WHAT EXPLAINS REGIONAL IMBALANCES IN PUBLIC INFRASTRUCTURE EXPENDITURE? EVIDENCE FROM INDIAN STATES

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Literature on regional growth suggests that divergences in infrastructure is a major factor behind the wide and persistent imbalances in regional growth in India. Using a state infrastructure expenditure function, possible factors that determine infrastructure expenditure and its role in the regional imbalance in infrastructure creation across 14 major Indian states are examined in the present paper. The study indicates that such factors as lagged expenditure, resource mobilization and per capita income may cause varying amounts of infrastructure expenditure across states. It also indicates that spending by the infrastructure-deficit states, political stability and positive spatial dependence in infrastructure expenditure have a balancing effect on infrastructure creation across regions. Those results suggest the need to do the following: (a) harness the favourable factors influencing public expenditure that include improving the financial capacity of the infrastructure-deficit states; (b) strengthen the positive spatial dependence among states through the creation of interstate infrastructure networks, such as railways and national highways; and (c) enable a conducive investment climate, which could boost competition among states for improved infrastructure creation.

I. INTRODUCTION

The role of infrastructure as a significant factor in supporting economic growth at the national and at the regional levels has been emphasized in existing literature.[1] Given that economic growth at the national level depends on growth in the regions within the country, the distribution of infrastructure facilities across different regions within an economy assumes importance in the context of achieving balanced regional growth. The issue is particularly relevant in India as a number of studies on regional development and growth in the country attribute the regional imbalance in infrastructure as being a major factor behind wide and persistent regional disparity (Shah, 1970; Das and Barua, 1996; Ghosh and De, 2005). A key question here is: Why is there such regional imbalance in infrastructure? The answer to this may have interesting implications for policies related to infrastructure set by national and subnational governments.

What drives the provision of infrastructure across different regions within an economy? As most of the infrastructure services are non-excludable, non-rival and prone to market failure, the provision of them occurs mainly through a public policy decision. The literature on this topic attributes the differences in regional infrastructure provision to several factors, including, among them, government's preferences for equity and/or efficiency and its fiscal health, economic status and the demography of the region, political factors, persistence of expenditure on infrastructure overtime, and spatial interdependence in infrastructure expenditure among regions. Those studies, however, are ambiguous regarding the relative importance of those factors in influencing infrastructure expenditure. Given that the empirical studies pertain to different countries and time periods and their findings differ, the issue of regional infrastructure provision becomes case-specific. India is a good case for exploring the factors behind regional infrastructure provision because, of late, there is growing emphasis on infrastructure investment to reduce the regional imbalance. In addition, very few studies on this issue have been undertaken in India, and the ones that have been carried out have dealt with either public expenditure in general or some specific infrastructure expenditure, such as health, but not with the determinants of infrastructure expenditure per se. Those studies have also not considered some crucial factors, such as the role of spatial interdependence in infrastructure

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[1]   See Romp and de Haan (2007) for a critical survey of the literature.

expenditure among regions and the relationship between infrastructure expenditure and actual infrastructure facilities.

Unlike the existing studies, in the present study, a more comprehensive list of determinants of infrastructure expenditure are considered, namely lagged infrastructure expenditure, government's preference for equity (the effect of current infrastructure stock and poverty ratio), financial capacity, economic status or per capita income, political stability and spatial interdependence in infrastructure expenditure, for a panel of 14 states over a 20-year period from 1991 to 2010. In the study, the determinants of economic and social infrastructure expenditure, capital, and revenue expenditure are examined separately and the potential endogeneity of some of the determinants, such as per capita income and infrastructure stock through a spatial dynamic system generalized method of moments (GMM) are addressed to obtain robust results.

In the following section, some stylized facts about infrastructure expenditure and actual infrastructure creation across states are put forward. Section III contains a brief review of the literature on the determinants of regional infrastructure provision. Next is a discussion of the empirical model adopted and the method used in the study. Section V gives a description of the data and variables used. The following section includes reports of the empirical results and a discussion on the findings and section VII concludes.
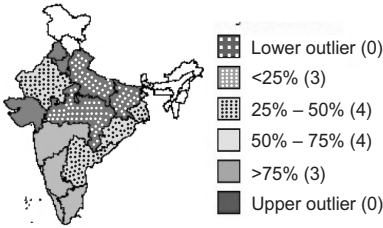
II. SPATIAL DISTRIBUTION OF INFRASTRUCTURE IN INDIA: SOME STYLIZED FACTS

In this section, the regional distribution of infrastructure index is compared 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. In the box, group values are mapped into six categories, four quartiles (1-25 per cent, 25-50 per cent, 50-75 per cent, and 75-100 per cent), and two outlier categories at the low and high end of the distribution. Outliers are values that are more than 1.5 times higher than the inter-quartile range (IQR), namely the difference between the seventy-fifth percentile (Q3) and the twenty-fifth percentile (Q1). According to the values, the states in the two upper quartiles and the high outlier are classified as a higher status group (shading areas in the map) and the rest as a lower status group (dotted areas).
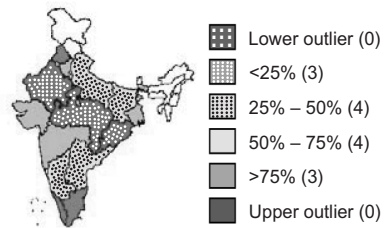
From the box maps in figure 1, the following can be inferred. First, there is a dual pattern of low-infrastructure and high-infrastructure index states, exhibiting an unequal endowment of infrastructure facilities across states. Second, this inequality in

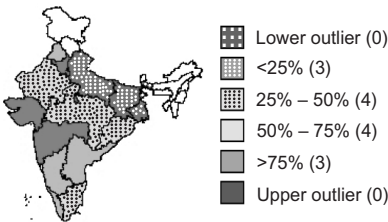**Figure 1. Level of expenditure per capita and infrastructure index**
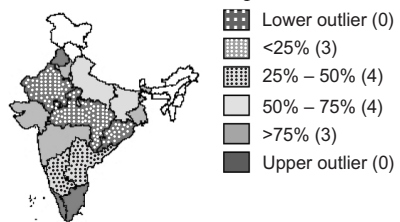
Expenditure-1991

Lower outlier (0)
<25% (3)
25% − 50% (4)
50% − 75% (4)
>75% (3)
Upper outlier (0)

Index-1991

Lower outlier (0)
<25% (3)
25% − 50% (4)
50% − 75% (4)
>75% (3)
Upper outlier (0)

Expenditure-2010

Lower outlier (0)
<25% (3)
25% − 50% (4)
50% − 75% (4)
>75% (3)
Upper outlier (0)

Index-2010

Lower outlier (0)
<25% (3)
25% − 50% (4)
50% − 75% (4)
>75% (3)
Upper outlier (0)

Source: Authors' calculations and mapping using GeoDa software.

infrastructure facilities is also persistent over the years. That is, the same pattern of low-status states, namely Bihar, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh and West Bengal, and high-status states, namely Gujarat, Haryana, Karnataka, Kerala, Maharashtra and Punjab, are observed in both 1991 and 2010. Third, the persistence in the relative position of states in the infrastructure index corresponds to their position in infrastructure expenditure. This means that the states that are not able to change their initial status in expenditure per capita are also not able to change their initial status in the index. Fourth, there is a spatial clustering of states with a similar status, with regard to both index and expenditure. The lower status states are seen lying close to each other as indicated by the dotted areas in the map and so are also the higher status states as shown by the shading areas, indicating the possibility of spatial dependence in infrastructure expenditure.

Those stylized facts suggest that the solution for regional balance in infrastructure may lie in more spending on the part of 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 prompts the need for an explanation as to what is constraining the states from spending more on infrastructure. In addition: What is the implication of the spatial clustering of states with similar status and does it have a 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, a discussion in the literature about the factors that determine infrastructure spending decisions is considered.

III. DETERMINANTS OF REGIONAL INFRASTRUCTURE PROVISION: AN OVERVIEW OF LITERATURE

Broadly, the literature identifies three groups of factors that are behind the regional infrastructure provision, namely economic, political and spatial factors. Economic factors are comprised of equity and/or efficiency considerations, resource constraints, demography and temporal persistence. 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 and Craig, 1987; Anderstig and Mattsson, 1989). While efficiency in the allocation of infrastructure spending entails incurring increased 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 and Ohkawara, 2000), only efficiency (Mizutani and Tanaka, 2008) and of both equity and efficiency (Zheng and others, 2013; Kemmerling and Stephan, 2002; Castells and Solé-Ollé, 2005). Furthermore, one factor cited as being behind the absence of an equity motive in the case of developing countries is the lack of financial resources (Arimah, 2005). With regard to the influence of demography, certain categories of infrastructure are population-serving, such as hospitals and schools, and expenditure on them increases with the increase in population. However, for other categories of infrastructure that are space serving, such as roads, pipelines and waterways, expenditure on them decreases with an increase in population size or urbanization (Biehl, 1989). While Hansen (1965) finds a positive relationship between infrastructure expenditure and population size, Randolph, Bogetic and Hefley (1996) and Yu and others (2011) find that infrastructure expenditure declines with higher urbanization and population size, pointing to the 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 takes place in subsequent years until it is completed (Castells and Solé-Ollé, 2005; Zheng and others, 2013) or sometimes for maintenance. Moreover, the ability of the government to finance infrastructure depends on its revenue generation capacity (Arimah, 2005; Kemmerling and Stephan, 2002; Yu and others, 2011; Randolph, Bogetic and Hefley, 1996; Mizutani and Tanaka, 2008; Painter and Bae, 2001). In addition, the higher the economic status of a region can also lead to greater infrastructure spending, partly because of the higher level of public revenue, and also in response to higher demand for infrastructure from the well-off citizens (Randolph, Bogetic and Hefley, 1996; Arimah, 2005).

In addition to economic factors, political motives, such as the possibility of electoral gains and the political affiliation of the incumbent government (Costa-I-Font, Rodriguez-Oreggia and Lunapla, 2003; Joanis, 2011; Zheng and others, 2013; Castells and Solé-Ollé, 2005; Solé-Ollé, 2013; Crain and Oakley, 1995), the government's sensitiveness to the existence of lobbying from large business firms (Crain and Oakley, 1995; Mizutani and Tanaka, 2008; Cadot, Röller and Stephan, 1999) and to voters' preferences for more infrastructure (Ghate, 2008), and a majority or stable government (Kemmerling and Stephan, 2002; Crain and Oakley, 1995; Mizutani and 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 on the level of public expenditure among neighbouring regions, which is explained by the existence of spillover effects,[2] yardstick competition[3] and tax competition[4] (Brueckner, 2003; Revelli, 2005; 2006). Yu and others (2011) find positive spillover effects among city governments' infrastructure expenditure. The spatial dependence in fiscal choices may also result from the lower tier (municipal) governments, in a federal set-up, reacting in a similar fashion to higher-tier (provincial) authorities' policies (Revelli,

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[2]   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.

[3]   The ill-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 the confidence of the voters.

[4]   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 in attracting people and businesses.

2003). Zheng and others (2013) find evidence of significant spatial dependence in central government investments across regions in China, resulting in two or more neighbouring jurisdictions receiving higher investment from the central government simultaneously.

The studies on the determinants of infrastructure expenditure at the regional or subnational levels are mostly directed towards developed countries. Furthermore, the findings about the relative importance of factors influencing infrastructure expenditure vary across studies. While some studies reveal the importance of economic factors, others have found that the role of political and institutional factors is significant and a few others have pointed to the role of spatial interaction among regions in influencing infrastructure expenditure. The difference in findings across studies is not surprising given that each of them pertain to different regions and time. 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 findings may also be different because a different category of infrastructure services is being considered or of the adoption of different methodologies. Moreover, data deficiencies result in constraints in considering all factors in the case of all economies or regions. In view of those variations, the study of determinants of interregional expenditure on infrastructure is an empirical issue and the finding is likely to be case- or time-specific to some extent.

Empirical literature on the determinants of infrastructure expenditure across states is rather sparse with regard to India. The studies in the country are either concerned with the behaviour of public expenditure in general or on specific infrastructure expenditure, such as health and education. The existing studies are also less comprehensive with respect to the different possible factors, as most of them focus 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 likely to ensure electoral gains than capital spending in infrastructure. Other studies demonstrate the association between coalition government and public expenditure (Dutta, 1997; Lalvani, 2005; Dash and Raja, 2013; Chaudhuri and Dasgupta, 2006). A few studies highlight the role of economic factors, such as per capita income and population size (Dash and Raja, 2013). Studies that explore the determinant of health and education expenditure, such as Rahman (2008) and Chatterji, Mohan and Dastidar (2015), find that per capita income and sources of revenue are significant determinants of expenditure.

To date, no studies in India have explored the role of spatial interaction effect and the existence of equity or efficiency motive nor have they examined the implications of infrastructure expenditure across states for regional imbalance in

infrastructure endowments, which matters most for balanced regional growth. In the present study, an attempt is made to fill the void in the literature by addressing all those issues. Using a panel data set of 14 major states during the period 1991-2010, the determinants of infrastructure expenditure is explored. Consequently, this study adds to the existing literature in several directions. First, total expenditure on infrastructure is split up into economic and social factors and, then further, into capital and revenue expenditure to investigate whether there are differences in the determinants of two kinds of infrastructure. Second, it is more comprehensive than existing studies as this study considers economic, political and spatial factors. Third, the issue of possible bidirectional causality between some of the determinants, such as per capita income and infrastructure stock with the dependent variable, namely per capita infrastructure expenditure through the spatial dynamic system GMM is addressed. Fourth, the implication of those factors for regional balance in infrastructure is examined.

IV. EMPIRICAL MODEL AND METHODOLOGY

Empirical model

The empirical model consists of an infrastructure expenditure function in which infrastructure expenditure of states[5] are explained by the three possible groups of factors: economic, political, and spatial interaction. Economic factors comprise efficiency and/or the 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 the infrastructure expenditure of states. Keeping in view those three factors and the way they are measured in the empirical studies, the state-level infrastructure expenditure function is set up as follows:

$$PCINFEXP_{it} = \alpha_i + \beta_1 PCINFEXP_{it-1} + \beta_2 W.PCINFEXP_{it} + \beta_3 PCRESMOB_{it}$$

$$\beta_4 PCSDP_{it} + \beta_5 POLSTAB_{it} + \beta_6 INFINDEX_{it} + \beta_7 HCR_{it} + \mu_{it} \qquad (1)$$

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 and $INFINDEX_{it}$

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represents infrastructure index. Subscript i = 1...14 refers to states and $t = 1....20$ represents time. α_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[6] 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 maintenance of existing infrastructure facilities is as important as expenditure on new infrastructure facilities. This is because diverting scarce domestic resources away from the maintenance and operation of existing stock may have a perverse effect on economic growth (Hulten, 1996). While addition to new infrastructure comes under capital expenditure, the maintenance of the existing infrastructure facilities is covered under revenue expenditure on infrastructure. Accordingly, the dependent variable, namely expenditure on infrastructure per capita is divided into revenue and capital expenditure. Furthermore, the dependent variable has two variants. In one variant, it is per capita expenditure on economic infrastructure (irrigation, power, transport, and communications); and in the second, it is per capita expenditure on social infrastructure (education, medical and 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 generally shows the phenomenon of temporal persistence. Hence, the effect of temporal persistence on expenditure per capita in the time t (*PCINFEXP$_{it}$*) is measured by the lagged per capita expenditure in the time *t-1*, i.e. *PCINFEXP$_{it-1}$.*

Spatial interaction effect (W.PCINFEXP$_{it}$)

　　　　As explained in an earlier section, spatial autocorrelation or spatial dependence in infrastructure expenditure of the states may exist because of such elements as competition, cooperation, and the spillover effect, manifesting in policy

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[6]　　It is useful to include a measure of demography, such as population density, as explanatory variables to determine whether the expenditure on infrastructure is population-serving or space-serving. However, population density or any measure of demography among explanatory variables have not been included, as the dependent variable is standardized using population, namely expenditure per capita, and population density is expected to affect the per capita expenditure negatively, which could result in a biased interpretation of the variable.

interdependence among the state governments. Furthermore, the so-called spatial dependence observed may be the result of some spatially auto-correlated shocks among the state governments. In addition, many economic infrastructures are characterized by networks that extend beyond administrative boundaries, such as roads, railways and power transmission. This can also lead to interdependence in infrastructure expenditure among neighbouring federal units.

The existence of spatial dependence is measured by the variable, $W.PCINFEXP_{it-1}$ This is the spatial counterpart of the dependent variable, which is calculated as the spatially weighted average of per capita infrastructure expenditure of the ith 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 with all expenditures, government revenue puts limits on the infrastructure expenditure. The variable $PCRESMOB_{it}$ is used as a measure of financial capacity of the government. This is calculated as the ratio of total receipts, 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 a higher-tier of government and debt burden, are found in empirical studies. Some of the variables, such as central grants for state governments' infrastructure expenditure, could not be included because of unavailability of data. In addition, it should be noted that including all the variables would reduce the degrees of freedom.

Economic status (PCSDP$_{it}$)

The economic status of a state is captured by per capita state domestic product, namely $PCSDP_{it}$. The higher the per capita income, the greater the spending on infrastructure, which is spurred by the effect of higher revenue effect and increased demand for infrastructure. Hence, the coefficient of the variable is expected to be positive.

Political factor (POLSTAB$_{it}$)

The influence of a political factor is proxied by the variable, $POLSTAB_{it}$ (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 zero (perfect instability or president's rule) and one (perfect stability in which the government has all the seats). Infrastructure expenditure may be undertaken for

political rent extraction, namely to get the maximum number of votes. There is evidence in literature (Acharya, 2004; Khemani, 2010) that political parties tend to pursue infrastructure projects that ensure more short-term electoral gains than the provision of infrastructure as a long-term and broader public good. This implies that a stable or majority party at the legislature may spend less on infrastructure than a weak majority legislature, which is more likely to worry about the possibility of re-election. However, the effect of a stable or majority government may also be beneficial for the provision of infrastructure expenditure as infrastructure projects are less likely to be held up because of conflict with the opposition in the legislature.

Government's preference (INFINDEX$_{it}$ and HCR$_{it}$)

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 gross domestic product (GDP) per capita seems to be an appropriate measure of the equity/efficiency motive with regard to the regional allocation of the central government's expenditure on infrastructure. It may not be an indicator of equity/efficiency when dealing with the determinants of regional government's infrastructure expenditure. In this case, output or GDP per capita would reflect the economic status of the particular region. Hence, existing infrastructure stock is used to detect if it has a balancing effect on infrastructure expenditure or otherwise. Existing stock of infrastructure is proxied by the variable, *INFINDEX$_{it}$*. It may indicate the presence or absence of a process of catching up in infrastructure expenditure among the states. That is, the infrastructure-deficit/ infrastructure-abundant states are spending more/less. If regions with high/low stock of infrastructure are spending less/more on infrastructure, there would be a narrowing in the gap between infrastructure-poor and infrastructure-abundant states, and the gap would widen in the opposite case. Three indices of infrastructure, namely aggregate infrastructure index, economic infrastructure index and a social infrastructure index, have been constructed applying Principal Component Analysis. The details of the Principal Component Analysis are given in the appendix. Apart from output in a region or existing stock of public capital, Randolph, Bogetic and Hefley (1996), Lalvani (2005), and Dash and Raja (2013) have also used some measure of poverty to capture the government's preferences in the expenditure provision of infrastructure. A key argument for the link between infrastructure spending and poverty alleviation, especially in less developed countries is that a reduction in poverty can be brought about through the promotion of economic opportunities through the construction of economic infrastructure, such as roads, electrification and irrigation, by development of human capital by providing social services, such as health and education, and by the provision of transfers to the poor (Randolph, Bogetic and Hefley,1996). Accordingly, head count ratio (*HCR$_{it}$*) has also been used as a measure

of poverty, as an explanatory variable, to examine whether states with higher poverty are spending more/less on economic/social infrastructure.

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 ordinary least squares to such a case is inappropriate as it could lead to dynamic panel bias resulting in biased estimates because of the correlation between the lagged dependent variables and the state-specific effect (Nickell, 1981). Furthermore, 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, an increase in the latter also leads to higher productivity, which could push per capita income to a higher level. Similarly, as expenditure occurs in response to the existing level of infrastructure stock, an increase or a 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 and 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 to the model to remove the state-specific effects and all endogenous variables with their own lagged levels are used as instruments (Anderson and Hsiao, 1981; 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 when the autoregressive parameter of the endogenous variable is moderately large, and the number of time series observations is moderately small. This is because lagged levels variables provide weak instruments for first differenced variables in this case. In comparison, the system GMM improve the precision of the estimator and reduces the bias. Although the 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 and Monteiro (2008) and Jacobs, Ligthart and Vrijburg (2009), have extended the SYS-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 (β_2) and system GMM estimator was found to be superior with a small bias.

An important choice about the system GMM estimator is whether to use one-step or two-step estimator. While the 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 the 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 estimator are downward biased. Furthermore, even in the presence of heteroscedasticity, there is a small improvement in efficiency gains from the two-step GMM estimator relative to the one-step GMM estimator for which inference based on the one-step GMM estimator is much more reliable than the two-step estimator. Thus, the robust one-step spatial system GMM estimator has been used for the model in equation (1).

The consistency of the system GMM estimator is verified by two tests: (a) the Sargan/Hansen test of over identifying restrictions, which is based on the hypothesis that instrumental variables are valid (not correlated with the error terms); and (b) by using Arellano and 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 out if there is any general spatial autocorrelation in the data, Moran's I test is used. To further detect which form of spatial dependence[7] (lag or error) in the panel data, two Lagrange Multiplier (LM) tests with their robust counterparts are available.[8] These tests (LM-lag and LM-error

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

8   While Anselin and others (1996) have developed these tests to be used in a cross-section setting, derivations of those tests for a spatial panel data model with spatial fixed effects is found in Debarsy and Ertur (2010).

tests) are conducted on the non-spatial model. The tests are preferred in their robust version as they are vulnerable to several forms of misspecification.

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 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 and Bijmolt, 2009). In addition, as recently shown by LeSage and Pace (2014), properly calculated marginal effects for spatial regression models yield robust results irrespective of the chosen spatial weighting matrix. As infrastructure facilities are likely to connect adjacent states, interdependence in expenditure on infrastructure is also expected between the states touching each other's boundary. Thus, the estimation of the model has been carried out with queen-contiguity weights, which defines neighbouring states as those with common borders and corners or vertices.[9]

V. DATA

The dataset comprises 14 major Indian states over a 20-year period (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 the 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 not included because of the differences in the structure of their economies from the rest of the states (Rao, Shand and Kalirajan, 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 *State Finances: A Study of Budgets* issued by the Reserve Bank of India for different years. The physical infrastructure data are gathered from a variety of sources. The data on

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9   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 the queen contiguity, both border and corner contacts are considered.

road and railway per 1,000 square kilometers of area is sourced from the Centre for Monitoring Indian Economy, infrastructure statistics for 2013 and the Ministry of Statistics and Programme Implementation, while the data on per capita installed capacity of power (in megawatt (mw)) is gathered from *Statistical Abstracts of India* and the *Handbook of Statistics on Indian States,* issued by the Reserve Bank of India, the India Energy Portal and NITI Aayog. The data on gross irrigated area as a percentage of gross cropped area is from *Agricultural Statistics at a Glance* whereas telephone per 100 populations (including Public DELs, Pvt. DELs, CMPs and WLL (fixed and limited)) is obtained from infrastructure statistics given by the Ministry of Statistics and Programme Implementation and *Statistical Abstracts of India* for different years. In addition, the data on percentage of children fully immunized is from *State Fact Sheets* of different rounds of National Family Health Surveys, Indian households' access to safe drinking water in per cent is taken from the Economic Survey. Finally, data from total number of schools for general education (primary and secondary) per 1,000 population is gathered from *Statistical Abstracts of India* and the Economic Survey.

Gross state domestic product data have been taken from National Accounts Statistics of the Central Statistics Office in constant prices and in current prices and, as they were in different base periods, converted to the 2004/05 base period. The converted 2004/05 constant and current prices data are 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 head count ratio are sourced from the Planning Commission. The timespan for which a ruling party prevailed is taken from Lalvani (2005) and extended until 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.

VI. EMPIRICAL RESULTS

In this section, the estimated results of equation (1) are reported. To determine whether a spatial model or a non-spatial one is appropriate, the process begins with the results of spatial diagnostic test in table 1 based on non-spatial ordinary least squares models. While the LM tests for error dependence and its robust version are insignificant, the LM tests for spatial lag dependence are significant suggesting a spatial lag model as the appropriate specification.

Table 1. Spatial diagnostic tests

Test	Economic infrastructure		Social infrastructure	
	Statistic	**P-value**	**Statistic**	**P-value**
Moran's I	0.135	0.001	0.021	0.690
LM error	0.454	0.500	0.213	0.644
Robust LM error	1.475	0.224	0.346	0.556
LM lag	8.619	0.003	0.009	0.108
Robust LM lag	9.641	0.002	0.134	0.091

The system GMM estimation results for both capital and revenue expenditure on economic and social infrastructure as dependent variables are given in table 2. The results suggest that lagged per capita expenditure on infrastructure[10] has a significant and positive effect on per capita infrastructure expenditure, indicating the existence of temporal persistence. Such temporal persistence is stronger in the case of social infrastructure than economic infrastructure as observed by the higher significance and larger coeffcient of the former. This may be because expenditure on economic infrastructure, such as transport, communication and irrigation facilities, once earmarked, needs not be incurred in every year's budget, but the expenditure on social infrastructure, such as schools, health and drinking water facilities and some welfare schemes, is to be incurred in each budget. In addition, revenue expenditure shows more temporal persistence than capital expenditure. This means that an increase in a state government's revenue spending on economic and social infrastructure by 1 per cent in a year would lead to more than 0.15 and 0.65 per cent increase in infrastructure spending per capita in the subsequent year for these types of infrastructure. This seems usual as revenue expenditure includes some committed components, such as payments of salaries and wages, along with maintenance expenditure on infrastructure, which requires continuous allocation in the government budget.

While the spatial lag is insignificant for social and revenue expenditures, the spatial lag for capital expenditure on economic infrastructure is significant and has a positive sign, indicating that an increase in expenditure in neigbouring 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 is more likely in case of economic

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[10]   When attempt was made with second and third lags of the dependent variable, the sign of all the variables are found to be intact, though there is some change in the level of significance of the variables.

Table 2. Determinants of per capita infrastructure expenditure

Independent variable:	Dependent variable: *PCINFEXP*			
	Economic infrastructure		Social infrastructure	
	Capital	Revenue	Capital	Revenue
L1.PCINFEXP	0.122	0.157 **	0.910 ***	0.656 ***
	(0.092)	(0.075)	(0.123)	(0.161)
W.PCINFEXP	0.025 *	-0.042	-0.011	0.007
	(0.012)	(0.025)	(0.036)	(0.004)
PCRESCMOB	0.718 ***	0.560 **	0.563 *	0.131 *
	(0.269)	(0.219)	(0.318)	(0.065)
PCSDP	0.485 *	1.098 *	-0.417	0.369
	(0.244)	(0.178)	(0.509)	(0.244)
POLSTAB	-0.535	-0.822 **	-0.219	0.085
	(0.566)	(0.377)	(0.354)	(0.086)
HCR	-0.010	-0.027 ***	0.014	0.000
	(0.023)	(0.005)	(0.039)	(0.002)
INFINDEX	-0.139	-0.657 ***	0.093	0.039
	(0.347)	(0.202)	(0.437)	(0.039)
Year dummy	Yes	Yes	Yes	Yes
Observations	266	266	266	266
No. of states	14	14	14	14
No. of lagged instruments	1,1	1,1	1,1	1,2
No. of instruments	8	9	8	10
AR(1) test	0.154	0.003	0.030	0.004
AR(2) test	0.605	0.515	0.777	0.383
Hansen over-identification test	0.350	0.198	0.112	0.149

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

infrastructure, which has components, such as transport, communication and energy, that add to productivity and growth directly, than social infrastructure. Another reason could be that the increased spending on interstate network facilties, such as highways and railways, which is mostly undertaken by the central government, may lead to more spending from several states in collaboration to increase their within-state infrastructure facilities needed for facilitating connection to the interstate network.

Regarding per capita resource mobility, it has a positive and significant effect on the provision of economic and social infrastructure, pointing towards the obvious importance of financial capacity of the states in dictating their expenditure. Both per capita resource mobilty and per capita state domestic product are positive and significant for the provision of economic infrastructure. This indicates that economically better off states have greater fiscal capacity and, hence, can spend more on economic infrastructure. In addition, the relative importance of the two factors is also more for capital expenditure than revenue expenditure.

The effect of political stabilty is mostly insignificant except for revenue expenditure on economic infrastructure. It is also negative for all categories of infrastructure except revenue expenditure on social infrastructure. This suggests that, for the most part, greater provision of infrastructure may be a means to secure political positions. Hence, a stable governement, which is less likely to worry about the opposition and possiblity of re-election, tends to spend less on infrastructure. To determine whether such an effect of political stabilty is the same for the single-party government and coalition government, a separate regression is run in which political stabilty is multiplied with a dummy for a single-party government. The result is reported in table 3. It shows that the political stabilty-single dummy interaction term (POLSTAB*SINGLE) has a positive sign for the former varibles having negative signs. This indicates that a government with a single party majority tends 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 the reverse for coalition governemnts in which there would be less spending on infrastructure, possibly because the government may face conflict from its coalition partners or the possibilty of more frequent re-elections. This is evident from the negative sign of the political stabilty variable for those variables, which now represent the effect of political stabilty in the presence of a coalition government. An exception is the revenue expenditure on social infrastructure on which the effect of political stability in the presence of single government is negative, but in the presence of a coalition government, it is positive. Moreover, political stabilty and its interaction variable are seen to be relatively more important for revenue expenditure than capital expenditure.

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

Independent variable:	Dependent variable: *PCINFEXP*			
	Economic infrastructure		Social infrastructure	
	Capital	Revenue	Capital	Revenue
L1.PCINFEXP	0.124	0.168 *	0.905 ***	0.660 ***
	(0.095)	(0.086)	(0.128)	(0.172)
W.PCINFEXP	0.020	-0.055 **	-0.014	0.009 **
	(0.014)	(0.023)	(0.035)	(0.004)
PCRESCMOB	0.730 **	0.627 **	0.569 *	0.088
	(0.284)	(0.249)	(0.329)	(0.078)
PCSDP	0.492 **	1.079 ***	-0.390	0.391
	(0.235)	(0.196)	(0.503)	(0.281)
POLSTAB	-0.762	-1.237 ***	-0.326	0.170 **
	(0.485)	(0.395	(0.336)	(0.080)
HCR	-0.009	-0.023 ***	0.011	-0.001
	(0.021)	(0.007)	(0.037)	(0.002)
INFINDEX	-0.087	-0.615 ***	0.072	0.035
	(0.323)	(0.218)	(0.426)	(0.033)
*POLSTAB*SINGLE*	0.355	0.562 **	0.160	-0.138 **
	(0.286)	(0.272)	(0.165)	(0.060)
Year dummy	Yes	Yes	Yes	Yes
Observations	266	266	266	266
No. of states	14	14	14	14
No. of lagged instruments	1,1	1,1	1,2	1,2
No. of instruments	9	10	11	11
AR(1) test	0.151	0.004	0.038	0.003
AR(2) test	0.716	0.757	0.782	0.313
Hansen over-identification test	0.567	0.360	0.394	0.153

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

The negative sign of the coefficient of the economic infrastructure index indicates that there could be an element of equity or a process of catching up in infrastructure service provision, namely that infrastructure-deficient states may spend more than infrastructure-abundant states. However, such an effect is only significant for revenue expenditure on economic infrastructure; it is also absent for social infrastructure provision.

The negative signs of the head count ratio for the provision of economic infrastructure and positive sign for the provision of social infrastructure imply that states with a higher proportion of the people in poverty are spending less on economic infrastructure but more on social infrastructure. The effect of this is significant only in the case of revenue expenditure on economic infrastructure.

The diagnostic tests for all the estimated models validate the consistency of the system GMM estimator. The AR(2) tests rule out the existence of second order serial correlation in residuals. Hansen tests,[11] being insignificant, also justify that the instruments used in all the models are valid, namely that they are not correlated with the residuals.

VII. CONCLUSIONS

There is a broad concensus in the literature that regional imbalance in infrastructure is a major reason behind the wide regional imbalance in growth and development in Indian states. In the present paper, the role of possible factors influencing states' expenditure on infrastructure per capita on economic and social infrastructure and their two components, capital and revenue expenditure, are analysed. The results reveal that the financial capacity of the government and past expenditure have a significant positive effect on both economic and social infrastructure expenditure. Per capita income and financial capacity of the government have a positive effect on economic infrastructure. There is also an indication of positive spatial dependence in expenditure on economic infrastructure, namely an increase in a state's expenditure is associated with an increase in its neigbouring states' expenditure. Some factors, such as past expenditure, are found to be relatively important in influencing the revenue expenditure rather than capital expenditure. A catching up process in a government's provison of economic infrastructure is seen, but only with respect to revenue expenditure. Political stability also figures in the

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[11] Roodman (2009) points out that dynamic panel models can generate too many instruments biasing the estimates. To limit the number of instruments, the maximum lags are restricted to two and the "collapse" option of Roodman (2006) is used in the present study.

revenue expenditures on infrastructure rather than the capital expenditure which counts for provision of infrastructure.

As those factors influence the creation of actual infrastructure facilities through their influence on infrastructure expenditure, they have implications for regional imbalance in infrastructure facilities. For example, the inverse effect of the infrastructure index on infrastructure expenditure implies more spending by infrastructure-poor states, which would help to lessen the regional imbalance in infrastructure facilities. Similarly, positive spatial dependence in the case of economic infrastructure also augurs well for the balanced creation of infrastructure facilties across states. However, differences in some factors and potential sources of infrastructure expenditure, such as past expenditure (temporal persistence), financial capcacity and per capita income, may accentuate the regional imbalance on infrastructure. The backward states have much less spending power than the states with high incomes and high revenues.

No change in the relative status of states in infrastructure index between 1991 and 2010 points to the dominance of the unfavourable factors over the favourable factors. An additional reason is that some favorable factors, such as the effects of infrastructure and incidence of poverty are active with regard to revenue expenditure on infrastructure, which does not directly translate into creation of infrastructure facilities. Hence, the strategy for achieving regional balance in infrastructure would require the harnessing of the favourable factors, especially those that influence capital expenditure and, hence, actual infrastructure creation. This can occur by augmenting the financial capacity of the infrastructure deficit states through central government grants or promoting private sector paricipation in infrastructure investment. The positive spatial dependence in economic infrastructure expenditure among states needs to be reinforced by setting up more infrastructure categories, such as railways, national highways that are part of interstate 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 aimed at building a more conducive investment climate could boost this competition and help in bridging the infrastructure-divide among states.

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APPENDIX

Infrastructure indices

The indices of aggregate, economic and social infrastructure have been constructed from infrastructure variables using Principal Component Analysis. The descriptive statistics for the variables are given in appendix table A.1. 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 appendix table A.2. The result shows that the first three components are significant as they have Eigen values greater than one. Those three components explain 30, 26 and 18 per cent of the total variance in infrastructure, respectively. Together, they explain 75 per cent of the total variance. Appendix table A.3 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 a similar way. The Eigen values and the proportion of variance explained by each principal component and the factor loading of the variables in the significant principal components used to construct these indices are given in appendix tables A.4, A.5, A.6 and A.7, respectively.

Appendix table A.1. Descriptive statistics of infrastructure components (total number of observations: 280)

Variable	Mean	Standard deviation	Minimum	Maximum
Road density	1 120.586	911.755	316	5 268.69
Rail density	25.892	9.639	9.6	44.52
Power	4 242.088	2 366.12	766.1187	12 911.15
Irrigation	44.691	23.729	12.34	98
Teledensity	9.871	15.244	0.11	80.36
Drinking water	75.54236	17.7115	18.9	97.6
Immunization	50.96723	19.4019	10.7	88.8
Education	0.9949216	0.40809	0.2081652	2.173089

Aggregate infrastructure

Appendix table A.2. Eigen values and proportion of variance explained by Principal Components

Component	Eigen value	Proportion explained	Cumulative total
Component 1	2.4259	0.3032	0.3032
Component 2	2.12599	0.2657	0.569
Component 3	1.49238	0.1865	0.7555
Component 4	0.977642	0.1222	0.8777
Component 5	0.500114	0.0625	0.9403
Component 6	0.225818	0.0282	0.9685
Component 7	0.171164	0.0214	0.9899
Component 8	0.809908	0.0101	1

Appendix table A.3. Factor loadings

Variable	Comp 1	Comp 2	Comp 3
Road density	0.1846	-0.5701	-0.1117
Rail density	0.6043	0.1385	-0.1524
Power	-0.033	0.0985	0.8259
Irrigation	0.4024	0.4172	-0.2355
Teledensity	-0.0641	0.0095	-0.0085
Drinking water	0.0832	0.6075	0.1799
Immunization	0.2824	-0.2403	0.4027
Education	-0.589	0.2126	-0.1791

Economic infrastructure

Appendix table A.4. Eigen values and proportion of variance explained by Principal Components

Component	Eigen value	Proportion explained	Cumulative total
Component 1	1.77689	0.3554	0.3554
Component 2	1.30595	0.2612	0.6166
Component 3	1.14985	0.23	0.8465
Component 4	0.602566	0.1205	0.9671
Component 5	0.164749	0.0329	1

Appendix table A.5. Factor loadings (economic infrastructure)

Variable	Comp 1	Comp 2	Comp 3
Road density	0.0244	0.9273	0.0452
Rail density	0.7498	0.2292	-0.127
Power	0.0055	-0.0197	0.0125
Irrigation	0.6611	-0.2935	0.1568
Teledensity	-0.0099	0.0342	0.9783

Social infrastructure

Appendix table A.6. Eigen values and proportion of variance explained by Principal Components

Component	Eigen value	Proportion explained	Cumulative total
Component 1	1.35303	0.451	0.451
Component 2	1.01013	0.3367	0.7877
Component 3	0.63684	0.2123	1

Appendix table A.7. Factor loadings (social infrastructure)

Variable	Comp 1	Comp 2
Drinking water	0.0053	0.9685
Immunization	0.7253	0.1677
Education	-0.6884	0.1814