ISSN 2454-5597

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Working Paper- 25
http://iire.in/ojs/index.php
Issue- July 2016

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PANEL DATA ANALYSIS: CONVERGENCE OF INDIAN STATES WITH INFRASTRUCTURE

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Abstract

Augmented Solow model neoclassical growth theory framework is used with infrastructure. The poor economies tend to grow more because of diminishing returns to capital. The idea of conditional convergence used by Barro and Sala-i-Martin(1992) for the β convergence of the steady state equilibrium is used for the Indian States and Union Territories with the Infrastructure Index. The panel data set is used for the analysis as it has more advantages over the cross section and time series data. The dynamic panel data is estimated using the fixed effect model and Generalized Methods of Moments for the estimation for the period of 1990-91 to 2010-11. The dynamic panel data models are more consistent and efficient estimator with the Generalized Methods of Moments than the fixed effect models. The Infrastructure Index and Growth have significant positive relationship**.** The Barro and Sala-i-Martin version of the β convergence holds for the Indian States and Union Territories a clear evidence of conditional convergence.

Key Words**:** Infrastructure Index, Fixed effect, Generalized Methods of Moments, Conditional Convergence
JEL Codes*:* C01, C23, C33, O18, R11

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Authors are grateful to Professor Neeraj Hatekar for his valuable comments and suggestions. However, the usual disclaimer applies.

1. INTRODUCTION:

Recently, several attempts have been made by the researchers and policy makers to study various dimensions of regional growth in India. One of the India National Policy objectives was to achieve the balanced regional development. Despite of several reforms, the country is obstructed with the unbalanced growth in various states and union territories of India. Understanding the inequality in terms of income level between the regions becomes crucial as it makes us understand the problems related to those specific regions like geographical barriers, labor and employment, infrastructure, trade barriers and also the resources available in those regions. All these factors affect the regional growth and development of that particular region. Such disparities can lead to economic, political and social problems among the regions and can further worsen the situation. One of the most important factors that affect the growth is ‘Infrastructure’. It has been a quite long in our Indian Planning System that infrastructure remaining at bottleneck to all three sectors agriculture, manufacturing and service sector. To enhance the growth of this sector there is essential need to develop infrastructure at the grass root level. In this context there is a need to study the relationship between the infrastructure and growth because Firstly, Infrastructure has both direct and indirect effect. Direct effect on the productive activities to increase the aggregate output and indirect effect on labour productivity, reduces the cost and leads to economies of scale in production. Secondly, infrastructure is closely associated with the externalities both positive as well as negative externalities. Positive externality promotes the productivity of the other factors of the production and negative externalities due to carbon emission, pollution *etc*.

The purpose of this study to re-examine the issue of convergence or divergence in neoclassical framework while incorporating the infrastructure index. To understand the role of infrastructure on regional growth that creates positive externalities or negative externalities. The paper is organized as follows: Section 2 discusses the background of infrastructure and growth related issues. Section 3 explains the theoretical framework of neoclassical economics. Section 4 discusses the data, methodology and various estimation methods. Section 5 discusses the analysis of results and last section concludes the paper.

2. BACKGROUND: INFRASTRUCTURE AND GROWTH:

The role of social overhead capital stimulates the direct productive activities (DPA) through investments. Such investment creates more economies of scale which are called divergent series of investment which promotes the growth of all sectors simultaneously. This unbalanced growth strategy was propounded by Hirschman (1958). The regional disparity is growing because of unbalanced growth was formulated by the circular causation theory of Myrdal (1958). Due to cumulative causation a region can have both backwash and spread effects. Backwash effects retard the growth of region by the pull factor *i.e.* outflow of capital and labor to other regions which will enhance the economic activities in the other regions are called spread effects. Spread effects are likely to grow with more investment in infrastructural facilities which will further expand the development of the region. It is difficult to predict that which effect will dominate in development process of a region. Most effective way to achieve the economic growth is by the intervention of the government in providing the public infrastructure. Hansen (1965) emphasized the role of public investment in economic development, divides public infrastructure into two categories: Economic Overhead Capital (EOC) and Social Overhead Capital (SOC). EOC is oriented primarily towards the direct support of productive activities or toward the movement of economic goods. SOC is designed to enhance human capital and consists of social services such as education, public health services, fire and police protection and homes for the aged. Aschauer (1990) rose an important question "Why infrastructure is important?" since it increases the public expenditure and fiscal deficit of country. He considered infrastructure as a merit good which enhance the productivity, growth and human capital in the economy. Such spending is necessary as it improves the employment and growth activities in the economy. Infrastructure is an input to production and raises the productivity of other factors. Infrastructure connects goods to the markets, workers to the industry, professional to the services and the poorer in rural areas migrate to urban commercial business center.

According to neoclassical growth theories with perfect capital and labor mobility will reduce the regional inequalities over time. The economies with the lower capital-labor ratio will tend to grow faster. Thus, the poor regions will grow much faster than the rich regions and converge to their steady state was led by Solow (1956). The idea of Convergence can be further classified firstly; if all countries have same level of savings and technology then it implies that all countries are moving towards the same long run level of incomes is called sigma convergence. Per capita income dispersion is reduced over time (σ- convergence). Secondly, if all countries have same level of saving and different level of technology implies that poor countries grow faster than the rich a country is called absolute convergence. Thirdly, if all countries have different level of savings and technology it implies that all countries will move towards different long run level of income is called beta convergence. The growth rate is regressed on initial level of per capita income and is negatively correlated then it can be termed as beta convergence or conditional convergence Barro and Sala-i- martin (1990, 1992). Within this neoclassical framework several studies are conducted at various country and regional level [Mankiw, Romer and Weil (1992); Islam (1995); Demurger (2001); Datta and Agrawal (2004); Ding, Haynes and Liu (2008); Brodzicki (2012)]

There are several studies to understand the infrastructure disparity and regional growth and development in Indian economy includes [Ghosh and De (1998); Majumder 2003); Raychaudhuri and Haldar (2009); Patra and Acharya (2011); Bhandari (2012); Bajar (2013)]. Ghosh and De (1998) concluded that a regional imbalance in states is due to the disparity in physical infrastructure whereas Majumdar (2003) concluded that variations in infrastructure level among states have reduced over time. Bhandari (2012) constructed health, education and infrastructure index where the BIMARU states are lowest in all three indexes compared to other states. Bajar (2013) concluded that electricity and telecommunication have outperformed than the transportation sector. Trade openness studies De and Ghosh (2005), Raychaudhuri and De (2010) conclude that infrastructure helps to reduces the poverty, inequality and the transportation cost and further enhance the growth in the economy. These studies have found the positive impact of infrastructure on per capita GDP.

Convergence with context to Indian economy includes [Cashwin and Sahay (1996); Nagaraj, Varondakis and Veganzones (1998); Rao, Shand and Kalirajan (1999); Adabar (2004); Nauriyal and Sahoo (2010); Bandyoupadhyay (2011); Somasekharan, Prasad and Roy (2011); Das, Ghate and Robertson (2013); Mukhopadhyay and Sarkar (2014); Chaterjee (2014)]. Nagaraj, Varondakis and Veganzones (1998) study includes 17 major states of India for the period of 1970-94 has used fixed effect and principal component analysis. Further he incorporated various infrastructure indicators including physical, financial and social infrastructure for convergence across the states and found the education has positive effect on growth. Similarly, Nauriyal and Sahoo (2010) studies convergence with infrastructure for 15 major states in period 1991-2006 where he finds convergence after period 2001 prior that Indian states incomes has resulted into divergence. A state-wise and district-wise convergence study conducted by Das, Ghate and Robertson (2013) for period 2001-2008 finds a very low rate of conditional convergence and disparity in terms of infrastructure, literacy and trade among states and district contributed in lack of evidence for absolute convergence. Chaterjee (2014) has found the strong evidence of beta convergence but not sigma convergence among 17 major states in Indian agriculture. Where, the rural infrastructure plays a positive and significant role in enhancing the agriculture growth.

3. THEORETICAL FRAMEWORK:

Neoclassical economics has developed many theories on growth models one of the prominent studies includes Solow model of economic growth. The neoclassical production function is homogeneous and constant returns to scale with variable proportion of capital and labor.

$$Y(t) = K(t)^{\alpha} + A(t)L(t)^{1-\alpha} \text{ ------------------------------ (1)}$$

Where Y- output, K – Physical capital stock, L – Labor and A – technology

If capital stock changes over time with the constant saving rate

$$\frac{\partial k/\partial t}{k} = \frac{sf(k)}{k} - (n + g + \delta) \quad \text{------------------------------------} \ (2)$$

Where k= K/AL and y = Y/ AL with s being constant. Taking log on both sides of the equation. The steady state equilibrium is

$$\ln\left[\frac{Y(t)}{L(t)}\right] = \ln\big(A(0)\big) + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n + g + \delta) \quad \text{------------} \ (3)$$

Thus, if the initial capital stock is below the equilibrium ratio, capital and output will grow at a faster pace than the labor force until the equilibrium ratio is approached. If the initial ratio is above the equilibrium value, capital and output will grow more slowly than the labor force. The convergence will occur if the economy approaches to the steady state equilibrium condition K^* otherwise it will result in divergence. Since Solow model has decreasing returns to capital so countries with the less amount of capital will grow at much faster rate because the rich countries would invest more in poor countries and thus will lead to higher growth in poor countries. Specifically, poor economies will tend to grow at much faster than the rich economies in terms of per capita income (Solow 1956). Since the Solow model was limited to a closed economy framework the further contribution by Barro and Sala-i-Martin (1992) worked on open economy framework. According to Barro and Sala-i-Martin (1992), Convergence would tend to grow faster if we consider the open economy model as the because of the mobility of capital from poor economies to rich economies. The increase in wages in rich economies will further increase the mobility of labor from poor economies to rich economies will increase the returns to scale in poor economies. Thus rate of convergence would be faster due to the migration of labor. For conditional convergence β- Convergence is necessary, but not sufficient for σ- convergence (Barro and Sala-i-Martin 1992). The countries which have same characteristics are likely to have conditional convergence conclusions made by further studies of Barro and Sala-i-Martin (1992) on convergence among States and region of United States. The Solow model only included the physical capital in the production function and totally ignored the human capital. Realizing the role of human capital in the economic growth and returns to the human capital cannot be denied. Mankiw, Romer and Weil (1992) included the human capital component in the Solow model. He stressed the importance of human capital in the production function and if it is not included will lead to omitted variable bias. The following Solow model with human capital is

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta} \quad \text{----------------------- (4)}$$

$$ln\left[\frac{Y(t)}{L(t)}\right] = lnA(0) + gt - \frac{\propto+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\ln(S_k) + \frac{\beta}{1-\alpha-\beta}\ln(S_h) \text{ ---- (5)}$$

The Mankiw conclusion that inclusion of human capital would lead to higher level of steady state equilibrium as human capital accumulation increases the physical capital on the income level. He included the working age population and school enrolment as the human capital parameters and formed the growth model with the human capital. The equations (3) and (5) gt is similar for all countries and A (0) = a +ε, where a is a constant term and ε is the country specific shock. The countries are differently endowed and the level of technology cannot be same for all countries. Dynamisms among the countries led to a panel data approach used by Islam (1995). He introduces the time variant η_t and cross country effects υ_t in the model.

$$y_{it} = \gamma y_{i,t-1} + \sum_{j=1}^{2} \beta_j x^j{}_{it} + \eta_t + \mu_i + \upsilon_{it} \text{ ----------------------- (6)}$$

Where,

Yit = ln y(t2), Yi,t-1 = ln y(t_1), $\gamma = e^{-\lambda T}$,

$\beta 1 = (1 - e^{-\lambda T})\frac{\alpha}{1-\alpha}$, $\beta 2 = -(1 - e^{-\lambda T})\frac{\alpha}{1-\alpha}$

$x^1{}_{it} =$ ln (S), $x^2{}_{it} = \ln(n+g+\delta)$

$\mu_i = (1 - e^{-\lambda T}) \ln A(0)$ $\eta_i = g(t_2 - e^{-\lambda T} t_1)$

Convergence does not imply that countries will converge to the similar levels of income but in reality it implies that countries will converge to different level of steady state income because there are differences in technology, institution, quality of labor force (Conditional convergence). To introduce unobserved factors and individual effects in the model he used a panel data. He improved the Mankiw version of the cross section OLS regression with the panel data modeling. According to him, the individual effect is correlated with the explanatory variables which results in Omitted variable bias. The panel data framework makes it possible to correct the bias Islam (1995). He used least square dummy variables (LSDV) estimator and found that rate of convergence is much higher than the cross section and pooled regressions.

We have used the panel data approach to incorporate state specific effects and time effects in our model. Since Infrastructure acts as input to the production process and differences in technology in terms of infrastructure differ from other state. We have augmented the Solow model including infrastructure. Brodzicki (2012) conducted a similar analysis by incorporating the education and transportation infrastructure in Solow model. For the inclusion of human capital, he used mincer approach by combining average years of schooling and average years of experience. While for transportation infrastructure he used only motorway system and railway system to construct the infrastructure index. We have used both physical and social infrastructure to construct the infrastructure index.

$$Y(t) = I^{\phi}K(t)^{\alpha} + A(t)L(t)^{1-\alpha} + \eta_t + \upsilon_{it} \text{---------------------} (7)$$

$$\ln\left[\frac{Y(t)}{L(t)}\right] = \ln\big(A(0)\big) + \frac{\phi}{1-\alpha}\ln(I) + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \eta_t + \upsilon_{it} \text{----------} (8)$$

Equations (7) and (8) show the augmented Solow model with the infrastructure in the panel data framework. Where, infrastructure index grows at the exogenous rate $\boldsymbol{\phi}$. Infrastructure has both positive and negative externalities so there are no constrained on $\boldsymbol{\phi}$.

4. DATA AND METHODOLOGY:

The Indian States and Union Territories (UT) are included in the analysis for the period of 1990-91 to 2010-11. Among the 35 states and union territories Daman and Diu, Dadra Nagar and Haveli, Lakshadweep, Mizoram and Chandigarh are not included in analysis because of lack of data and missing values. The states which are formed in year 2000 (Jharkhand, Uttaranchal and Chhattisgarh) are included in parent state to maintain the balanced panel data set. Thus the analysis includes 27 states and Union Territories for the analysis. The dynamic panel data models are used for analysis using the following list of variables shown in tables 1 and 2. The lagged growth rate was introduced in Datta and Agrawal (2004) study and thus used for analysis.

Table 1: Definition of Variables

Variables	Explanation
GR	Growth Rate (%)
GR (-1)	Lagged Growth Rate (%)
IGDP	Initial level of GDP
INFRA	Infrastructure Index
POPGR	Population Growth Rate (%)

The infrastructure index is formed using weighted mean. The weights are derived from using the principal component analysis for various infrastructural variables. The infrastructure index is formed considering physical, financial and social infrastructure variables. To maintain uniformity for comparing among states and UT the following list of variables are included for infrastructure index.

Table 2: Definition of Infrastructural Variables

Variables for Infrastructure Index	Explanation
LRO/ THOUSAND SQ.KM	Total length of roads per thousand sq.km
LRA/ THOUSAND SQ.KM	Total length of railways per thousand sq.km
VE (%)	Percentage of villages electrified
PER CAPITA CE	Per capita consumption of electricity
II	Irrigation intensity
BO/ LAKH POP	Bank offices per lakh population
PS/ LAKH POP	Primary and secondary schools per lakh population
HOSP/ LAKH POP	Government hospitals per lakh population
BEDS/ LAKH POP	Beds per lakh population

Sources: Statistical abstract of India, Central statistical organization and Census of India.

4.1. Unit Root Test:

Unit root test are conducted for all the variables using Hadri test, Levin, Lin and Chu test, LM, Pesaran and shin W- stat, ADF – Fisher chi- square, PP- fisher chi square. The Hadri test of unit root set null hypothesis at stationary and is superior to the other test as it corrects heteroscedasticity and serial correlations across the cross sections among the States and UT. The unit root test is shown in table 3 using Hadri test.

Table 3: Unit Root Test

Variables	Z Statistics	P Value
GR	0.90626	0.1824
d(GR(-1))	-1.05400	0.8541
dd(IGDP)	0.36766	0.3566
d(INFRA)	-0.13057	0.5519
POPGR	1.15862	0.1233

The data is stationary for growth rate at first difference and GDP at second difference, Infrastructure index at first difference and population growth rate is at level. Since all variables are not difference at first difference means that there is no long term relationship between the variables the Henceforth co-integration test is not required. Further the Hausman test is used to know the fixed effect and random effect. It supports for the fixed effect over the random model for the estimation.

4.2. Fixed Effect Model:

Fixed effect model which the intercept terms vary over the individual units

$$y_{it=}\ \alpha_i + x'_{it}\beta + \varepsilon_{it},\quad \varepsilon_{it} \sim \text{IID}\ (0, \sigma^2{}_e) \qquad \text{-------------------- (9)}$$

Assumed x_{it} are independent of all ε_{it}

$$y_{it} \ = \ \sum_{j=1}^{N} \alpha_j d_{ij} + X'_{it}\beta + \varepsilon_{it} \qquad \text{--------------------------- (10)}$$

Where dij = 1 if i = j and 0 elsewhere. It includes dummy variables to the model. The estimator of β is called as the least squares dummy variable (LSDV) estimator.

$$y_{it} - \bar{y}_i = (\ x_{it} - \bar{x}_i)'\beta + (\varepsilon_{it} - \bar{\varepsilon}_i). \quad \text{------------------------ (11)}$$

This model in deviation from individual means and does not include the individual effects αi. The transformation the deviation from individual means is called within transformation. The β obtained from transformed model is called within estimator or fixed effects estimator.

$$\beta_{FE} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_i)\,(x_{it}-\bar{x}_i)\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_i)(y_{it}-\bar{y}_i) \text{ --------- (12)}$$

It is assumed that all x_{it} are independent of ε_{it}. Fixed effects are consistent only if ε_{it} is normally distributed. Thus β_{FE} is consistent only if the following condition holds

$$E\{(x_{it}-\bar{x}_i)\varepsilon_{it}\} = 0 \qquad \text{--------------------------- (13)}$$

$$E(x_{it}\varepsilon_{it}) = 0 \qquad \text{---------------------------- (14)}$$

Thus xit is strictly homogeneous that is does not depend on the values of the error term.

4.3. Generalized Methods of Moments:

We use Dynamic panel models with a lagged dependent variable and exogenous variable.

$$y_{it} = x'_{it}\beta + \Upsilon y_{i,t-1} + \alpha_i + \varepsilon_{it} \text{------------------------ (15)}$$

In panel data model, we choose the model based on fixed effects and random effects but in case of dynamic panel data model is different because y_{it-1}will depend on α_i

Fixed effects estimator γ for period t = 1….T

$$\hat{\gamma}_{FE} = \frac{\sum_{i=1}^{N}\sum_{t=1}^{T}(y_{it}-\bar{y}_i)\left(y_{i,t-1}-\bar{y}_{i,-1}\right)}{\sum_{i=1}^{N}\sum_{t=1}^{T}\left(y_{i,t-1}-\bar{y}_{i,-1}\right)^2} \qquad \text{--------------------------- (16)}$$

The estimator is biased and inconsistent for N → ∞ and fixed T. Above equations the expectation is not zero as it tends to infinity, the transformed lagged dependent variable is correlated with the within transformed error. If T → ∞ the above equation converges to zero and the resultant is consistent estimator.

The problem of inconsistency can be solved by eliminating the individual effects α_i, we take first differences.

$$y_{it} - y_{i,t-1} = \gamma(y_{i,t-1} - y_{i,t-2}) + (\varepsilon_{it} - \varepsilon_{i,t-1}), \qquad t = 2, \dots, T \quad \text{-------} \ (17)$$

We need instrumental variable estimator since $y_{i,t-2}$ is correlated with $y_{i,t-1} - y_{i,t-2}$ but not with $\varepsilon_{i,t-1}$

$$\hat{\gamma}_{IV} = \frac{\sum_{i=1}^{N}\sum_{t=2}^{T} y_{i,t-2}(y_{it} - y_{i,t-1})}{\sum_{i=1}^{N}\sum_{t=2}^{T} y_{i,t-2}(y_{i,t-1} - y_{i,t-2})} \quad \text{---------------------------} \ (18)$$

A necessary condition for consistent estimator is

$$plim \frac{1}{N(T-1)} \sum_{i=1}^{N}\sum_{t=2}^{T} (\varepsilon_{it} - \varepsilon_{i,t-1}) y_{i,t-2} = 0 \quad \text{---------------} \ (19)$$

Anderson and Hsiao (1981) proposed an alternative where $y_{i,t-2} - y_{i,t-3}$ is used as instrument

$$\hat{\gamma}_{IV2} = \frac{\sum_{i=1}^{N}\sum_{t=3}^{T} (y_{i,t-2} - y_{i,t-3})(y_{it} - y_{i,t-1})}{\sum_{i=1}^{N}\sum_{t=3}^{T} (y_{i,t-2} - y_{i,t-3})(y_{i,t-1} - y_{i,t-2})} \quad \text{---------------------} \ (20)$$

If consistency

$$plim \frac{1}{N(T-2)} \sum_{i=1}^{N}\sum_{t=3}^{T} (\varepsilon_{it} - \varepsilon_{i,t-1})(y_{i,t-2} - y_{i,t-3}) = 0 \quad \text{---------} \ (21)$$

Imposing more number of moments can increase the consistency and the efficiency of the estimator. List of instrumental variables and exploring more numbers of moments and should be varying with the time period (t) was suggested by Arellano and Bond (1991).

Vectors of error terms

$$\Delta\varepsilon_i = \{\varepsilon_{i2} - \varepsilon_{i1} \dots \varepsilon_{i,T} - \varepsilon_{i,T-1}\} \quad \text{-----------------------} \ (22)$$

And matrix of instruments is

$$Z_i = \begin{Bmatrix} [y_{io}] & 0 & 0 \\ 0 & [y_{io}, y_{i1}] & 0 \\ 0 & 0 & [y_{io} \dots, y_{i,T-2}] \end{Bmatrix} \quad \text{------------------} \ (23)$$

All moment conditions can be written as

$$E(Zi'\Delta\varepsilon i) = 0 \quad \text{--------------------------} \ (24)$$

GMM estimator

$$\hat{\gamma}_{GMM} = \left(\left(\sum_{i=1}^{N} \Delta y'_{i,-1} Z_i\right) W_N \left(\sum_{i=1}^{N} Z'_i \Delta y_{i,-1}\right)\right)^{-1} * \left(\sum_{i=1}^{N} \Delta y'_{i,-1} Z_i\right) W_N \left(\sum_{i=1}^{N} Z'_i \Delta y_i\right) \text{------------ (25)}$$

W_N is the weighting matrix which is positive definite and known as identity matrix. The consistency of $\hat{\gamma}_{GMM}$ depends on the optimal weighting matrix which gives smallest asymptotic covariance matrix for $\hat{\gamma}_{GMM.}$ The optimal weighting matrix is proportional to the inverse of covariance matrix of sample moments. Thus the GMM estimator are consistent when T is small than the fixed estimator (Roodman 2007).

5. RESULTS:

The variables included in the analysis are earlier used in Nagaraj, Varondakis and Veganzones (1998) studies for the convergence across the states in India. We have constructed a composite infrastructure index including the variables for transportation, electricity, irrigation intensity, Bank offices, and health and education infrastructure. Present study has highlighted the availability of infrastructural facilities over the post-liberalization period from 1990-91 to 2010-11 shown in figures 1 to 5. The newly formed states Uttarakhand, Chhattisgarh and Jharkhand which are formed in year 2000 are included in their parent state as the data was not available. The Maps below represents the disparity among the states and union territories. These maps are constructed using QGIS software. The darker portion indicates the higher infrastructure facilities and vice-versa.

Figure 1: Infrastructure Index Status (1990-91)

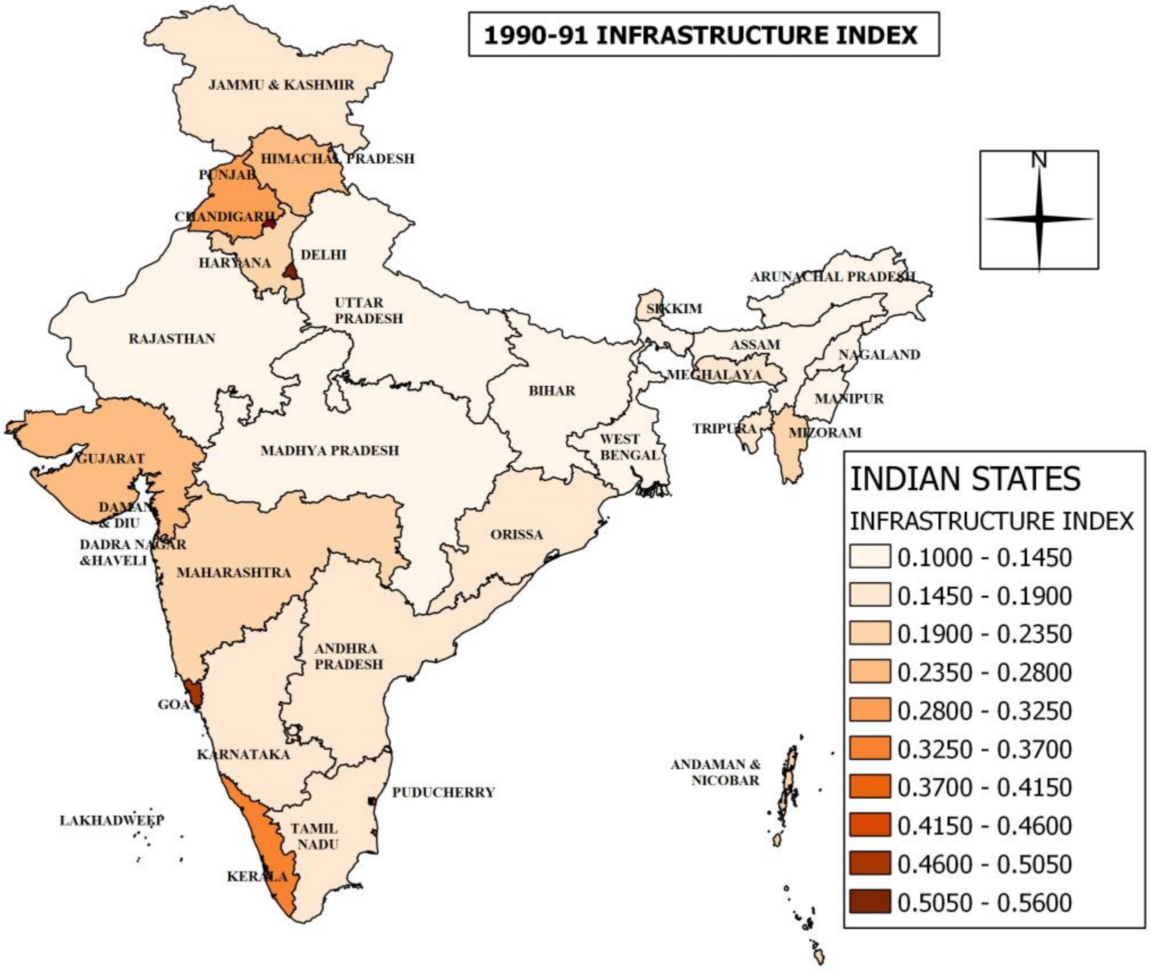


Figure 2: Infrastructure Index Status (1995-96)

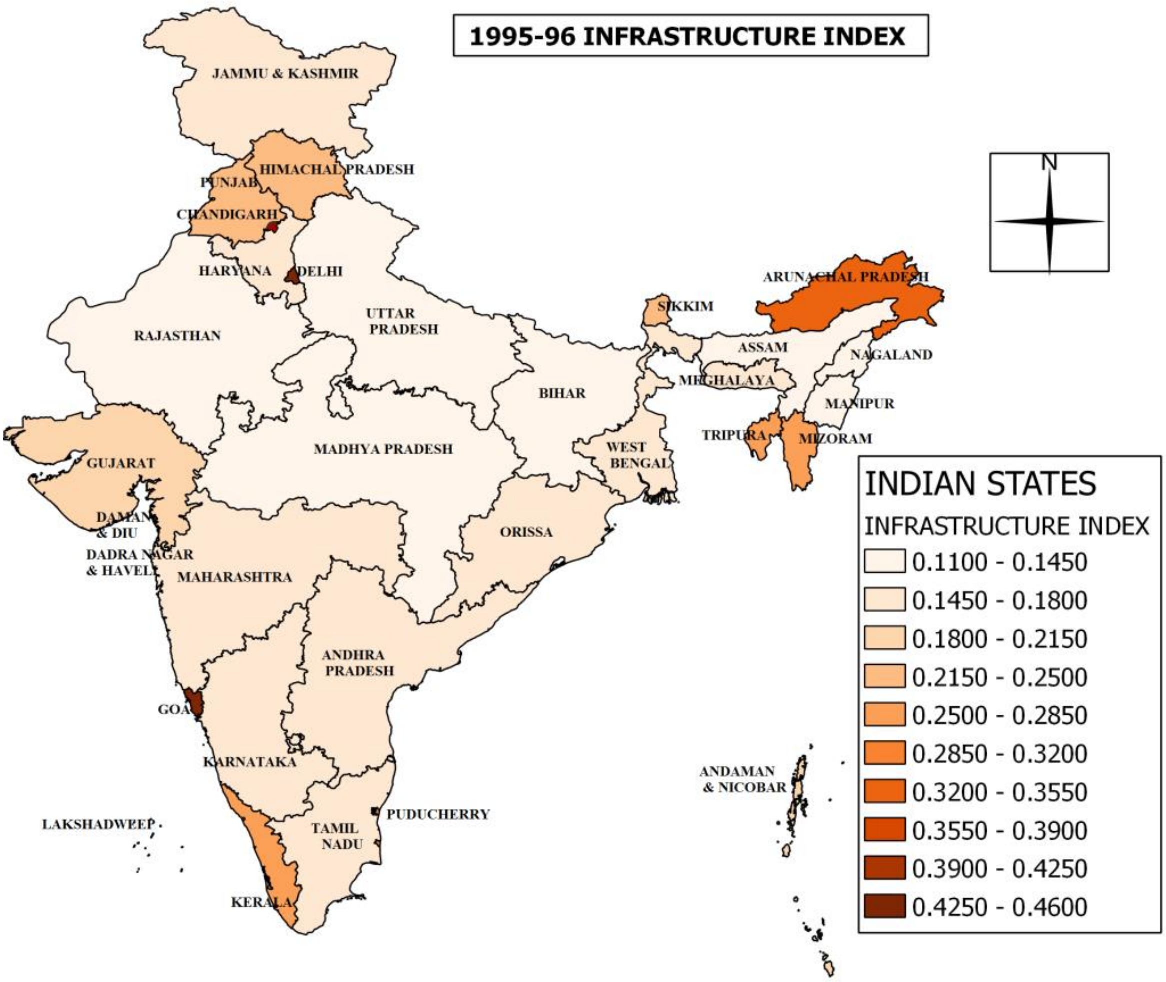


Figure 3: Infrastructure Index Status (2000-01)

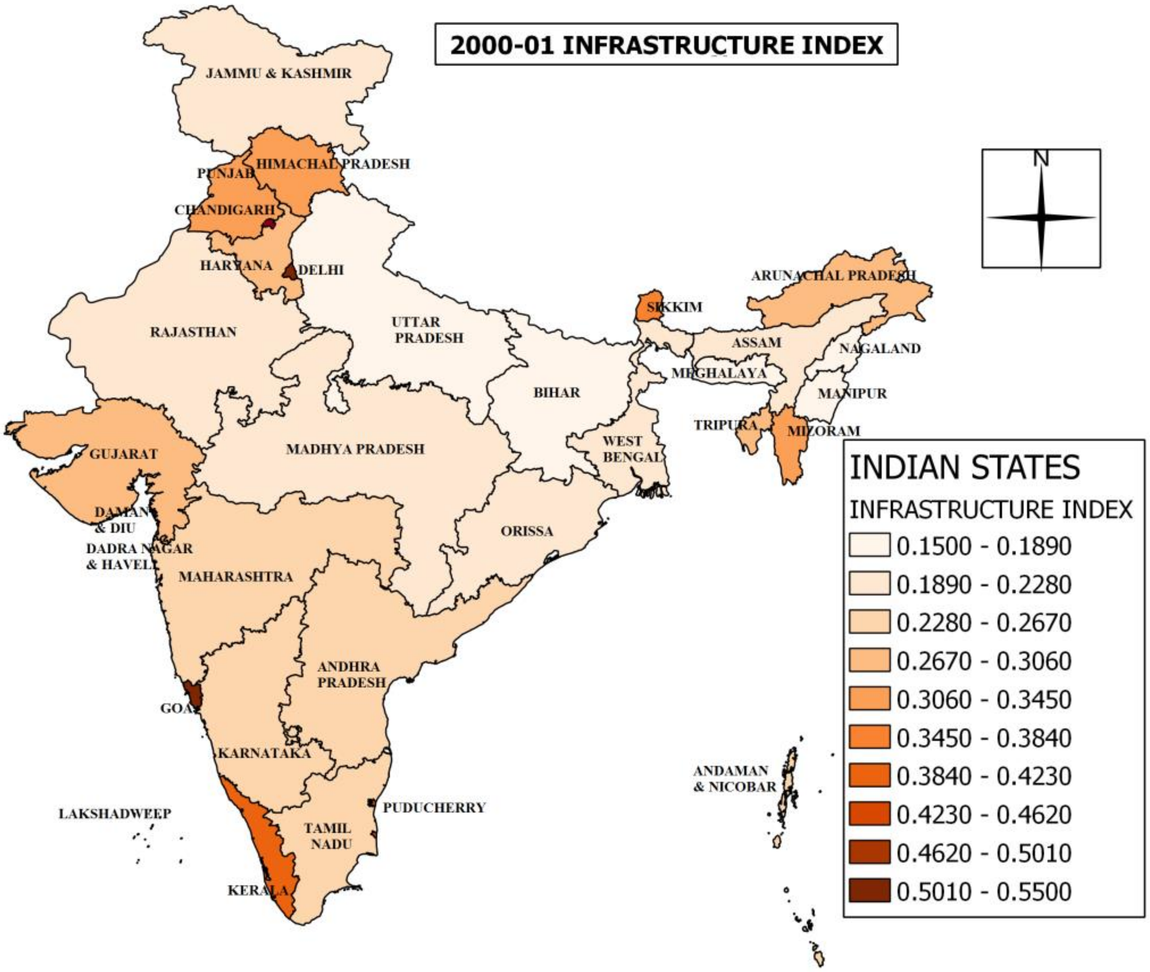


Figure 4: Infrastructure Index Status (2005-06)

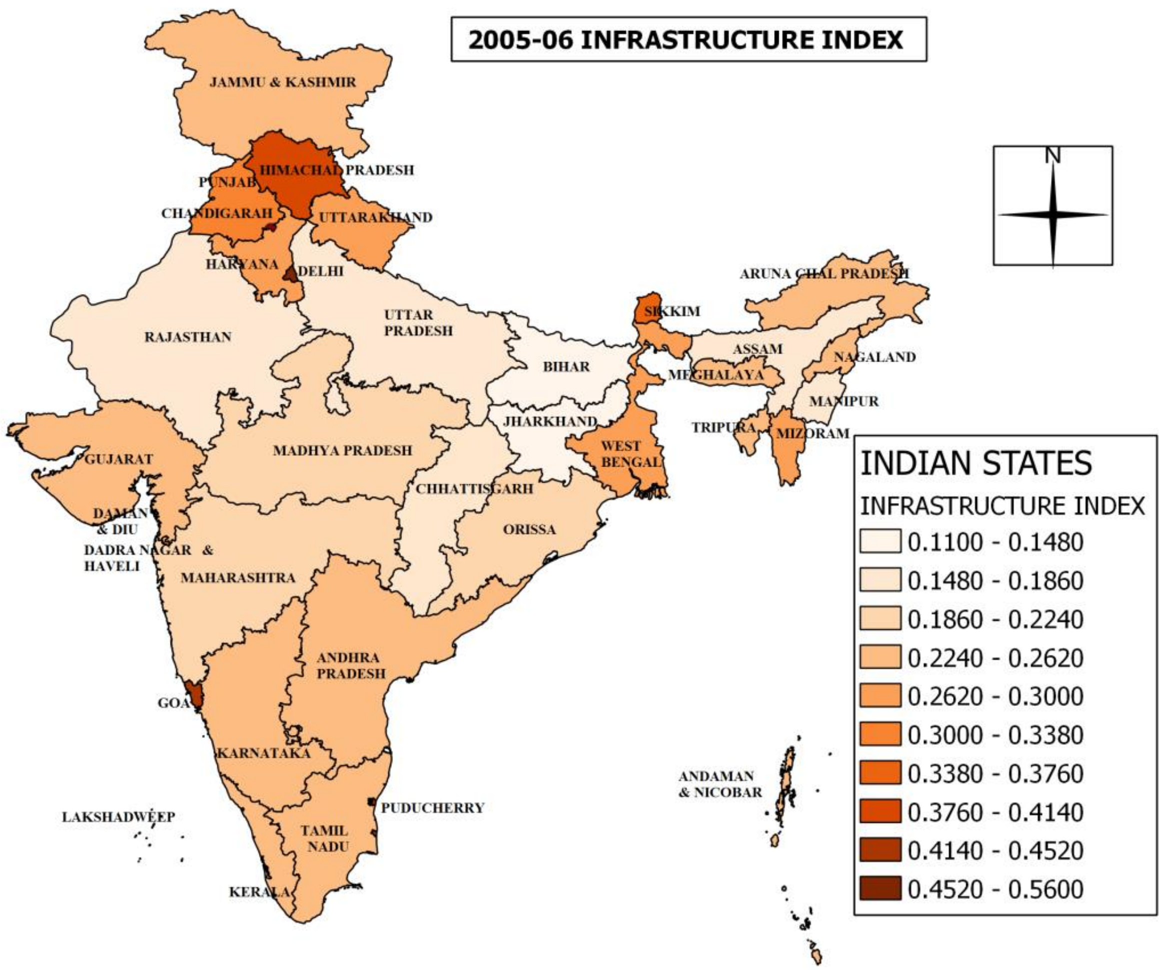
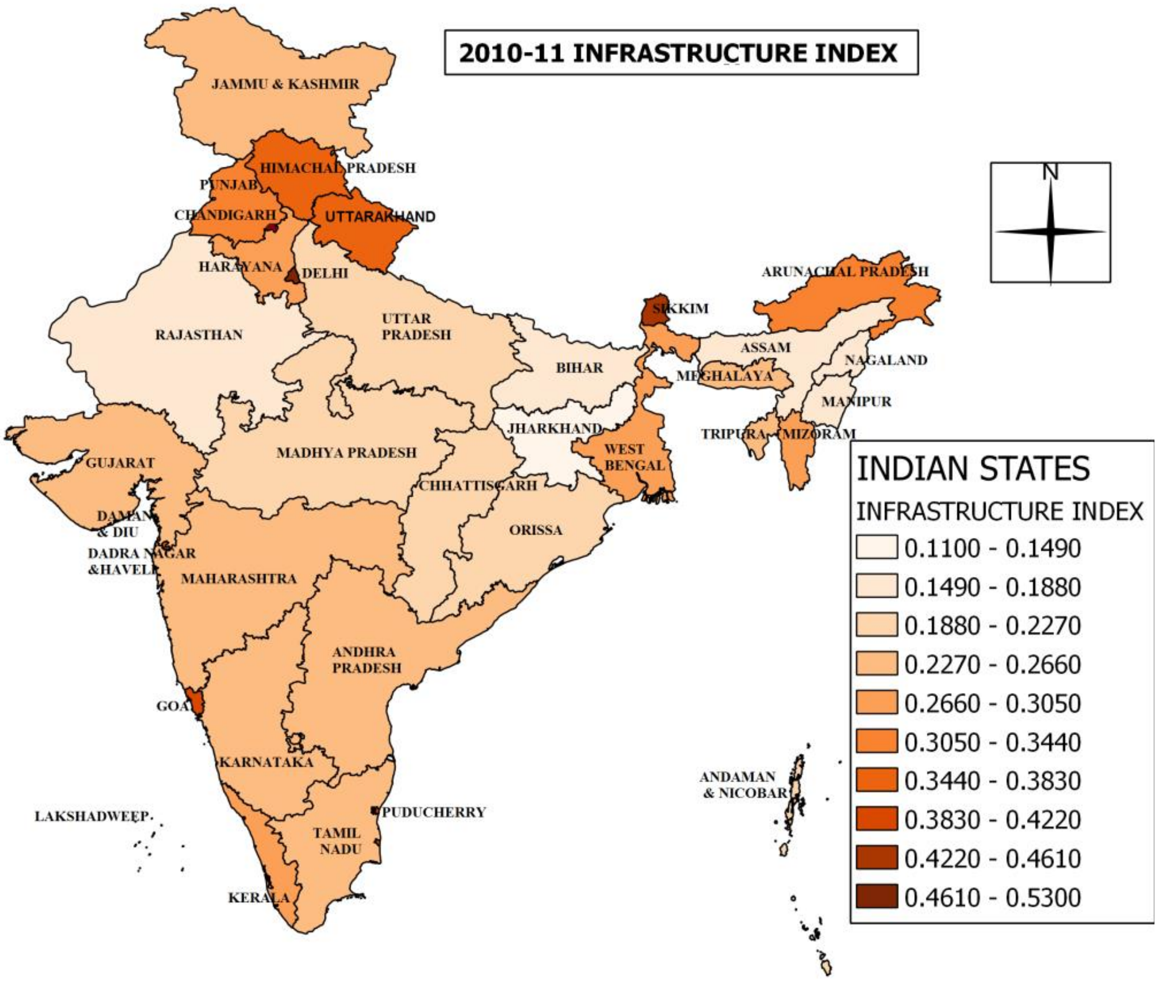


Figure 5: Infrastructure Index Status (2010-11)



The situation has changed over the periods from post liberalization period. Chandigarh, Delhi, Goa, Puducherry, Punjab, Haryana, Himachal Pradesh and Kerala have contributed to the higher infrastructure index. Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, Jammu and Kashmir and West Bengal have medium infrastructure index. Among the seven sisters Arunachal Pradesh, Meghalaya, Tripura and Mizoram are better in infrastructure index than Assam, Nagaland and Manipur. BIMARU states and Orissa have low infrastructure index. Among the BIMARU states Madhya Pradesh, Chhattisgarh and Uttar Pradesh are better than the Bihar, Jharkhand and Rajasthan.

Among all Indian states and union territories Chandigarh is the highest and Jharkhand is the lowest in terms of infrastructural facilities.

The panel data set is used for the analysis as it has more advantages over the cross section and time series data. The Country, State, regions are heterogeneous Thus the panel data allows for each Individual and at various time periods can be taken consider for the analysis. Panel data model has both have fixed effects and random effects. Random effects are correlated with other explanatory variables and are biased. We conducted Hausman test which supports for fixed effect. Panel data regression for fixed effect (model 1) and generalized methods of moments (model 2) are summarized in tables 4 and 5.

Table 4: Fixed effect (model 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GR(-1)	0.1772	0.0278	6.3759	0.0000***
IGDP	-0.0004	0.0001	-2.9438	0.0034**
INFRA	0.3579	0.1335	2.6818	0.0076**
POPGR	0.1121	0.1549	0.7237	0.4697
R-squared	0.245999	--	--	--
Adjusted R-squared	0.165091	--	--	--
F-statistic	3.040454	--	--	--
Prob (F-statistic)	0.000000	--	--	--

Note: *** Significant at one percent level. ** Significant at five percent level. * Significant at ten percent level.

Table 5: Generalized Methods of Moments (model 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GR(-1)	0.1536	0.0165	9.3095	0.0000***
IGDP	-0.0006	0.0002	-2.9956	0.0029**
INFRA	0.3618	0.0372	9.7378	0.0000***
POPGR	0.2360	0.632	0.3733	0.7091
J-statistic	22.39263	--	--	--
Prob (J-statistic)	0.496667	--	--	--
Instrument rank	27	--	--	--

Note: Cross-section fixed (first differences), White period instrument weighting matrix, White period standard errors and covariance (d. f. corrected).
*** Significant at one percent level. ** Significant at five percent level. * Significant at ten percent level.

Growth rate is regressed on lagged growth, initial level of per capita GDP, and infrastructure index and population growth rate. In both the models the lagged growth rate is statistically significant at one percent level. The convergence holds if there exists a negative relation between the current period growth and initial value of per capita GDP *i.e*. (β<1). The (IGDP) initial level of per capita GDP is negative and statistically significant at five percent level. The coefficient value of initial level of per capita GDP is 0.4 percent and 0.6 percent in model 1 and model 2. Thus, in both the models there is a clear evidence of conditional convergence (β-convergence). The infrastructure index (INFRA) in both the models is positive and statistically significant at five percent in model 1 and at one percent in model 2. The increase in Infrastructure index by one percent will increase the growth rate by 35 percent in model 1 and 36 percent in model 2. The population growth rate is insignificant in both the models. The R square is low because the explanatory variables are less. The F-statistic value is statistically significant which predicts the overall reliability of the model. The generalized methods of moments are the more consistent than the OlS and LSDV estimators Ding, Haynes, Liu (2008). In GMM, the J-statistic is to know the model is over identified as the instruments are more than the parameters. Both the model shows the evidence of conditional convergence. In GMM estimator the convergence rate is slightly higher than the fixed effect model.

Convergence rate are similar to Datta and Agrawal (2004) studies with the telecommunication infrastructure.

It indicates that the States and UT would eventually converge to their individual steady state. The BIMARU states are poorer in terms of availability of infrastructure similar conclusions by Nauriyal and Sahoo (2010) studies. The poor states which are poorer in terms of infrastructure can achieve the steady state by investing more in the physical and social infrastructure. Since infrastructure has a positive relationship with the growth and development of the region there is a need to boost infrastructure investment in the lagged states to enhance the employment opportunities and growth activities. The mobility of capital in the form of infrastructure will lead to more trade activities in the region by reducing the transportation cost. Evidence of conditional convergence with infrastructure will help the poorer states to grow more rapidly as the mobility of capital and labor would flow from rich states to the poor states in form of investment in building up the infrastructure will enhance the construction activities and will further lead to migration of labor and more employment opportunities. Thus the poor states will tend to grow faster than the richer states. Further adequate amount of infrastructure will bring in the more growth activities in agriculture, industries and service sector. The investment in physical, financial and social infrastructure would not only enhance the employment opportunities but would also enhance the development aspect by investment in health and educational sector which will lead to better health and skilled laborers. Thus investment in infrastructure in poorer states can reduce the disparity and will eventually lead to the steady state in the Indian economy.

6. CONCLUSION:

We have analyzed the neoclassical framework of augmented Solow model for the steady state equilibrium for the Indian economy. Neoclassical model assumption of factor substitution and diminishing returns to capital establish a model of convergence to the steady state equilibrium as the poor economies tend to grow more than the rich economies. The rich countries would invest more in the poor economies and will tend to boost the growth in the poor economies. The economies would not converge to same steady state lead to the development by Barro and Sala-i- martin idea of β convergence (conditional convergence). We have augmented the model using the infrastructure index as the technical progress in the production function to analyze the conditional convergence among the states and union territories of India. The infrastructure index includes physical, financial and social infrastructure. The Dynamic Panel data is estimated using the fixed effect model and Generalized Methods of moments for the estimation for the period of 1990-91 to 2010-11. The dynamic panel data models are more consistent and efficient estimator with the Generalized Methods of Moments than the ordinary least squares.

From the view of policy implication, it is crucial to identify the factors determining the growth models. Infrastructure acts as a catalyst of regional growth and development. The study points the disparity in terms of availability of infrastructure facilities. The BIMARU states are poor in terms of infrastructure facilities. Bringing in more infrastructure investment in this region can increase the construction activities will increase the demand for industrial products like steel, cement *etc*. and will increase the employment of laborers. This expansion activity will enhance the growth and development of poor states from the rich states. Thus poor states will grow at much faster than the rich states. There is a need to identify the poor states so that policy makers will try to pump in the investment in infrastructure projects in lagged states.

The Barro and Sala-i-Martin version of the beta convergence holds for the Indian states and Union territories a clear evidence of conditional convergence. Infrastructure index has the positive externalities to growth and is statistically significant. There exists huge disparity in terms of infrastructural facilities among the Indian states and union territories. The poor states are likely to converge with the help of more investment in infrastructure will increase the mobility of capital and labor. Such investment in infrastructure will increase the economic activity in the poor states and thus will help them to achieve steady state equilibrium faster.

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APPENDIX

Table A1: Unit Root

Variables	Unit Root Test		
GR	Method	Statistic	Prob.**
	Null: Unit root (assumes common unit root process)		
	Levin, Lin and Chu t*	-4.94254	0.0000
	Breitung t-stat	-4.83298	0.0000
	Null: Unit root (assumes individual unit root process)		
	Im, Pesaran and Shin W-stat	-7.51399	0.0000
	ADF - Fisher Chi-square	152.395	0.0000
	PP - Fisher Chi-square	657.285	0.0000
d(GR(-1))	Method	Statistic	Prob.**
	Null: Unit root (assumes common unit root process)		
	Levin, Lin and Chu t*	-2.78297	0.0027
	Breitung t-stat	-2.25063	0.0122
	Null: Unit root (assumes individual unit root process)		
	Im, Pesaran and Shin W-stat	-6.18240	0.0000
	ADF - Fisher Chi-square	130.809	0.0000
	PP - Fisher Chi-square	336.745	0.0000
dd(IGDP)	Method	Statistic	Prob.**
	Null: Unit root (assumes common unit root process)		
	Levin, Lin and Chu t*	-2.43071	0.0075
	Breitung t-stat	-2.97638	0.0015
	Null: Unit root (assumes individual unit root process)		
	Im, Pesaran and Shin W-stat	-6.30691	0.0000
	ADF - Fisher Chi-square	132.813	0.0000
	PP - Fisher Chi-square	336.359	0.0000
d(INFRA)	Method	Statistic	Prob.**
	Null: Unit root (assumes common unit root process)		
	Levin, Lin and Chu t*	-6.33158	0.0000
	Breitung t-stat	-12.9025	0.0000
	Null: Unit root (assumes individual unit root process)		
	Im, Pesaran and Shin W-stat	-8.41334	0.0000
	ADF - Fisher Chi-square	166.355	0.0000
	PP - Fisher Chi-square	464.287	0.0000
POPGR	Method	Statistic	Prob.**
	Null: Unit root (assumes common unit root process)		
	Levin, Lin and Chu t*	-73.8253	0.0000
	Breitung t-stat	-2.27480	0.0115
	Null: Unit root (assumes individual unit root process)		
	Im, Pesaran and Shin W-stat	-32.6659	0.0000
	ADF - Fisher Chi-square	203.046	0.0000
	PP - Fisher Chi-square	158.124	0.0000

***Note*:** Individual effects and individual linear trends. Newey-west automatic bandwidth selection and Barttlet kernel balanced observation for each test.

Table A2: Hausman Test

Cross-section and period random effects test comparisons:

Variable	Fixed	Random	Var (Diff.)	Prob.
DIGR	0.177230	0.177572	0.000056	0.9635
DDIGDP	-0.000424	-0.000381	0.000000	0.2923
DINFRA	0.357947	0.175784	0.009426	0.0606
POPGR	0.112093	0.103758	0.003668	0.8905

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