Working Paper 337

The Impact of Infrastructure Provisioning on Inequality: Evidence from India

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ISBN 978-81-7791-193-0

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THE IMPACT OF INFRASTRUCTURE PROVISIONING ON INEQUALITY: EVIDENCE FROM INDIA

Sumedha Bajar and Meenakshi Rajeev*

Abstract

India witnessed high levels of growth in the last decade but national levels of poverty and inequality remain high. Infrastructure provision is seen as a particularly important instrument for helping in regional development where government can play a significant role due to the public goods nature of infrastructure facilities. Literature confirms the positive association between infrastructure and growth. However, it is not necessary that economic growth attributable to infrastructure development will consequently lead to a reduction in inequality. This paper analyses the links between physical infrastructure and inequality and determines the nature of this relation and focuses on 17 major Indian states. Gini coefficient (for rural and urban sectors combined) was used as the dependent variable and it was computed data on Monthly Per Capita Consumption Expenditure (MPCE), which was estimated from Unit level records of the periodical Household Consumer Expenditure surveys of National Sample Survey Organisation for the years 1983, 1987-88, 1993-94, 2004-05, and 2009-10 (Rounds 38th, 43rd, 50th, 61st and 66th round respectively). The paper shows that the impact of infrastructure on consumption inequality across states differs for the type of infrastructure under consideration and the relation of infrastructure with inequality is not necessarily negative. The results have shown that some components of infrastructure, mainly power and roads, are associated with increased interpersonal inequality at the regional level and the paper provides some explanations for this result. The results of this study do not prescribe abandoning transportation projects or infrastructure development but instead recommend that the government should emphasize also on investments in complementary policies. Infrastructure can help open up opportunities but it should not be that these benefits are reaped by those who are in a position to be able to take advantage of these.

JEL Codes: H41, D63, O1, O2
Keywords: Physical Infrastructure, Regional Inequality, India

Introduction

There has been evidence at both macroeconomic and microeconomic levels that infrastructure development helps improve productivity and growth[1]. Concurrently, by way of working through these channels infrastructure may also play a role in reducing inequality in an economy as shown in Calderon and Serven (2004 and 2008), Lopez (2003) amongst others. But the nature of the relationship between growth, inequality and infrastructure is not clearly defined. To begin with, the association between infrastructure and growth has been well established with the general agreement being that the two are positively related. However, it may be wrong to believe that economic growth that may be attributable to infrastructure development should necessarily lead to a reduction in inequality.

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We are thankful to an anonymous referee for valuable comments and suggestions. We are grateful to RBI for its support to ISEC. Usual disclaimer applies.

[1] See Holtz-Eakin 1994, Canning (1999), Calderón and Servén (2003), Hulten and Schwab (2000), Roller and Waverman (2001), Fernald (1999), Demetriades and Mamuneas (2000), Easterly and Serven (2003), Sanchez-Robles (1998) amongst several others. For a detailed review see Romp and de Haan (2007).

Empirical evidence on the second set of relationships, i.e. between infrastructure and inequality is also found to be sparse, inconclusive and largely anecdotal (Chatterjee and Turnovsky, 2012; Calderon and Serven, 2014). It may be that through increasing access to productive opportunities, through reducing production and transaction costs (and thereby leading to industrial or agro-industrial development) and by helping increase the value of assets of the poor, infrastructure can help reduce inequality. Additionally, by providing easier geographic access, through improved transport infrastructure, labour mobility is enhanced which can make the surplus labour to move to places where labour is in short supply. A well-developed communication infrastructure can help ease the information flow and help disadvantaged individuals gain access to productive opportunities by connecting them to core economic activities (Calderon and Serven, 2004; Fan and Zhang, 2004 etc). Literature has also highlighted favourable impact of enhanced availability and quality of not just physical but also social infrastructure development on human capital and hence on productivity level, earning capabilities and welfare of the poor (see Calderon and Serven, 2014 for survey of literature on impact of infrastructure on growth and inequality). However, it may also be the case that infrastructure yields a higher return in richer areas that are already relatively abundant in private capital. This could be due to the complementary relation between infrastructure and private capital and human capital and will result in increasing income inequality. Infrastructural differences as an explanation for polarised economic growth across Indian states have been proved in Bandyopadhyay (2011). Just as there exist literature that found negative relation between infrastructure development and inequality, there exist studies that find the reverse to hold true (Brekman *et al*, 2002; Banerjee, 2004; Khandker *et al*, 2007).

With this background the current paper aims to answer whether there is any link between physical infrastructure and inequality and the nature of the relation between the same for major Indian states and to provide evidence of this relation from India. The scope of this study is limited to an analysis of 17 major Indian states. Gini coefficients are available for 5 time point 1983, 1987-88, 1993-94 and 2004-05 and 2009-10. These particular data points are important as they relate to the time period when the Indian economy underwent significant changes, beginning with the implementation of initial liberalisation policies in early 1980s, followed by wide-ranging reforms in the 1990s. This had a considerable impact on the rate of economic growth and it helped the economy break away from the label of "Hindu rate of growth" to becoming one of the fastest growing countries but how this economic growth impacted inequality has been a topic of debate. Second, this period saw a distinct change in infrastructure policies, for example there was increased focus on introducing private investment into the sector, stress on urban infrastructure development and the telecommunication revolution that occurred in the 1990s brought into fore the importance of development of telecom infrastructure.

The rest of the paper is organised as follows. Section 2 provides a brief review of studies conducted both internationally and nationally concerned with the effects of infrastructure development on the extent of inequality. Section 3 describes the data, coverage and time period selected for this study. Section 4 provides some basic stylised facts and provides an overview of state-level inequalities in monthly per capita expenditure (MPCE) data obtained from the recent five quinquennial rounds of NSSO and state-level infrastructure development. Section 5 presents the quantitative assessment of the

relation between infrastructure and extent of inequality and finally, Section 6 draws together the conclusions.

Review of Literature

This section gives a quick overview of recent literature on the effects of infrastructure on inequality. The analysis of framework varies from time series models of the national economy to panel data based models consisting of countries and states/provinces.

The various channels through which infrastructure can impact inequality and help reduce it have been highlighted in Estache, 2003; Gannon and Liu, 1997; Estache and Fay, 1995; Jacoby, 2000 amongst others. Essentially, infrastructure helps underdeveloped regions and disadvantaged individuals gain access to productive opportunities by helping connect to core economic activities. Reduction in production and transaction costs through access to roads has been a key determinant of income convergence for the poorest regions in Argentina and Brazil (Estache and Fay, 1995).

In addition to the conventional channels through which infrastructure impacts the economy, literature has identified new channels like the impact of infrastructure development in improving human capital which then helps in increased job opportunities and productivity (for details see Brenneman and Kerf, 2002; Agenor and Moreno-Dodson, 2006). By investing in roads, for instance, governments may not only reduce production costs for the private sector and stimulate investment, but also improve education and health outcomes by making it easier for individuals to attend school and seek health care. With their health improving, individuals become not only more productive, but they also tend to study more. In turn, a higher level of education makes individuals more aware of potential risks to their own health and that of their family members. Moreover, investment in infrastructure, by improving health and life expectancy, may reduce uncertainty about longevity and the risk of death, thereby increasing the propensity to save. As a result of these various effects, the impact of infrastructure on income and welfare is compounded.

For China, Fan, Zhang and Zhan (2002) using provincial data for 1970 to 1997 and simultaneous equation model documented the critical role of infrastructure development in raising growth levels and significantly reducing rural poverty and regional inequality. According to them this happened mainly because of the increased opportunity for rural non-farm employment that followed expansion of infrastructure. Recent study by Zheng and Kuroda (2013) on the role of two types of public infrastructure – transportation and knowledge infrastructure - in China's regional inequality, growth and on industrial geography across 286 cities found that an improvement in transportation infrastructure reduced trade cost and increased growth and decreased income gap but at the expense of increasing industrial agglomeration between cities. However, for knowledge infrastructure it was suggested that it increases growth as well as decreases income gap and industrial agglomeration.

Taking into account the impact of both the quantity and quality of infrastructure on distribution of income Calderon and Chong (2004) provide evidence on the negative relation between both quantity and quality of infrastructure and income inequality for time period 1960-97. They made use of cross-country and panel regression (using GMM dynamic methods to minimize endogeneity problems) and various types of infrastructure indices. Calderón and Servén (2005) in their study delved into both

growth and the inequality aspects of infrastructure investment by providing an empirical evaluation of the impact of infrastructure development on economic growth and income distribution, using a large panel data set covering more than 100 countries and spanning 40 years (1960-2000). They concluded that availability and quality of infrastructure services for the poor in developing countries had a significant positive impact on their health and/or education and, hence, on income and welfare. Seneviratne and Sun (2013) studied the income distribution and infrastructure links for ASEAN-5 countries. They ran a set of pooled OLS regressions covering 76 advanced and emerging market economies for time period 1980-2010 and found that better infrastructure improved income distribution but the same could not be said for investment in infrastructure. The study suggests that infrastructure development can have double effects on poverty reduction and inclusive growth. For the ASEAN-5 countries, benefits of growth could be shared more evenly by removing infrastructure gaps. But literature on this topic has not been unanimous in support of infrastructure development leading to a reduction in inequality. In the study by Brakman *et al* (2002) it was found that government spending on infrastructure has increased regional disparities within Europe. In a similar vein, for India, Banerjee (2004) and Banerjee and Somanathan (2007) have studied the impact of access to infrastructure services on distribution of income and they report that the two are positively related, i.e., the benefits of infrastructure services have accrued mostly to the higher income groups as opposed to benefitting the poor. The study by Khandker and Koolwal (2007) found a limited distributional impact of building paved roads on income in rural Bangladesh

The paper by Raychaudhari and De (2010) made an attempt to understand the interlinkages among infrastructure, trade openness and income inequality using a panel data of 14 Asia-pacific countries spanning the period 1975 to 2006 and concluded that trade openness and infrastructure influence income inequality but the reverse is not necessarily true. Also, the effect of infrastructure development on trade is not found to be significant.

In India, a number of studies based on National Sample Survey (NSS) estimates of household consumption expenditure reveal mixed evidence on aggregate and regional trends. According to Bhalla (2003) both urban and rural Gini coefficients declined between 1993-94 and 1999-00. State-wide Gini coefficients were published by Government of India National Human Development Report (2001) for the years 1983, 1993-94 and 1999-2000. Amongst the 32 states and union territories seven states experienced an increase in rural inequality and fifteen states experienced an increase in urban inequality (Pal and Ghosh, 2007). Although, there have been many studies on this issue (Jha, 2004; Sen and Himanshu, 2005; Deaton and Dreze, 2002; Banerjee and Piketty, 2001), studies concentrating on the impact of infrastructure on inequality have been scarce.

Ghosh and De (2005) carried out a detailed study on the role of infrastructure on the inter-state inequality in India for the period 1970-71 to 1999-2000. They regressed the real per capita State GDP on several social, financial and physical infrastructure variables and found that inter-state disparity in per capita net State domestic product, physical, social and financial infrastructure facilities among Indian States has been rising significantly during the past 25 years; and physical and social infrastructure facilities have proved to be highly significant factors in determining the inter-state level of development. Study by Majumder (2012) looks at the impact of infrastructure on poverty and

inequality using data from the NSS rounds of 1993-94 and 2004-05. The results from his study point that there has been increasing inequality along with physical infrastructural and expansion of regional infrastructural facilities enhances average consumption level of the people and reduces the proportion of people living below poverty line. But his study did not take into consideration the impact of telecommunication infrastructure.

Empirical investigation of impact of infrastructure on inequality (consumption) as measured by Gini coefficient calculated using the MPCE data provided by NSSO at state level in a panel data framework was hard to find. For this paper, estimation of relationship with inequality, information from NSS surveys conducted in 1983, 1987-88, 1993-94, 2004-05 and 2009-10 has been utilised.

Most of the existing studies on India make use of infrastructure indices as an aggregate measure of infrastructure development. But in doing so, the impact of individual infrastructure sectors is masked. This paper proposes to gauge the impact of individual infrastructure and not just an aggregate index.

Data and Methodology

India is a union of 28 states and 7 union territories but the analysis in this paper is confined to 17 major states -Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. These 17 states account for about 90 percent of national net domestic product, 92 percent of national gross fixed capital formation (GFCF) and 93.5 percent of total labor force in 2009-10 and are therefore representative.

For testing the impact of infrastructure development on inequality in India, Gini coefficient has been used as dependent variable. Gini coefficient has been computed state-wise using the data on Real Monthly Per Capita Consumption Expenditure (MPCE) which have been estimated from Unit level records of the periodical Household Consumer Expenditure surveys of National Sample Survey Organisation for the years 1983, 1987-88, 1993-94 and 2004-05 and 2009-10 (Rounds 38th, 43rd, 50th, 61st and 66th round respectively). Gini coefficients were computed at an aggregate level for both rural and urban combined. The real MPCE is obtained after deflating with Consumer Price Index for Agricultural Labourers (CPIAL) for rural areas, and deflated using Consumer Price Index for Industrial Workers (CPIW) for urban areas. However, while using NSS surveys to analyse inequality there are certain limitations (see Jayadev et al. 2007) that need to be mentioned here. The NSS survey design is such that there is under representation/ undervaluation of the rich/wealthy and this may result in underestimation of inequality. This has to be kept in mind while interpreting the results. Due to lack of any other data we operate under the presumption that the degree of underrepresentation is same across the major states.

For the purpose of this paper data series for PCNSDP in 2004-05 constant prices was used for the states under review. This data was obtained from Central Statistical Organisation (under MOSPI, Government of India) website. Data for Electricity consumption (kWh per capita), Surfaced road density (km of surfaced road per 1000 sq. km of geographical area), Rail density (km of rail length per 1000 sq km of geographical area), Teledensity (per 10,000 people), infant mortality rate and gross enrolment

ratio was compiled from Statistical Abstract of India, CMIE database on infrastructure and respective Ministries of the Government.

These three decades are characterised by stark differences in terms of the infrastructure development policies shaped in large part by the changing political priorities of governments in each decade (Lall and Rastogi, 2007). Beginning of 1980s, following the second oil crisis, concentration was mainly on rural India and the Sixth Five Year Plan (FYP) was characterised by massive public investment in sectors like rural roads, ground water irrigation and a system of procurement prices. Rural electrification did not mean electrification of rural households but grid extensions were provided to farms to meet the demand for irrigation. There was great politicization of fiscal policy and was characterised by fiscal profligacy. The entry of Rajiv Gandhi in 1984 is characterised by two noteworthy features with respect to infrastructure development. The development of telecommunication sector acquired a position of significance and large amounts of investments were made for the same. The Centre for Development of Telematics was established in 1987 and it set the stage growth of Indian IT industry during the 1990s. Secondly, the build out of infrastructure for ground water irrigation and electricity supply for irrigation purposes continued, however, the financial situation of State Electricity Boards deteriorated and there appeared chronic shortages of power for commercial and urban use. The development of critical transportation and urban infrastructure continued to be neglected.

During the post-1991 period, the emphasis was on fiscal consolidation and investment in infrastructure became a major casualty when the aim of central government was to reduce fiscal deficit from 8.4 per cent of GDP in 1990-91 to 5 per cent 1992-93. Although, the decline in infrastructure spending and putting on hold almost all infrastructure projects should have impacted the GDP growth adversely but marked improvement in targeting of infrastructure spending and telecom-related reforms had an impact on productivity. Until 1994 Telecom was a government monopoly. National Telecom Policy (1994) helped liberalize the sector and recognise the importance of telecom sector as an important component of infrastructure. The second half of 1990s saw an upsurge in recognition of the shortages in infrastructure that were appearing. *India Infrastructure Report* (NCAER 1995), was the first of its kind and many of the recommendations in it found their way into government policy. *World Development Report* (World Bank, 1994) brought to the attention of policymakers the initiatives followed globally to induce greater private sector participation in infrastructure development which would later become part of many of the policies crafted by Indian policymakers. With the Ninth Five Year Plan FYP debate over private sector participation entering into infrastructure sector was initiated and steps taken to encourage the same and there was an emergence of a strategic focus on infrastructure policy. It also emphasised the disproportionate reliance on congested national highways compared to railways.

The decade of 2000s saw the policy suggestions and initiatives take shape. There was targeted spending on national highways network and build-out of Golden Quadrilateral and related North-South and East-West road corridors under the tenth FYP. Policies to create enabling conditions for the private sector financing of infrastructural projects were initiated (such as Viability Gap Funding etc.). With the Electricity Act of 2003 policy framework was brought to draw private investment in the sector. A Committee on Infrastructure was set up in 2004 in order to induce private investment in infrastructure

and to draw out plans for public private partnerships. Eleventh FYP envisaged stepping up the gross capital formation in infrastructure from 5 per cent to 9 per cent of GDP. Despite the emphasis placed on PPP by plan documents, the response of private sector has been lukewarm. Several reasons have been highlighted such as overlapping regulatory jurisdiction, improper design, bidding transparency issues, project costs and time overruns etc.

Thus, it can be gauged that each of the three decades of 1980s, 1990s and 2000s were characterised by different policy focus, infrastructure policies pursued and development of various infrastructure sectors.

Basic Stylized Facts

Much has been said in the existing literature about regional inequalities across states in India. In 1980-81, an average citizen of Punjab was four times richer than the average citizen of Bihar. The situation has not changed much since then. In 2009-10 the per capita income level in Bihar (the poorest state in India) was still one fourth of that of Maharashtra (the richest state) and one third of that of Punjab. Maharashtra which had 8 per cent of total national population contributed 16 per cent of the aggregate net state domestic product (NSDP) in 2009-10, while Bihar with more than 10 per cent of population contributed only 4.5 per cent of the aggregate NSDP. The share of India's population living with per capita NDP less than half the aggregate per capita NDP for India has increased marginally from 10.2 per cent in the 1980s to 10.7 per cent in the 2000s (assuming all households within a state have equal absolute income).

In the pre reform period, it was states like AP, Rajasthan, Tamil Nadu, Haryana, Punjab, Karnataka that were doing well but in the post reform period almost all states have succeeded in increasing their rates of growth and this pattern is especially remarkable for states like Maharashtra, Tamil Nadu, Bihar, Gujarat. Paradoxically, when we look at the Gini coefficients, that have been calculated using monthly per capita consumption expenditure, and attempt to discern the pattern in temporal behaviour of inequality and compare it with the cross state temporal behaviour of the growth rates of per capita NSDP we find a decreasing trend in interpersonal inequality during the period 1983 to 1993-94 for most states and disturbingly, an increasing trend is observed during the period 1993-94 to 2004-05 which continues till 2009-10 although to a lesser extent. All the states experienced an increase in inequality in varying degrees in the post reform period with states like Maharashtra, Kerala, Tamil Nadu, Karnataka, West Bengal, and Punjab having the highest figures of Gini inequality.

In order to see the relation between inequality and per capita NSDP, scatter plots are presented in Figures 1 which shows the relation between Gini and PCNSDP for 1983, 1987, 1993, 2004 and 2009 (these have been estimated by the author as well as cross checked with Motiram and Vakulabharanam, 2011). We can see that from the 1990s onwards a positive relationship appears between income (PCNSDP) and inequality i.e. states that had higher per capita NSDP were also the ones that had higher inequality.

As an instrument through which inequality can be reduced, infrastructure development in the country has taken prominence especially in the recent decades. During the pre-reform period, infrastructure development was undertaken in a manner that involved removing specific bottlenecks

which had started cutting into the growth process. However, in India there is a need for forward looking approach in which infrastructure is built ahead of demand. In what follows we take a look at the pattern in which infrastructure development has taken place across states in India. The major infrastructure variables used for this study are per capita electricity consumption (KwH), Road density (km of surfaced road per 1000 sq. km of geographical area), Rail density (km of rail length per 1000 sq km of geographical area) and Tele-density (per 10000 population). In Table 1 state-wise trend growth rate of PCNSDP and availability of infrastructure variables has been presented. We observe that the initially poor states[2] Bihar, MP, Rajasthan, UP, Orissa and Assam had a very high growth rate for electricity consumption in the 1980s (Table 1ii). This is mainly because of the low base they started off with. The richer states like Punjab, Gujarat, Haryana and Maharashtra had per capita electricity consumption as high as 300 KwH, 224 KwH, 200KwH and 225 KwH, respectively, in 1981 whereas that of Bihar – 54, MP – 88, Rajasthan – 87, Orissa – 95 and UP – 74 KwH was far below the national average[3].

Similarly, road density in these initially poor states was considerably below the national average in all the three decades. In fact, the gap between road density of the rich and the poor states was so high that the average road density of the poor states in 2001-10 was still lower than that of the rich states in 1981-90 (see Table 2i and 2ii). Rail density was high to begin with in Bihar and U.P. as the British left a well-developed railway system in these states. But an increase in rail density in MP, Rajasthan, Orissa and Assam was observed as new rail routes were laid to improve access to reserves of natural resources in these states.

Amongst the rich income states, Haryana, Punjab and Tamil Nadu had the highest PCNSDP growth rates in the decade of 1981-90 and were also the best endowed with infrastructure facilities. Punjab had the highest road density (757 sq km) followed by Tamil Nadu (736 sq km) and Haryana had the fourth highest road density during the period of 1981-90. These states were also found to have the highest per capita electricity consumption, and a significant trend growth rate of more than 5% was registered by them despite the relatively wide base that already existed (See Table 1i).

The other two rich income states, Maharashtra and Gujarat also had higher infrastructure availability in the beginning of the period under consideration (1980-81) and they continued to build upon it with electricity consumption growing at 7.4% in Gujarat and 7% in Maharashtra between time period 1981-90, and the consumption kept growing at the rate of 4 to 5% even during 1990s and 2000s. These states also succeeded in building up their road-infrastructure with the highest trend growth in road density reported during the 1980s and by 2010 road density of Maharashtra (1091 sq km) and Gujarat (719 sq km) was fairly high but was still below that of Kerala (state with highest road density of 2839 per 1000 sq km in 2010), Punjab, West Bengal and Tamil Nadu.

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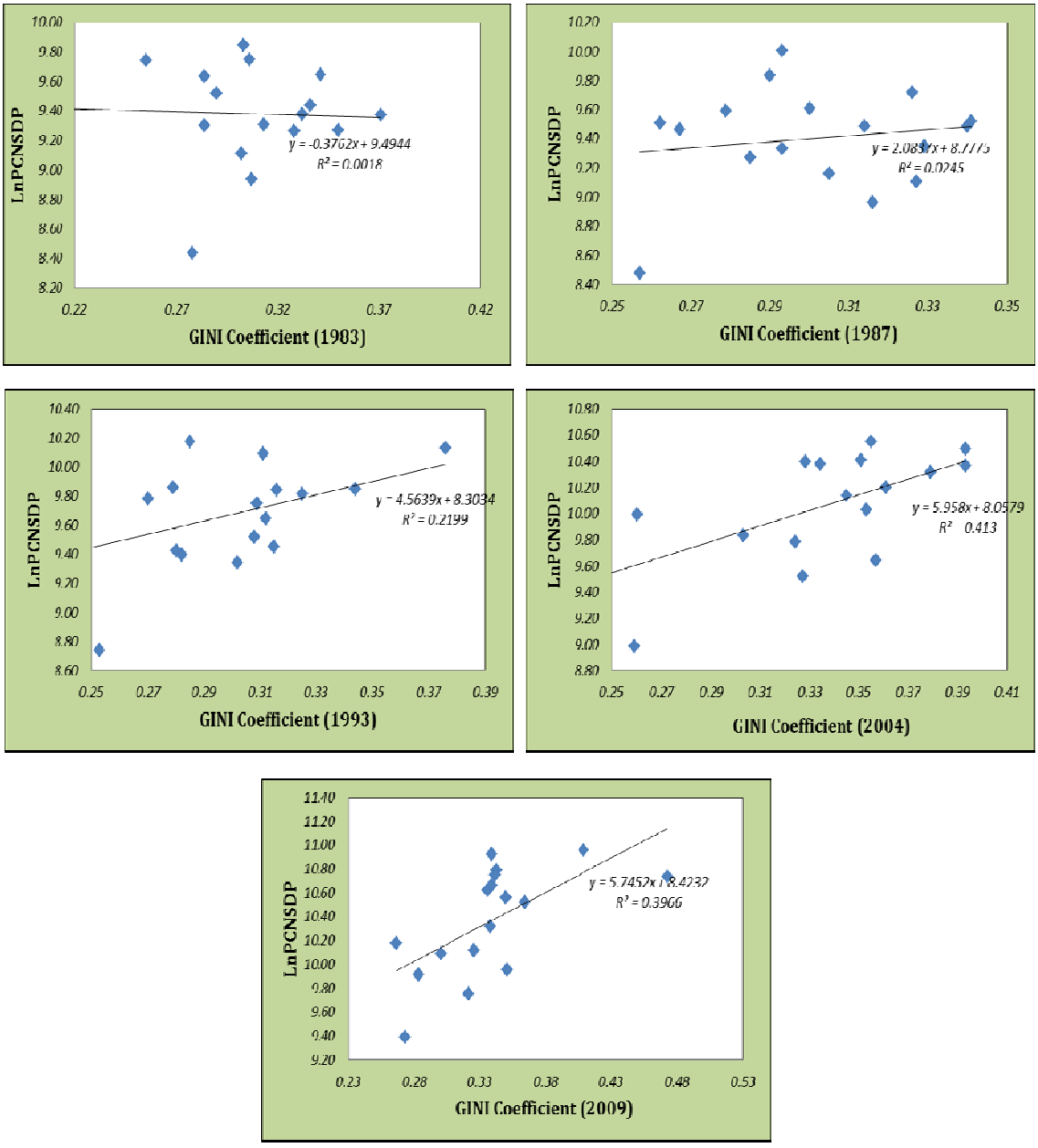
[2] States are classified as rich if their average PCNSDP is more than (India's mean PCNDP+0.5(std dev)), poor if it is less than (india's mean PCNDP-0.5(std dev)), and middle income if it lies in between. **A state is said to have high (or low) growth rate if the NSDP trend growth rate for the state is more (or less) than 0.5*(India's trend NDP growth rate) for that time period.

[3] Data available upon request

Figure1: Scatter Plot between PCNSDP and Gini Coefficient for 17 Indian states



Another interesting feature that the data indicates is that for all the three categories – rich, poor and middle income states- trend growth rate of electricity consumption was higher during the decade of the 1980s than during the 1990s (except for Kerala and West Bengal) and it picked up again in 2000s. For roads network, rich states had a higher trend growth rate during the 1980s and the 2000s than during the 1990s, but for both poor and middle income states trend growth rate of road density has been steadily rising and was highest during the 2000s indicating that there have been continuous attempts to catch up with the rich states (exceptions are Orissa and Andhra Pradesh). However, despite this consistently increasing growth rate in road density, the average road density in

the poor income states (except U.P.) in 2001-10 was still lower than the average road density of the rich states in 1981-90, which indicates towards the scale of catching up that these states are still left to do.

Performance of middle income states was only slightly better than that of the poor income states. Both electricity consumption and rail density average trend growth rate was worst during the 1990s. Average per capita electricity consumption and road density was always found to be between that of the rich and the poor income states during all the three decades – 1981-90, 1991-00 and 2001-10. However, rail density of most of the middle income states was lower than the rail density in poorer states and the rail density of poor income states was not much lower than that of the rich income states.

Telecommunication revolution is evident in India from the sheer trend growth rate figures for all states –rich, poor or middle income especially in the time period 2000-10. But even in this case, it was the rich states that had better tele-density to begin with followed by the middle income and poor income states. And even though on an average the poorer states had a higher growth rate (average 43% for poor income and 32% for the rich income states), followed by the middle income group, the average teledensity was still much higher in the richer states.

With this background, it will be interesting to see whether in India infrastructure development has resulted in any change in inequality levels as the empirical research literature is not very clear on this relationship. Since in India, the measure of inequality is calculated from the consumption expenditure data collected by the quinquennial NSSO surveys, we use the same as a proxy for income inequality with the idea being that with an increase in income, the consumption increases.

Econometric Analysis

To analyse the proposed relation between infrastructure and inequality for states in India, the choice of explanatory variables follows the existing empirical literature on the determinants of inequality (Milanovic, 2000, Calderon and Serven, 2004). The dependent variable for the purposes of this paper is combined (urban and rural) Gini coefficient that has been computed state-wise using the data on Monthly Per Capita Consumption Expenditure (MPCE) which has been estimated from Unit level records of the periodical Household Consumer Expenditure surveys of National Sample Survey Organisation for the years 1983, 1987-88, 1993-94 and 2004-05 and 2009-10. Since the value of Gini lies between 0 and 1, we calculate the (log) Odds ratio for Gini coefficients as this will give normal-distribution of error term and consider that as the dependent variable.

Moving now to the determinants of inequality, we postulate the following equation:

$$\ln(G) = \beta_0 + \beta_1 X + \beta_2 I + \varepsilon_{it}$$

where, G represents the odds ratio of Gini coefficient; X represents the matrix of basic controls based on previous work by Calderon and Serven (2004), Chong (2004) and others; and I represents the matrix of variable of interest for this paper, that is, measures of infrastructure variables mentioned in the sections above. As part of control variables we have included:

- (log) level of NSDP per capita; and its square, which helps test for non-linear effects which are a sign of conventional inverted U-shaped Kuznets curve effect. Theoretically, at very low levels of income, income inequality must also be low as everybody lives at, or close to, subsistence level. With the increase in income, in the initial stages, inequality rises as scarce resources like human and physical capital and returns from them are unequally distributed. But after a point, resources get diffused among the population; wage differentials diminish and institutional changes take place that help narrow this inequality (Kuznets, 1955; Milanovic, 2000). Thus, we expect positive sign for coefficient of level of NSDP (as income rises, inequality increases) and negative sign for square of NSDP per capita (after a point inequality starts decreasing with rise in income) for Kuznets curve effect to hold;
- Size of the modern (non- agricultural) sector, which is calculated as the share of industry and services sector in the economy's total NSDP. As the growth process begins, people migrate from traditional agricultural sector where incomes are lower to the modern industrial sector where both the wages and wage differentiation is higher, that is, rapid growth of the non-agricultural sector and wider-inequality within it result in increasing inequality. Thus, we expect a positive sign for the coefficient on this variable, as larger the size of the non-agricultural sector, the larger the Gini coefficient (higher inequality).
- **State-wise expenditure on social services** in India (includes both revenue and capital expenditure) has been included as a control variable, as expenditure on social services such as sanitation and education can have a significant impact on the income of poor households via their effect on health and education outcomes. Expansion in education and improvement in health outcomes are regarded as significant tools in reducing inequality. A study by Datt and Ravallion (2002), used 20 household surveys for India's 15 major states and concluded that a lack of basic education, along with other factors, acts as an impediment on the ability of the poor to participate in productive opportunities for economic growth. Thus, we expect a negative relation between inequality and measures of social expenditure.

Infrastructure facilities can have a positive or negative impact on inequality. If infrastructure is built in areas that are already abundant in physical and human capital and have the greatest potential because of an already proven dynamism, then infrastructure could adversely affect inequality. However, if infrastructure is developed in regions that lack facilities and face resource crunch, these regions may manage to exploit the new production possibilities and this will help reduce inequality (Ferreira, 1995). In an environment with capital market imperfections, expanding public infrastructure services could reduce the inequality of opportunity among entrepreneurs, increase the return on investment, and raise entrepreneurial activity among the less-favored segments of society (Ferreira, 1995). Better transport infrastructure can help connect the lower income groups to markets and expand the sets of opportunities available to them. For instance, rehabilitating rural roads in Bangladesh raised non-agricultural wage employment in targeted households and fostered markets that have become increasingly diversified across sectors (Khandker and Koolwal, 2007).

Greater public investment in infrastructure can help raise the factor income through an improvement in productivity, while also affecting relative factor returns and the distribution of income

and welfare through the labor-leisure choice (Chatterjee and and Turnovsky, 2012). The theoretical model by Pi and Zhou (2012) that included infrastructure as an input in production function with both skilled and unskilled labour studied the impact on skill premium. A higher supply of infrastructure can raise the marginal productivity of both - skilled and unskilled labour and the effect on skill premium will depend on the factor intensity of the sector. For example, if the sector that uses more unskilled labour is making use of infrastructure services more intensely then there will be an outflow of capital from skilled to unskilled sector thereby increasing the wage rate of unskilled labour and reducing skilled-unskilled wage inequality or it could also be vice versa. Additionally, telecommunication infrastructure can help reduce inequality by helping connect to core economic activities and allowing easy access to additional productive opportunities. An interesting channel through which electrification programs can impact employment was studied by Dinkelman (2011) and he found that rural households with access to electricity also had higher female employment. This was because the time that was freed up from the efforts that went in wood collection and spent on cooking and lighting would then be spent at work through self-employment or micro-enterprises.

In addition to the conventional channels through which infrastructure impacts the economy, literature has identified new channels like the impact of infrastructure development in improving human capital which then helps in increased job opportunities and productivity (for details see Brenneman and Kerf, 2002; Agenor and Moreno-Dodson, 2006). By investing in roads, for instance, governments may not only reduce production costs for the private sector and stimulate investment, but also improve education and health outcomes, by making it easier for individuals to attend school and seek health care. With their health improving, individuals become not only more productive, but they also tend to study more. In turn, a higher level of education makes individuals more aware of potential risks to their own health and that of their family members. Moreover, investment in infrastructure, by improving health and life expectancy, may reduce uncertainty about longevity and the risk of death, thereby increasing the propensity to save. As a result of these various effects, the impact of infrastructure on income and welfare is compounded.

We have tried to look into the relationship that infrastructure has with inequality for 17 major Indian states. As has been mentioned earlier the nature of this relationship is not clear-cut (for example see Brakman *et al,* 2002; Banerjee, 2004, World Bank, 2006) and it would be interesting to see whether infrastructure development has led to a reduction in inequality in India and this will have policy implication.

The regression results where the dependent variable is the log odds ratio for Gini coefficient is presented in Table 4. Our discussion will focus on the results from random effect estimators as Breusch Pagan LM test indicates that variance across entities is significantly different from zero and random effect model is preferred over simple OLS regression and Hausman test suggests the use of random effect over fixed effect for the dataset (See table 5).

We found the relation between income (PCNSDP), and its square, and Gini is not significant. We also found no evidence of a Kuznets behaviour, whose hyopthesis states that inequality rises in early stages of development and decreases afterwards. Subsequently, we observed that for this dataset, the relation between inequality and share of non-agriculture sector is positive and significant both at 5

and 10 percent levels. We can thus conclude that a larger share of modern (non-agriculture) sector has resulted in an increase in inequality or consumption distribution when considering all the states together. The result for per capita expenditure on social services by state government is interesting; as it has a negative impact on inequality. It highlights the importance of a government role and well targeted social programs, which can have a significant impact in reducing inequality by providing access to education, health and other social services to all and not just to a favoured or 'lucky' few in a society.

Amongst the infrastructure variables, indicator for power infrastructure (per capita electricity consumption) and road density show a positive relation with the Gini coefficient. The relation with road infrastructure is significant at 1 percent level, which is a surprising result as it suggests that an increasing road density also increases inequality. Possible explanations for this phenomenon derived from the literature and existing theories could be: first, according to the political business cycle theory (Rogoff, 1990; Dixit and Londregan, 1996 etc.) the geographic distribution, timing and composition of infrastructure development is decided upon electoral terms and their geographical distribution is directed towards those areas considered critical for re-election bid rather than based on development criteria; this could mean that roads were built in more visible and electorally important areas, alternatively, the investment decisions to build roads are politically driven and depart from efficiency criteria resulting in an over accumulation of stock resulting in negative returns; another option could be that although the roads exist, their quality is dubious and it may not have the expected impact on increasing access to productive opportunities or productivity. These potential explanations for the observed result cannot be proved with the existing dataset however, are mentioned for their plausibility.

This paper puts forward an alternative explanation for this result. The dependent variable in this case is the Gini coefficient obtained from consumption expenditure data. The survey conducted by NSSO details the expenditure on durable and non-durable goods. It could be possible that the increased access to markets provided by better roads network, allowed people with more resources/incomes to incur higher expenditure on luxury goods or products that were not available in the markets around them before (such as expenditure on expensive cars, television sets, refrigerators, houses, expenditure on social functions). With a better road network, productive opportunities may be available to those who did not have access earlier, but the benefits from these may have accumulated by the already rich in relative terms, as better investment opportunities lead to ever higher returns, which translate into an even more unequal consumption pattern. The following quote does describe this situation in the context of China and it may not be too far from reality for an Indian situation as well:

> "*The expressway network (in China) has…helped to promote a sharp increase in private car ownership… roads are sometimes built expressly for the purpose of converting countryside into revenue-generating urban land…For Beijing's airport expansion, 15 villages were flattened and their more than 10,000 residents resettled…but...former farmers…(were) barred from unemployment benefits and other welfare privileges*."
>
> The Economist (February 14, 2008)

The electric sector in India has been laden with a multitude of problems like a high and inefficient bureaucracy, widespread theft of electricity and a great amount of politicization. Despite the electricity generating capacity increasing, the per capita consumption of electricity remains low. The state owned enterprises are highly subsidized and yet the consumption is low.

The sector faces large transmission and distribution losses and has experienced a decrease in the consumption share of the industry while that of agriculture is rising (Tongia, 2003). This is mainly due to the price charged for the commercial use of electricity, which is much higher than that for agriculture usage. The electricity, which is being supplied for agriculture consumption purposes, is highly subsidized and often provided free of charge before elections. It may be argued that the consumption of electricity in the rural sector is directed at agricultural purposes, which should result in a decrease in inequality. However, the supply of electricity in rural areas remains limited and most of the supply for agricultural activities is riddled with time restrictions and poor quality. A high percentage of agricultural electrical consumption is used in water pumps where most of them are unmetered. This forces a different pricing scheme as farmers are charged a flat rate for electricity. This flat rate pricing is regressive as it assists the large land owners more than the small farmers. Politicians cater to large landowners as they are key in swinging votes and are often the patriarchs in their community. This results in excessive power loads and lowered voltage levels. System managers control loads by cutting the supply to certain areas and mostly serve for few off-peak hours. Hence, the results corroborate with the Indian reality. Additionally, urban consumption of electricity is much higher as is the level of inequality and in this paper the measure of inequality is a combined- urban and rural- Gini. This could mean that it is the results are being driven by the urban sector for electricity.

Railway infrastructure displays a negative and significant relation with inequality suggesting that in India railways resulted in benefits that have been relatively equally shared. Telecommunication infrastructure shows a positive sign however insignificant. Although some literature suggests the telecommunication revolution in India (beginning late 1990s) was beneficial as it helped people and firms connect to core economic activities and allowed access to additional productive opportunities (Jensen, 2007).

Thus, we can conclude that regions with a comparatively higher road infrastructure development were also the ones with higher inequality. Expansion of infrastructure may have resulted in higher consumption (MPCE) however these benefits were not equally shared by the regions.

Conclusion

This paper makes an attempt to understand the relation between infrastructure availability and inequality across 17 major Indian states. Although most studies in the relevant literature found a positive contribution of infrastructure development to aggregate income, research on the distributional implications of infrastructure development remain limited. In theory there are several mechanisms by which infrastructure development leads to a favourable impact on distribution of income and help decrease inequality, however, the evidence of the same are lacking. In the case of India, the same negative relation between infrastructure and inequality in consumption expenditure could not be proved for all infrastructure variables.

The impact of infrastructure variables on consumption inequality measure indicates that some components of infrastructure –power and road – are associated with increasing interpersonal inequality at the regional level. This paper offers a novel explanation for these results as the measure for inequality under consideration is consumption inequality and with increased access to roads and electricity, the consumption of goods such as higher end cars, access to material for building more expensive houses, expenses on social functions, and durable goods such as television sets, refrigerators and the like, increases for those people who had higher income (and by implication the demand for these goods) to begin with but did not have access to markets.

There are three explanations for a positive relation between electricity infrastructure and inequality. First, electricity supplied for agriculture consumption purposes is highly subsidized and often provided free of charge before elections. This should have resulted in lower inequality, however the supply of electricity in rural areas remains limited and most agriculture electricity supply is riddled with time restrictions and poor quality. Second, most of the agricultural electricity consumption is directed at pumping water where most pumps are unmetered and all farmers are charged a flat rate for electricity. Third, even in terms of consumption of electricity, it is higher in urban areas than in rural areas, and inequality in urban areas is much higher than in rural sector.

It can therefore be inferred from the study that expansion of regional infrastructural facilities may enhance average consumption level of the people but these impacts are not uniform across the populace, and is accompanied by increased inequality within the states.

Expansion of infrastructure may have resulted in higher consumption in the form of increased monthly per capita expenditure or higher per capita NSDP. The initially rich states were also the ones best endowed with infrastructure facilities – roads, electricity, railways and telecommunication infrastructure. These states continued to remain in the rich income category with average PCNSDP much above India's average PCNSDP, and these states managed to grow in terms of their infrastructure endowments but the rich states also displayed higher levels of inequality. However, in terms of the impact on inequality, the hypothesis that infrastructure yields a higher return in richer areas that are already relatively abundant in private capital and that could be due to the complementary relation between infrastructure and private capital and human capital and will result in increasing income inequality seems to ring true.

From a public policy perspective, the results of this study do not prescribe abandoning transportation projects or infrastructure development but instead emphasize also on investments in complementary policies. Infrastructure can help open up opportunities but these benefits are reaped by those who are in a position to be able to take advantage of these. Instead of making the gains available purely based on random chance (right sector or place), efforts should be made such that infrastructure facilities are effectively utilized by all and this can occur if infrastructure is built in a more informed way and alongside complementary policies that help the less well-off take advantage of the facilities. The hypothesis that infrastructure yields a higher return in richer areas that are already relatively abundant in private capital, and that could be related to the complementary relation between infrastructure, private, and human capital and its result in an increasing income inequality may ring true but this warrants a further analysis at district level and is beyond the scope of this paper.

Table 1i: Trend growth rate of PCNSDP and infrastructure variables in the Rich states

State	PCNSDP			Elec			Road			Rail			Tele	
	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1991-00	2001-10
Haryana	3.72	2.25	6.98	5.73	1.91	7.37	2.12	0.98	3.95	-0.35	0.55	-0.29	20.16	35.64
Punjab	3.49	2.48	4.11	9.85	4.44	5.50	2.07	2.88	4.01	0.13	-0.23	0.22	22.21	30.62
Tamil Nadu	3.46	5.25	7.69	6.38	5.25	6.73	2.11	-1.98	2.76	0.38	0.56	-0.36	21.84	33.88
Maharashtra	3.21	4.71	8.28	7.04	3.94	4.91	6.38	3.68	3.87	0.35	-0.02	0.32	15.13	25.60
Gujarat	2.77	6.00	8.53	7.42	6.56	5.83	6.16	4.51	1.23	-0.39	0.07	-0.50	16.38	31.90
HP	2.67	4.43	5.16	12.74	6.89	12.86	6.16	4.37	3.34	0.24	0.16	1.20	25.84	35.24
Kerala	1.14	4.83	7.16	4.45	4.87	3.58	3.62	3.19	10.04	0.51	0.43	0.00	22.00	30.46
Mean	2.92	4.28	6.84	7.66	4.84	6.68	4.09	2.52	4.17	0.13	0.22	0.09	20.51	31.91

Table 1ii: Trend Growth Rate of PCNSDP and Infrastructure Variables in the Poor States

State	PCNSDP			Elec			Road			Rail			Tele	
	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1991-00	2001-10
Assam	1.10	0.33	3.20	8.51	0.16	5.44	2.51	2.53	10.50	0.95	0.05	-0.78	21.44	44.78
MP	1.17	7.68	4.23	10.38	4.99	6.75	3.99	0.50	4.84	0.56	-0.05	0.21	16.36	37.61
UP	2.40	2.31	3.70	9.11	1.73	2.99	3.27	5.90	5.61	0.20	0.00	0.18	19.95	42.88
Bihar	2.53	7.84	5.08	8.17	2.81	6.54	0.82	0.95	9.85	0.65	-0.24	0.92	19.15	45.73
Orissa	2.92	2.38	7.43	8.47	1.95	8.10	1.85	17.16	0.59	0.28	2.04	0.47	21.59	44.38
Rajasthan	3.22	4.03	4.98	10.35	5.51	6.72	5.52	4.56	8.31	0.27	0.28	-0.22	21.44	42.71
Mean	2.22	4.09	4.77	9.16	2.86	6.09	2.99	5.27	6.62	0.48	0.35	0.13	19.99	43.01

Table 2i: Average PCNSDP and Infrastructure Availabilty in the Rich States:

1981-90, 1991-00, 2001-10

State	PCNSDP			Elec			Road			Rail			Tele	
	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1991-00	2001-10
Punjab	20512.8	26981.6	35214.5	436.7	750.6	1350.3	756.7	945.1	921.8	42.7	42.1	42.1	2.6	31.3
Haryana	18756.5	25811.5	40610.8	262.5	485.3	1045.1	492.3	570.1	674.0	33.1	34.2	35.3	1.6	20.6
MH	16180.5	25773.9	40686.0	298.7	503.3	893.7	338.6	626.0	716.6	17.2	17.7	18.0	3.0	19.0
Gujarat	14637.7	22145.1	34743.2	298.3	643.9	1278.4	271.8	409.9	670.0	28.4	27.1	26.7	2.0	22.0
HP	14443.1	20479.8	33753.5	117.4	269.0	805.7	95.7	254.5	303.2	4.6	4.8	5.1	2.0	26.8
Kerala	13474.8	19986.1	34022.6	127.6	235.0	419.3	670.6	1086.6	2482.4	23.8	26.8	27.0	2.6	30.5
TN	12978.7	20819.9	33954.3	217.6	423.5	943.3	735.9	921.9	1076.0	30.5	31.3	31.8	2.6	31.3
Mean	15854.9	23142.6	36140.7	251.2	472.94	962.26	480.2	687.72	977.72	25.76	26.28	26.57	2.35	25.94

Table 2ii: Average PCNSDP and Infrastructure Availabilty in the Poor States: 1981-90, 1991-00, 2001-10

State	PCNSDP			Elec			Road			Rail			Tele	
	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1981-90	1991-00	2001-10	1991-00	2001-10
Bihar	4779.4	7628.5	10938	80.1	129.5	213.1	169.2	190.4	313.9	32.3	30.2	30.8	0.3	7.2
MP	7526.2	12616.8	17338	147.4	330.2	621.7	140.5	223.0	287.8	13.3	13.4	13.7	0.8	9.7
UP	9298.8	12057.1	15059	108.9	190.0	343.8	262.8	448.9	719.8	30.6	30.3	30.4	0.6	10.7
RJ	9915.7	14848.4	19655	132.5	278.2	588.7	132.2	217.0	335.2	16.5	17.2	17.0	1.0	15.8
Orissa	10986	12385.4	18400	135.2	317.5	649.3	114.5	330.3	230.1	12.9	13.8	15.0	0.6	10.7
Assam	13223	14503.7	17085	50.5	97.3	168.3	113.2	145.8	307.5	28.7	30.8	30.7	0.5	9.1
Mean	9288.5	12340.0	16412	109.1	223.8	430.8	155.4	259.2	365.7	22.4	22.6	22.9	0.6	10.6

Source: Author's Calculations

Table 3: Infrastructure stocks and Consumption Inequality: Panel Regression Analysis
Dependent variable: log (odds ratio for Gini Co-efficient)
Sample of 17 Indian states, Gini computed using MPCE for the years 1983, 1987-88, 1993-94, 2004-05 and 2009-10

Variable	Random Effect
Ln(Income per capita)	-1.209 (1.05)
Square(LnIncome per capita)	0.06 (0.05)*
modsecnsdp	0.77 (0.34)***
Ln(PCSocX)	-0.12 (0.07)*
Ln electricity consumption (per capita)	0.06 (0.05)
Ln(Road density)	0.21 (0.06)***
Ln(Rail density)	-0.12 (0.04)***
Ln(Teledensity)	0.01 (0.03)
Constant	3.96 (5.38)
Observation	85
Adj R square	0.70

Numbers in parenthesis below the coefficient estimates are robust standard errors after correcting for heteroskedasticity *, ** and ***; indicate that the variable is significant at 10, 5 or 1 per cent level. LnPCNSDP = Log Per Capita Net State Domestic Product; sqLnPCNSDP = square (LnPCNSDP); lnelec = Ln (Electrictyconsumption per capita); lnroad = ln(Road density); Lnrail = ln(Rail density); lntele = Ln (Teledensity); modsecnsdp = Share of Modern sector in NSDP; lnPCSocX = Log(per capita social expenditure)

Table 4: Test for Deciding Panel Data Model

Test	Test Results	Conclusion
Breusch-Pagan LM test	Chi sq = 9.02 Prob> chi sq = 0.01	Reject null hypothesis that variances across entities is zero (no panel effect). Random effects is appropriate over OLS
Hausman test	Chi sq = 2.16 Prob > chi sq = 0.9	Do not reject null hypothesis that error terms are not correlated with regressors. Random effects model is preferred over Fixed effects model

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ISBN 978-81-7791-193-0

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