrees of freedom.

**Economic Status ($PCSDP_{it}$)**

Economic status of a state is captured by per capita state domestic product, i.e. $POLSTAB_{it}$. Higher the per capita income, higher is the spending on infrastructure through a higher revenue effect as well as a higher infrastructure demand. Hence, the coefficient of the variable is expected to be positive.

**Political factor ($POLSTAB_{it}$)**

The influence of political factor is proxied by the variable, (political stability), which is measured by the ratio of share of ruling party in the total number of seats in the state legislature. The ratio remains the same for the time period in which the same ruling party prevails. The values of political stability index should be between 0(perfect instability or president's rule) and 1(perfect stability in which the government has all the seats). Infrastructure expenditure may be undertaken for political rent extraction, i.e. to get maximum votes. There is evidence in literature[8] that political parties tend to take up those infrastructure projects that ensure more short-term electoral gains than provision of infrastructure as a long-term and broader public good. This implies that a stable or majority party may spend less on infrastructure than a weak majority legislature, which is more likely to worry about the possibility of re-election. But the effect of a stable or majority government may also be beneficial for infrastructure expenditure provision as infrastructure projects are less likely to be held up because of conflict with the opposition in the legislature.

**Demography ($POPDEN_{it}$)**

The demography of a state is measured by population density ($POPDEN_{it}$), defined as the number of persons per square kilometre. The effect of this variable on infrastructure spending will depend on whether the infrastructure in question is population-serving (increasing expenditure associated with increasing population) or space-serving (decreasing expenditure with increasing population). Hence, the expected sign of $POPDEN_{it}$ can be either positive or negative.

**Equity/Efficiency ($INFINDEX_{it}$)**

A number of studies have used output in a region or existing stock of public capital to capture the government's preferences (existence of equity-efficiency elements) in the expenditure provision of infrastructure. Output or GDP per capita seems like an appropriate measure of equity/efficiency motive in case of regional allocation of central government's expenditure on infrastructure. It may not be an indicator of equity/efficiency where we are dealing with the determinants of state government's infrastructure provision per se rather than its allocation at sub-state level. Hence, we have used existing infrastructure stock to detect the existence of equity or efficiency motive of the government. The variable, $INFINDEX_{it}$ is used as a proxy for existing stock of infrastructure. If regions with high/low stocks of infrastructure spend less/more on current infrastructure it may show the government's concern for equity. But, if the authority has concern for efficiency, the state with high stock of infrastructure may spend more on current infrastructure to maintain quality and contain the depreciation of the existing infrastructure stocks while the state with low infrastructure stock have less requirement to spend. Three indices of infrastructure such as aggregate infrastructure index, economic infrastructure index and a social infrastructure index have been constructed applying Principal Component Analysis (PCA). The details of the PCA are given in the Appendix.

[8] Acharya (2004), Khemani (2010)

### 2.2. Estimation strategy

The empirical model (equation (1)) is a dynamic panel specification with the presence of lagged dependent variable and state-specific fixed effects. Application of traditional procedures such as OLS to such a case is inappropriate as it could lead to dynamic panel bias resulting in biased estimates due to correlation between the lagged dependent variables and the state-specific effect.[9] Further, there could be the problem of reverse causality with some of the explanatory variables being endogenous. For instance, not only a higher or lower per capita income ($PCSDP_{it}$) leads to higher or lower spending on infrastructure, increase in the latter also leads to higher productivity, which could push up per capita income to a higher level. Similarly, as expenditure occurs in response to the existing level of infrastructure stock, increase or reduction in the former is also responsible for a higher or lower level of the latter. In addition to the problem of dynamic panel bias and reverse causality, equation (1) has the presence of a spatial interaction term ($W. PCINFEXP_{it}$), which calls for the adoption of some spatial econometric method for its estimation.

To address the dynamic panel bias problem as well as the reverse causality problem, there are two widely used methods: the 'Difference GMM' approach developed by Arellano and Bond (1991) and the 'System GMM' approach of Arellano and Bover (1995) and Blundell and Bond (1998). The Difference GMM approach adopts first-differencing the model in order to remove the state-specific effects and all endogenous variables with their own lagged levels are used as instruments (Anderson and Hsiao, 1981; and Hansen, 1982). The System GMM approach helps in estimating a system of two simultaneous equations: one is the original levels equation with lagged first differences as instruments, and the other is the first-differenced equation with lagged levels as instruments. Both approaches successfully overcome the dynamic panel bias and endogeneity problems by transforming instrumenting variables and applying GMM.

However, Blundell and Bond (1998) point out that the Difference GMM estimator has a downward bias and low precision where the autoregressive parameter of the endogenous variable is moderately large and the number of time-series observations is moderately small. This is because lagged-level variables provide weak instruments for first differenced variables in this case. In comparison, the System-GMM improves the precision of the estimator and also reduces the bias. Although System-GMM approach seems suitable for the estimation of equation (1), the presence of spatial interaction term calls for spatial version of the same. While several studies such as Elhorst (2010) have extended the Difference GMM estimator, studies such as Kukenova & Monteiro (2008) and Jacobs et al. (2009) have extended the System-GMM estimator of Blundell and Bond (1998) to account for spatial effects. In the spatial version also, the Difference GMM was found to have a large bias in respect of the spatial autoregressive parameter ($\beta_2$) and System-GMM estimator being superior with a small bias.

An important choice to make regarding the System-GMM estimator is whether to use one-step or two-step estimator. While one-step estimator is built under the assumption that the error term is independent (no serial correlation) and homoscedastic across countries and time, for the two-step estimator, the residuals of the first step are used to estimate consistently the variance-covariance matrix in the presence of heteroscedasticity and serial correlation. Although one-step estimator is asymptotically less efficient than the two-step estimator in the presence of heteroscedasticity, Monte Carlo simulations by Arellano and Bond (1991) and Blundell and Bond (1998) suggest that standard errors of the two-step estimates are downward biased. Further, even in the presence of heteroscedasticity, there is a small

[9] Nickell (1981)

improvement in efficiency gains from the two-step GMM estimators relative to the one-step GMM estimators for which inference based on the one-step GMM estimator are much more reliable than the two-step estimator. Thus, we have used the robust one-step spatial system GMM estimator to our empirical model in equation (1).

The consistency of the system GMM estimator is verified by two tests: a) Sargan/Hansen test of over identifying restrictions which is based on the hypothesis that instrumental variables are valid, i.e. not correlated with the error terms, and b) Arellano & Bond (1991) test to verify the hypothesis of the absence of second-order autocorrelation (AR(2)) in residuals.

Prior to implementing the spatial dynamic System-GMM regression, specification tests are usually conducted to determine which model (spatial or non-spatial) is appropriate for the empirical study. To find if there is any general spatial autocorrelation in the data, Moran's I-test is used. To further detect the form of spatial dependence[10] (lag or error) in the panel data, two Lagrange Multiplier (LM) tests with their robust counterparts are available.[11] These tests (LM-lag and LM-error tests) are conducted on the non-spatial model. The tests are preferred in their robust version as they are vulnerable to several forms of mis-specification.

A spatial model such as equation (1) requires creation of spatial lag variables for which a spatial weight matrix is necessary to impose a neighbourhood structure on the dataset. In spatial econometrics, neighbours are usually defined by a binary relationship (0 for non-neighbours, 1 for neighbours). Broadly, such binary weight matrices are broadly classified into two categories: those based on distance and those based on contiguity. In spatial regression, models estimated with first-order (includes only direct neighbours and not neighbours' neighbours) contiguity weights matrices are seen performing better, on average, than those using distance weights matrices in terms of their higher probabilities of detecting the true model and the lower-mean squared error (MSE) of the parameters (Stakhovych & Bijmolt, 2009). In addition, as recently shown by LeSage & Pace (2014), properly calculated marginal effects for spatial regression models yield robust results irrespective of the chosen spatial weighting matrix. Since, infrastructure facilities are likely to connect adjacent states, interdependence in expenditure on infrastructure are also expected between the states touching each other's boundary. Thus, we have carried out the estimation of the model with queen-contiguity weights, which defines neighbouring states as those with common borders as well as corners or vertices.[12]

## 3. DATA

The dataset comprises of 14 major Indian states over 20 years (1991-2010). The states are Andhra Pradesh (undivided state), Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. These states constitute 93 per cent of population and 91.5 per cent of Net Domestic Product (NDP) of the country. The special category states of North and North Eastern parts and the small states such as Goa are left out in view of the

[10] While the spatial lag model (SAR) has the spatial lag of the dependent variable as an explanatory variable, spatial error model (SEM) includes a spatial autoregressive term in error.

[11] While Anselin et al. (1996) has developed these tests to be used in a cross-section setting, derivations of these tests for a spatial panel data model with spatial fixed effects is found in Debarsy and Ertur (2010)

[12] Contiguity-based weights matrices include rook and queen. Areas are neighbours under the rook criterion if they share a common border, but not vertices. In queen contiguity, both border and corner contacts are taken into account.

differences in the structure of their economies from the rest of the states (Rao et al., 1999). The data on different components of infrastructure expenditure such as irrigation, power, transport and communications, education, medical and public health, water supply and sanitation and those on revenue receipts and capital receipt have been taken from *RBI's State Finances: A Study of Budgets* for different years. The physical infrastructure data is gathered from a variety of sources. The data on road and railway per 1000 square kilometers of area is sourced from CMIE and Infrastructure statistics 2013, MOSPI, while the data on per capita consumption of electricity (in kwh) is gathered from *TERI Energy Data Directory and Year Book* and *Annual Report (2001-02) on the Working of State Electricity Boards and Electricity Departments.* The data on gross irrigated area as percentage of gross cropped area is from *Agricultural Statistics at a Glance* whereas data on telephone per 100 populations is obtained from *Infrastructure Statistics* of MOSPI and *Statistical abstracts of India* for different years. Further, the data on infant mortality rate per 1000, households' access to safe drinking water and literacy rate, both in percent, is taken from the *Economic Survey* (various issues).

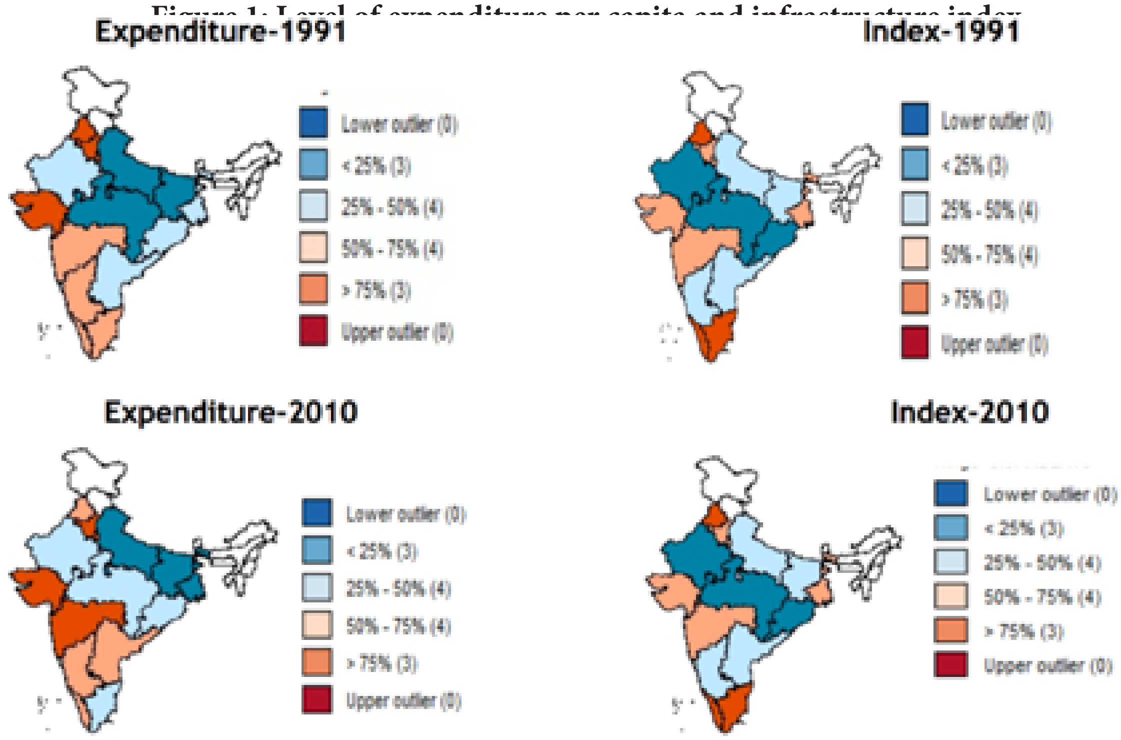
GSDP data has been taken from the *National Accounts Statistics* of CSO in constant prices as well as current prices and, as they were in different base periods, converted to 2004-05 base period. The converted 2004-05 constant and current prices data is further used to construct the deflator at 2004-05 prices. The data on expenditure, revenue, and capital receipts have been converted into real magnitudes, being normalized by the 2004-05 deflators. The data on population is taken from the Census of India. The time span for which a particular ruling party prevailed is taken from Lalvani (2005) and extended till 2010. The data on total number of seats in the legislative assembly of the states and the seats obtained by the parties in government for different years are sourced from *Election Reports on State* for different years. The variables constructed from the data are as described in the previous section. All the variables have been taken in logarithms except the political stability and infrastructure indices.

## 4. SPATIAL DISTRIBUTION OF INFRASTRUCTURE IN INDIA: SOME STYLIZED FACTS

In this section, we compare the regional distribution of infrastructure index with infrastructure expenditure per capita. The maps of the level of per capita infrastructure expenditure vis-à-vis that of infrastructure index for 1991 and 2010 are depicted in Figure 1. Box maps group values into six categories such as four quartiles (1-25%, 25-50%, 50-75%, and 75-100%) and two outlier categories at the low and high end of the distribution. Outliers are values, which are more than 1.5 times higher than the inter-quartile range (IQR), i.e., the difference between the 75th percentile (Q3) and the 25th percentile (Q1). According to the values, the states in the two upper quartiles and the high outlier are classified as higher status group (red and infra-red areas in the map) and the rest as lower status group (blue and infra-blue area).

From the box maps in figure 1, one can infer that there is a dual pattern of low-infrastructure and high-infrastructure index states, exhibiting an unequal endowment of infrastructure facilities across states. Two, this inequality in infrastructure facilities is also persistent over the years. That is, the same pattern of low status states, i.e., Rajasthan, Uttar Pradesh, Bihar, West Bengal, Odisha, Madhya Pradesh and high status states, i.e. Punjab, Haryana, Gujarat, Maharashtra, Karnataka, and Kerala are observed in both 1991 and 2010. Three, the persistence in the relative position of states in infrastructure index corresponds to their position in infrastructure expenditure. This means that the states which are not able to change their initial status in expenditure per capita are also not able to change their initial status

Figure 1: Level of expenditure per capita and infrastructure index




in index. Fourth, there is a spatial clustering of states in similar status, both in index and expenditure. The lower status states are seen lying close to each other as indicated by the infra-blue and blue areas in the map and so also the higher status states as shown by the red and infra-red areas, showing the possibility of spatial dependence in infrastructure expenditure.

These stylized facts suggest that the solution for regional balance in infrastructure may lie in more spending by the infrastructure-deficient states, given the association between inequality in infrastructure facilities and inequality in infrastructure expenditure. Hence, the unchanged relative position of states in infrastructure expenditure seeks explanation as to what constrains the states to spend more on infrastructure? Further, what is the implication of the spatial clustering of states with similar status: does it have any role in influencing infrastructure expenditure? The explanations may have to do with different factors affecting the expenditure on infrastructure provision as discussed in the literature review section. In the next section, we look into the factors that determine infrastructure spending decisions.

## 5. EMPIRICAL RESULTS

In this section, we report the estimated results of equation 1. To determine whether a spatial model or a non-spatial one is appropriate, we start with the results of spatial diagnostic test in Table 1 based on a non-spatial OLS model. While the LM tests for error dependence and its robust version are insignificant, the LM tests for spatial lag dependence is significant suggesting a spatial lag model as the appropriate specification. The system GMM estimation results for expenditure on aggregate infrastructure, economic and social infrastructure as dependent variables are given in Table 2. The results suggest that lagged per capita expenditure on infrastructure has a significant and positive effect on per capita

**Table 1: Spatial Diagnostic Tests**

| Test | Statistic | p-value |
|---|---|---|
| Moran's I | 0.069 | 0.118 |
| LM error | 1.859 | 0.172 |
| Robust LM error | 0.4279 | 0.513 |
| LM lag | 6.35 | 0.011 |
| Robust LM lag | 4.918 | 0.026 |

infrastructure expenditure indicating the existence of temporal persistence. This means that increase in a state government's spending on infrastructure by 1 percent in a year would lead to more than 0.18 percent increase in infrastructure spending per capita in the subsequent year and, more so in the case of expenditure on economic infrastructure, the increase is by 0.34 percent.

**Table 2: Determinants of per capita infrastructure expenditure**

| | Dependent variable: PCINFEXP | | |
|---|---|---|---|
| Independent variable: | Total Infrastructure | Economic Infrastructure | Social Infrastructure |
| L1.PCINFEXP | 0.202* | 0.345*** | 0.189** |
| | (0.099) | (0.101) | (0.073) |
| W.PCINFEXP | -0.014* | 0.030** | -0.000 |
| | (0.007) | (0.013) | (0.004) |
| PCRESCMOB | 0.166*** | 0.257** | 0.107*** |
| | (0.037) | (0.104) | (0.028) |
| PCSDP | 0.725*** | 0.216*** | 0.317*** |
| | (0.112) | (0.079) | (0.098) |
| POLSTAB | -0.096* | -0.120 | -0.044 |
| | (0.056) | (0.118) | (0.036) |
| POPDEN | -0.017 | -0.105* | -0.019 |
| | (0.033) | (0.057) | (0.011) |
| INFINDEX | -0.117** | -0.049 | -0.028* |
| | (0.046) | (0.077) | (0.015) |
| Year dummy | Yes | Yes | Yes |
| Observations | 266 | 266 | 266 |
| No. of States | 14 | 14 | 14 |
| No. of lagged instruments | 1,2 | 1,1 | 1,1 |
| No. of instruments | 11 | 12 | 16 |
| AR(1) test | 0.006 | 0.008 | 0.004 |
| AR(2) test | 0.727 | 0.821 | 0.284 |
| Hansen over-identification test | 0.693 | 0.946 | 0.848 |

Note: *, **, *** show statistical significance of coefficients at 10, 5 and 1% respectively and standard errors are reported in parentheses. *p* values are reported for AR and Hansen tests.

The spatial lag coefficient is negative for total infrastructure, perhaps due to the negative sign of the social infrastructure. This indicates the possibility of a positive spatial spillover effect of infrastructure expenditure on a state from its neighbours, resulting in a lowering effect on expenditure of a state. Unlike social infrastructure, the spatial lag for economic infrastructure is significant and has a positive sign, indicating that an increase in expenditure in neighbouring states lead to an increase in the concerned state's expenditure. A possible reason for this is the competition among states to attract domestic or foreign investment following the economic reform of 1991. Such competition among states is more likely in case of economic infrastructure, which has components such as transport, communication and energy that adds to productivity and growth directly, than social infrastructure. Another reason could be that the increased spending on inter-state network facilities such as highways and railways, which is mostly due to central government, may lead to more spending from several states together for increasing their within-the-state infrastructure facilities needed for facilitating connection to the inter-state network.

As regards per capita resource mobility and PCSDP, both are significant and positive; while the former points towards the obvious importance of financial capacity of the states in dictating their expenditure, the latter implies the crucial influence of income and demand effect associated with the change in per capita income. The magnitude of the coefficients shows the relative importance of per capita resource mobility for the provision of economic infrastructure while that of PCSDP for social infrastructure.

The result also shows that population density has a negative and significant impact on economic infrastructure indicating higher/lower expenditure provision in states with low/high population density. This inverse relationship points to the possible existence of economies of scale in the provision of economic infrastructure and its space-serving nature. The effect of political stability is negative, which suggest that more infrastructure provision may be a means to secure political positions. Hence, a stable government, which is less likely to worry about the opposition and possibility of re-election, tend to spend less on infrastructure. In order to see whether such effect of political stability is same for the single-party government and coalition government, we run a separate regression where political stability is multiplied with a dummy for single-party government. The result is reported in Table 3. It shows that the political stability-single dummy interaction term (POLSTAB*SINGLE) has positive sign. This indicates that a government with the single party majority tend to spend more on infrastructure as it is less likely to face conflict within the government and from the opposition in the legislature. The results are reverse for the coalition governments. There would be less spending on infrastructure, which could be due to the government facing conflict from its coalition partners as well as the possibility of more frequent re-elections. This is evident from the negative sign of political stability variable, which now represents the effect of political stability in the presence of coalition government; the variable is significant for aggregate and economic infrastructure expenditure.

The negative sign of the coefficient of infrastructure index indicates that there could be an element of equity in infrastructure service provision, i.e. infrastructure-deficient states may spend more than infrastructure-abundant states. The effect is significant for social infrastructure.

**Table 3. Determinants of Per capita infrastructure expenditure (with political stability-single party interaction)**

| Dependent variable: PCINFEXP | | | |
|---|---|---|---|
| Independent variable: | Total Infrastructure | Economic Infrastructure | Social Infrastructure |
| L1.PCINFEXP | 0.226** | 0.344*** | 0.188** |
| | (0.097) | (0.092) | (0.074) |
| W.PCINFEXP | -0.014* | 0.023* | -0.000 |
| | (0.008) | (0.012) | (0.004) |
| PCRESCMOB | 0.148*** | 0.268*** | 0.106*** |
| | (0.033) | (0.080) | (0.029) |
| PCSDP | 0.677*** | 0.215*** | 0.316*** |
| | (0.104) | (0.076) | (0.099) |
| POLSTAB | -0.127** | -0.208* | -0.048 |
| | (0.057) | (0.106) | (0.040) |
| POPDEN | -0.016 | -0.087 | -0.019 |
| | (0.032) | (0.052) | (0.011) |
| INFINDEX | -0.102** | -0.055 | -0.028* |
| | (0.044) | (0.068) | (0.015) |
| POLSTAB*SINGLE | 0.044 | 0.119 | 0.005 |
| | (0.026) | (0.083) | (0.018) |
| Year dummy | Yes | Yes | Yes |
| Observations | 266 | 266 | 266 |
| No. of States | 14 | 14 | 14 |
| No. of lagged instruments | 1,2 | 1,2 | 1,2 |
| No. of instruments | 12 | 16 | 17 |
| AR(1) test | 0.464 | 0.369 | 0.377 |
| AR(2) test | 0.494 | 0.779 | 0.772 |
| Hansen over-identification test | 0.542 | 0.727 | 0.777 |

Note: *, **, *** shows statistical significance of coefficients at 10, 5 and 1% respectively and standard errors are reported in parentheses. *p* values are reported for AR and Hansen tests.

The diagnostic tests for all the estimated models validate the consistency of the system GMM estimators. The AR(2) tests rule out the existence of second order serial correlation in residuals. Hansen tests[13], being insignificant, also justify that the instruments used in all the models are valid, i.e. not correlated with the residuals.

[13] Roodman (2009) points out that dynamic panel models can generate too many instruments biasing the estimates. To limit the number of instruments, this study has restricted the maximum lags to two and used the 'collapse' option of Roodman (2006).

## 6. CONCLUSION AND POLICY IMPLICATIONS

There is a broad consensus in the literature that regional imbalance in infrastructure is a major reason behind the wide regional imbalance in growth and development in Indian states. We have analysed, in this paper, the role of possible factors influencing states' aggregate expenditure on infrastructure per capita as well as its two components, i.e. expenditure on economic and social infrastructure. The results reveal that financial capacity of the government, per capita income and past expenditure have significant positive effect on the aggregate infrastructure expenditure as well as both of its components: economic and social infrastructure expenditure. Population density is found to have negative effect on the provision of economic infrastructure, showing the possible existence of economies of scale. Moreover, there appears to be an element of equity in government's provision of social infrastructure, as suggested by the negative relation between infrastructure index and expenditure. Further, political stability also figure in the provision of infrastructure. In states with single party government, political stability has positive effect on infrastructure expenditure while it has the opposite effect, especially on economic infrastructure, in states with coalition government. Finally, there is a sign of positive spatial dependence in expenditure on economic infrastructure, i.e. an increase in one state's expenditure is associated with the increase in its neighbouring states' expenditure.

As these factors influence the creation of actual infrastructure facilities through their influence on infrastructure expenditure, they have implications for regional balance or imbalance in infrastructure facilities. For example, the inverse effect of infrastructure index on infrastructure expenditure implies more spending by infrastructure-poor states, which would help to lessen regional imbalance in infrastructure facilities. Similarly, positive spatial dependence in case of economic infrastructure also augurs well for balanced creation of infrastructure facilities across states. However, differences in some factors and potential sources of infrastructure expenditure such as past expenditure (temporal persistence), financial capacity and per capita income may accentuate regional imbalance on infrastructure. The backward states which are at lower level in these factors would be constrained to spend less than the states with high-income and high revenues. The existence of economies of scale, i.e. negative effect of population density on economic-infrastructure expenditure may also have adverse implication for backward states as there is a need for larger expenditure.

To the extent the relative status of states in infrastructure index has not changed between 1991 and 2010, it points to the dominance of the unfavourable factors over the favourable factors. Hence, the strategy for achieving regional balance in infrastructure would require augmenting the financial capacity of the infrastructure deficit states through central government grants or promoting private sector participation in infrastructure investment. The positive spatial dependence in economic infrastructure expenditure among states needs to be reinforced through setting up of more of the infrastructure categories such as railways, national highways which are of inter-state nature connecting several states together. Albeit, these infrastructure categories come under the central government's jurisdiction, these can be instrumental in inducing efforts from individual states to build up their own infrastructure facilities such as state highways and other local roads in order to connect to these inter-state infrastructure networks. Moreover, as the spatial correlation in economic infrastructure expenditure may also be the result of competition in infrastructure spending among states to attract domestic and foreign investment, further reforms for more conducive investment climate could boost this competition and help in bridging the infrastructure-divide among states.

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# APPENDIX

## Infrastructure Indices

Infrastructure index has been constructed from different infrastructure variables using Principal Component Analysis (PCA). The descriptive statistics for the components are given in Table A1. The steps for computation of aggregate infrastructure index are as follows. The Eigen values and the proportion of variance explained by each principal component is reported in Table A2. The result shows that the first three components are significant as they have Eigen values greater than 1. These three components explain 36, 29 and 17 per cent of the total variance in infrastructure respectively. Together, they explain 84 percent of the total variance. Table A3 reports the rotated factor matrix, which shows the factor loadings of the original infrastructure variables for each principal component. The three principal components are combined to construct a single index of infrastructure using ratio of the percentage variation explained by each component to total variation accounted for by them jointly as weights. The indices of economic infrastructure and social infrastructure are also constructed in similar way. The factor loading of the variables in the significant principal components used to construct these indices are given in Table A4 and Table A5.

**Table A1: Descriptive statistics of infrastructure components** (Total number of observations: 280)

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Road density | 1120.586 | 911.755 | 316 | 5268.69 |
| Rail density | 25.892 | 9.639 | 9.6 | 44.52 |
| Power | 550.449 | 340.243 | 20 | 1663.01 |
| Irrigation | 44.691 | 23.729 | 12.34 | 98 |
| Tele-density | 9.871 | 15.244 | 0.11 | 80.36 |
| Drinking water | 75.542 | 17.712 | 18.9 | 97.6 |
| Infant mortality Rate | 59.468 | 21.737 | 10 | 124 |
| Literacy | 65.413 | 11.853 | 38.48 | 93.61 |

**Table A2: Eigen values and proportion of variance explained by Principal Components**

| Component | Eigen value | Proportion Explained | Cumulative Total |
|---|---|---|---|
| Comp1 | 2.94731 | 0.3684 | 0.3684 |
| Comp2 | 2.38834 | 0.2985 | 0.667 |
| Comp3 | 1.3898 | 0.1737 | 0.8407 |
| Comp4 | 0.490399 | 0.0613 | 0.902 |
| Comp5 | 0.394711 | 0.0493 | 0.9513 |
| Comp6 | 0.201979 | 0.0252 | 0.9766 |
| Comp7 | 0.119305 | 0.0149 | 0.9915 |
| Comp8 | 0.0681489 | 0.0085 | 1 |

**Table A3: Factor Loadings (Aggregate Infrastructure)**

| Variable | Comp1 | Comp2 | Comp3 |
|---|---|---|---|
| Road density | 0.201 | 0.112 | -0.606 |
| Rail density | 0.161 | 0.691 | -0.041 |
| Power | 0.216 | -0.182 | 0.448 |
| Irrigation | -0.178 | 0.653 | 0.086 |
| Tele density | -0.047 | 0.035 | -0.079 |
| Drinking water | 0.080 | 0.194 | 0.646 |
| IMR | -0.661 | -0.083 | 0.009 |
| Literacy | 0.640 | -0.074 | -0.003 |

**Table A4: Factor loadings (Economic Infrastructure)**

| Variable | Comp1 | Comp2 | Comp3 | Comp4 |
|---|---|---|---|---|
| Road density | 0.0125 | 0.9353 | 0.0403 | -0.0076 |
| Rail density | 0.7315 | 0.2316 | -0.1298 | 0.0235 |
| Power | 0.0009 | -0.0055 | 0.0035 | 0.9993 |
| Irrigation | 0.6817 | -0.2654 | 0.1462 | -0.0263 |
| Tele density | -0.0053 | 0.0318 | 0.9799 | 0.0038 |

**Table A5: Factor loadings (Social Infrastructure)**

| Variable | Comp1 | Comp2 |
|---|---|---|
| Drinking water | 0.0002 | 0.9997 |
| IMR | 0.7132 | 0.0182 |
| Literacy | 0.701 | 0.0187 |

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