Working Paper No. 35
July 2015

International Labour Office

GLU

The impact of infrastructure provisioning on inequality: evidence from India

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GLOBAL LABOUR UNIVERSITY

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Editing: Barbara Schmitz
Layout: Harald Kröck

THE IMPACT OF INFRASTRUCTURE PROVISIONING ON INEQUALITY: EVIDENCE FROM INDIA

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ILO Cataloguing in Publication Data

Bajar, Sumedha; Rajeev, Meenakshi

The impact of infrastructure provisioning on inequality : evidence from India / Sumedha Bajar and Meenakshi Rajeev ; International Labour Office, Global Labour University (GLU), 2015
35 p. (Global Labour University working paper ; No. 35)

International Labour Office; Global Labour University

infrastructure / economic growth / poverty alleviation / income distribution / India

10.03

Printed in Switzerland

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). By evaluating Indian states with different levels of development (measured in terms of per capita net state domestic product (NSDP)) the paper shows that the impact of infrastructure on consumption inequality across states differs not just for the type of infrastructure under consideration but also for the income category the state belongs to. The results have shown that some components of infrastructure, mainly power and roads, tend to increase interpersonal inequality at the regional level and the paper provides some explanations for this result. The initially rich states were also the ones with a better endowment for infrastructure facilities and these states continued to remain in the rich income category with an average PCNSDP much above India's, and they managed to grow in terms of their infrastructure endowments. They, however, also showed higher levels of inequality. 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.

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1. INTRODUCTION

Despite high levels of growth observed in India during the last decade, national levels of poverty and inequality remain high (Bhattacharya & Sakthivel, 2004; Das & Barua, 1996; Ghosh, 2008; Kar and Sakthivel, 2007). Moreover, the level of disparities among regions has been increasing thus casting doubt whether the benefits of growth are being shared in an equitable manner. Rising regional inequalities have several repercussions on economic and political stability in the country (Nagaraj, Varoudakis and Veganzones, 2000). Therefore, it is important to understand the determinants of development for sub-national regions. The literature points to various sets of strategies through which the objective of balanced regional development can be accomplished such as industrial development, rural development, migration, infrastructure development, subsidies to capital and labour, fiscal incentives, and administrative decentralization to list only a few (Markusen 1994; Higgins and Savoie 1995 and Richardson and Townroe 1986). Infrastructure provision is seen as a particularly important instrument for promoting regional development where government can play a significant role due to the public goods nature of infrastructure facilities. It is an important mechanism whereby wealth can be distributed across members of the society by utilizing the so called market forces. Consequently, in India, infrastructural bottlenecks were touted as one of the main factors deterring 'inclusive' growth and have thus become the focus of various policy announcements made by the Government.

Empirical evidence, at both macroeconomic and microeconomic levels, suggests that infrastructure development helps to improve productivity and growth (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 (2001), Sanchez-Robles (1998) amongst several others. For a detailed review see Romp and de Haan (2007)). Concurrently, by way of working through these channels infrastructure can also reduce inequality in an economy as shown by Calderon and Serven (2004 and 2008) and Lopez (2003) amongst others. But the nature of 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 these two are positively related. However, it is wrong to assume that economic growth attributable to infrastructure development will consequently lead to a reduction in inequality. Literature has shown that economic growth can be associated with rising inequality and poverty (Ravallion, 2004).

Empirical evidence on the second set of relationship, i.e. between infrastructure and inequality is sparse, inconclusive, and largely anecdotal (Chatterjee and Turnovsky, 2012; Calderon and Serven, 2014). Infrastructure increases the access to productive opportunities and reduces production and transaction costs, which leads to industrial or agro-industrial development and raises the value of assets of the poor. In this regard, infrastructure can reduce inequality. Additionally, better

infrastructure enhances labour mobility as it expands geographic access and improves transportation opportunities and therefore, gives surplus labour the ability to move to places where labour is in short supply. A well-developed communication infrastructure can 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 consequently on productivity levels, earning capabilities, and social welfare particularly for the poor (Calderon and Serven,2014). However, infrastructure can also yield higher returns in richer areas where private capital is already relatively abundant. This could be due to the complementary relation between infrastructure, private capital, and human capital and will result in increasing income inequality. Bundhopadyay (2011) proved infrastructure differences can explain polarised economic growth rates across Indian states. Just as there are studies that found a negative relation between infrastructure development and inequality, there also exist studies that found the reverse to hold true (Brekman et al, 2002; Banerjee, 2004; Khandker et al, 2007).

This paper analyses the links between physical infrastructure and inequality and determines the nature of this relation and its impact on major Indian states and provides evidence of this relation in India. The major highlight of this paper is to show that the impact of infrastructure on inequality is a function of the level of development of a region. By evaluating Indian states with different levels of development (measured in terms of per capita net state domestic product (NSDP)) the paper shows that the impact of infrastructure on consumption inequality across states differs not just for the type of infrastructure under consideration but also for the income category the state belongs to.

The scope of this study is limited to an analysis of 17 major Indian states during the period 1980-81 to 2009-10. The choice of time period is determined by three main factors. First, India experienced a turning point in the early 1980s when the government implemented its first liberalisation policies followed by wide-ranging reforms in the 1990s. This had a considerable impact on the rate of economic growth and helped the economy to break away from the label of "Hindu rate of growth"[1] and to become one of the fastest growing countries in the world. Second, during this period infrastructure policies changed distinctively, for example the government increasingly focussed on introducing private investment into the sector and stressed the development of urban infrastructure. Additionally, the telecommunication revolution occurred in the 1990s and brought the importance of development of telecom infrastructure into fore. And third, it was possible to obtain coherent and reliable data on relevant infrastructure variables for the chosen time period where the data on monthly per

[1] Late Prof. Raj Krishna termed India's GDP growth rate of 3.5 per cent per annum as the 'Hindu rate of growth'

capita consumption expenditure (MPCE) could be obtained from the five rounds of Consumption Expenditure Surveys conducted by National Sample Survey Organisation.

The rest of the paper is organised as follows. Section 2 provides a brief review of international and national studies concerning the effects of infrastructure development on inequality. Section 3 describes the data, coverage, and time period selected for this study. Section 4 provides some basic stylised facts and an overview of state-level inequalities in monthly per capita expenditure (MPCE) data obtained from various rounds of NSSO. The evolution of infrastructure availability is also presented in this section. Section 5 presents the quantitative assessment of the relation between infrastructure and inequality and finally, section 6 draws conclusions.

2. REVIEW OF LITERATURE

This section briefly summarises the recent literature on the effects of infrastructure development on inequality. The framework of this analysis varies from time series models of the national economy to panel data based models consisting of countries and states or provinces.

The various channels through which infrastructure can impact inequality and help reduce it have been highlighted, amongst others, by Estache, (2003), Gannon and Liu (1997), Estache and Fay (1995), and Jacoby (2000). Essentially, infrastructure benefits underdeveloped regions as disadvantaged individuals gain access to productive opportunities by connecting them to core economic activities. A reduction in production and transportation costs as a result of easier accessibility through 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, some researchers have identified new channels like the beneficial impact of infrastructure development on human capital, which in turn increases job opportunities and productivity (Brenneman and Kerf, 2002; Agenor and Moreno-Dodson, 2006). By investing in roads governments may not only reduce production costs for the private sector and hence stimulate investment, but also improve education and health, as it becomes easier for individuals to attend school and to seek health care. With their health improving, individuals not only become more productive, but also tend to increase their study. 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 can reduce uncertainty about longevity and the risk of death by improving health and life expectancy, which increases the propensity to save. As a result of these various effects, the impact of infrastructure on income and welfare is compounded.

Fan, Zhang and Zhan (2002) identified by evaluating provincial data from 1970 to 1997 in a simultaneous equation model, that infrastructure development played a critical role for rising growth rates and for reducing poverty and regional inequality in China. According to them this occurred mainly because the expansion of infrastructure opened up new opportunities for employment outside agriculture in rural regions. A recent study by Zheng and Kuroda (2013) about the role of public transportation and knowledge infrastructure – on China's regional inequality, on growth, and on industrial geography across 286 cities found that an improvement in transportation infrastructure reduced trade cost, increased growth, and decreased the income gap but at the expense of increasing industrial agglomeration between cities. Moreover, they suggested that knowledge infrastructure increases growth and decreases the income gap as well as industrial agglomeration.

Taking into account the impact of both the quantity and quality of infrastructure on distribution of income Calderon and Chong (2004) took the impact of both quantity and quality of infrastructure on income inequality into account and provided evidence of a negative relation between those from 1960 to 1997. They used cross-country and panel regressions (using GMM dynamic methods to minimize endogeneity problems) and various types of infrastructure indices. Similarly, Calderón and Servén (2005) considered the growth and inequality aspect of infrastructure investment by evaluating impact of infrastructure development on growth and income inequality using a large panel data set covering more than 100 countries over a time period of 40 years (1960-2000). They concluded that a greater availability and quality of infrastructure services had a significantly positive impact on health and/or education and, hence, on income and welfare for especially the poor in developing countries. Seneviratne and Sun (2013) studied the links between income distribution and infrastructure for ASEAN-5 countries. They ran a set of pooled ordinary least squares (OLS) regressions covering 76 advanced and emerging market economies for the time period between 1980 and 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 the literature on this topic has not been unanimously supporting the argument of infrastructure development leading to a reduction in inequality. The study by Brakman et al (2002) found that government spending on infrastructure increased regional disparities within Europe. In a similar vein, for India, Banerjee (2004) and Banerjee and Somanathan (2007) analysed the impact of accessibility to infrastructure services on the distribution of income and showed that these two are positively related, i.e. the benefits of infrastructure services were mostly accrued in higher income groups as opposed to benefitting the poor. The study by Khandker and Koolwal (2007) found that expanding paved roads had a limited distributional impact on income in rural Bangladesh.

The paper by Raychaudhari and De (2010) attempted to understand the inter-linkages among infrastructure, trade openness, and income inequality using panel data of 14 Asia-pacific countries from 1975 to 2006 and concluded trade openness and infrastructure influence income inequality but the reverse is not necessarily true. Also, the effect of infrastructure development on trade was not significant.

In India, a number of studies based on National Sample Surveys (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 the 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 between 1970-71 and 1999-2000. They regressed the real per capita State GDP on several social, financial, and physical infrastructure variables and found that inter-state disparity measured in per capita net State domestic product rose physical, social, and financial infrastructure facilities significantly among Indian States during the past 25 years. Additionally, physical and social infrastructure facilities proved to be highly critical factors in determining the inter-state level of development. A study by Majumder (2012) looked at the impact of infrastructure on poverty and inequality using data from the NSS rounds of 1993-94 and 2004-05. The results from this study show inequality increased along with physical infrastructure and the expansion of regional infrastructural facilities enhanced average consumption levels and reduced the proportion of people living below the poverty line. But this study did not take into consideration the impact of telecommunication infrastructure.

Empirical studies of the impact of infrastructure on inequality (consumption) as measured by the Gini coefficient, which is calculated using the MPCE data provided by NSSO at state level in a panel data framework, was difficult to find. Therefore, this paper utilized information from NSS surveys conducted in 1983, 1987-88, 1993-94, 2004-05, and 2009-10 to estimate the relationship with inequality.

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 of an aggregate index.

3. DATA, COVERAGE OF STATES AND TIME PERIOD

India is a union of 28 states and 7 union territories but the analysis in this paper is confined to the17 major states of: Andhra Pradesh (A.P.), Assam, Bihar, Gujarat, Haryana, Himachal Pradesh (H.P.), Jammu and Kashmir (J&K), Karnataka, Kerala, Madhya Pradesh (M.P.), Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu (T.N.), Uttar Pradesh (U.P.), and West Bengal (W.B.). 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 labour force in 2009-10. Hence, they are representative.

For testing the impact of infrastructure development on inequality in India, the Gini coefficient was used as the dependent variable. We computed the Gini coefficient per state by using the 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). We calculated the Gini coefficients at an aggregate level, i.e. for both rural and urban regions combined. However, while using NSSs to analyse inequality, there are certain limitations (see Jayadev et al. 2007) that need to be mentioned here. The structure of an NSS underrepresents the rich or wealthy population and thus, underestimates inequality. This has to be kept in mind when interpreting the results.

For the purpose of this paper data series for Per Capita Net State Domestic Product (PCNSDP) in 2004-05 constant prices were used for the above mentioned 17 Indian states. This data was obtained from the National Accounts Statistics published by Central Statistical Organisation (Government of India). For testing the impact of infrastructure development on inequality in India, the Gini coefficient was used as the dependent variable. In some exercises we also grouped the states into two categories – high income and low income states - based on their PCNSDP in 2009-10. We did this to measure whether the impact of infrastructure on inequality differs for particular income states. 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), and per capita social expenditure incurred by the government was compiled from Statistical Abstract of India, CMIE database on infrastructure, Reserve Bank of India's Handbook of Statistics.

Although, the Gini coefficients are available for five point in times, i.e. of 1983, 1987-88, 1993-94,2004-05, and of 2009-10, they are spread across three decades from the 1980s to the 2010s. These three decades are characterised by stark differences in terms of the infrastructure development policies, which the government shaped through its drastically changing political priorities in each

decade (Lall and Rastogi, 2007). Beginning of 1980s, following the second oil crisis, the government mainly concentrated on rural India and hence, 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 providing electricity to rural households but rather extending the electric grid to allow farms to meet the demand for irrigation. There was great politicization of fiscal policy and this was era of bigger government and public spending. The entry of the Prime Minister Rajiv Gandhi in 1984 was characterised by two noteworthy features in regards to infrastructure development. First, the 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 to cultivate and improve India's telecom sector and help it catch up with the rest of the world thus setting the stage for take-off of the Indian Information Technology (IT) industry during the 1990s. Secondly, extending infrastructure for ground water irrigation and consequently, expanding the electricity supply continued, however, the financial situation of the State Electricity Boards deteriorated and chronic shortages of power appeared for commercial and urban consumers. The development of critical transportation and urban infrastructure continued to be neglected.

In the post-1991 period the government shifted away from these policies and instead emphasised fiscal consolidation. Investment in infrastructure became a major casualty when the central government aimed to reduce the fiscal deficit from 8.4 percent of GDP in 1990-91 to 5 percent 1992-93. Although, the decline in infrastructure spending and the hold on almost all infrastructure projects should have negatively impacted GDP growth rates it instead impacted productivity through the improvement in targeting of infrastructure spending and telecom-related reforms. Until 1994 Telecom was a government monopoly. National Telecom Policy (1994 and 1999) helped to liberalize the sector and to recognise the importance of the telecom sector as an essential component of infrastructure. The second half of the 1990s saw an upsurge in infrastructure shortages that were increasingly recognised. The *India Infrastructure Report* (NCAER, 1995) was the first of its kind and many of its recommendations were later realised in government policy. The *World Development Report* (World Bank, 1994) brought to attention the globally followed initiatives that induce greater private sector participation in infrastructure development, which later became part of many of the policies crafted by Indian policymakers. The ninth Five Year Plan (FYP) initiated the participation of the private sector into the infrastructure sector and encouraged to take first steps towards a strategic focus on infrastructure policy. It also pointed out the disproportionate reliance on congested national highways compared to railways.

During the decade of 2000s saw the above mentioned policy suggestions and initiatives take shape. During the tenth FYP the government targeted spending on national highway network and build-out of Golden Quadrilateral and its related North-South and East-West road corridors. Policies enabling the private

sector to finance 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. In order to provide direction to the efforts to prioritize infrastructure development, especially, the Public Private Partnerships (PPP) effort, Government constituted a Committee on Infrastructure (CoI) in August 2004 under the chairmanship of the Prime Minister, with the objectives of initiating policies that would ensure time-bound creation of world class infrastructure, delivering services matching international standards, developing structures that maximize the role of PPPs and monitoring progress of key infrastructure projects to ensure that established targets are realized. The eleventh FYP envisaged to increase the gross capital formation in infrastructure from 5 percent to 9 percent of GDP. Despite the emphasis placed on PPP by plan documents, the response of the private sector was lukewarm. Several reasons can explain this 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 policies emphasised, numerous infrastructure policies pursued and various infrastructure sectors development.

4. 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. In 2009-10 the per capita income level in Bihar (the poorest state in India) was still one fourth that of Maharashtra (the richest state) and one third that of Punjab. Maharashtra, which inhabits 8 percent of the total national population, contributed 16 percent of the aggregate net state domestic product (NSDP) in 2009-10, while Bihar inhabiting more than 10 percent of the population contributed only 4.5 percent of the aggregate NSDP.

It has been observed that although, growth rates of per capita NSDP in all states have experienced an increase in varying degrees, there has not been a smooth and continuous increasing trend for any of the states. In the pre-reform period, states like A.P., Rajasthan, Tamil Nadu, Haryana, Punjab, Karnataka were doing well but in the post-reform period almost all states succeeded in increasing their rates of growth and this was especially remarkable for states like Maharashtra, Tamil Nadu, Bihar, Gujarat. Paradoxically, when we look at the Gini coefficients and attempt to discern its pattern in cross state temporal behaviour of inequality and compare it to 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 an increasing trend during the period 1993-94 to 2004-05, which continued until 2009-10 although to a lesser extent.

In order to see the relation between inequality and per capita NSDP, scatter plots are presented in Figure 1 which show the relations between the Gini coefficient and PCNSDP for 1983, 1987, 1993, 2004, and 2009. We can see that from the 1990s onwards there is a positive relationship between income (PCNSDP) and inequality, i.e. states that had higher per capita NSDP were also the ones that had higher inequality. Motiram and Vakulabharanam (2011) gave a detailed overview of poverty and inequality across Indian states since the 1980s and the most relevant observations for this study are that inequality has increased among states since the 1990s, although these changes are less dramatic in the later survey rounds (2004-05 and 2009-10). Upon a closer look we found that a large diversity exists where some states experienced a decrease in inequality and others an increase. In the 1980s, the majority of states experienced a decrease in inequality when comparing the figures from the 1983 round with the figures from 1987-88. Except for A.P., Assam, J&K, Kerala, M.P., Orissa, and U.P. inequality decreased in all other states. Even when we compare inequality figures from 1987-88 to 1993-94, most states experienced a decline in their Gini coefficients. States like Kerala, Assam, M.P., Orissa and U.P. that had seen a rise in inequality witnessed a drop in inequality in when comparing between 1987-88 and 1993-94.

In comparison, when looking at the later rounds, inequality substantially increased in almost all states between 1993-94 and 2004-05. This was a long period of ten years and the increase was mostly driven by changes in urban inequality. When comparing 2004-05 with 2009-10 we find many states that experienced an increase in inequality and, amongst these, Kerala deserves special attention as its inequality rates were already very high to begin with. Assam, A.P., and Maharashtra experienced an increase in inequality. We also observe that states with higher growth rates have also witnessed higher increases in inequality.

If we compare infrastructure stock availability and inequality levels of a state in 1983-84, 1993-94, 2004-05, and 2009-10, we find a unique pattern that becomes more obvious in later years. In Table 1, we arranged the states in a manner that those with the highest Gini coefficients (or highest levels of inequality) are ranked higher. In 1983, Tamil Nadu had the highest inequality and was followed by Rajasthan, Maharashtra, and Kerala. In the second column, we ranked the states according to their level of road density (per 1000 sq km area) and those with the highest road density are ranked highest. Similarly, states were also ranked accordingly for electricity consumption and telecom density infrastructure. It is interesting to note that states with lower inequality in 1983, like Orissa, Bihar, J&K, and Assam, were also the ones ranked the lowest in regards to infrastructure availability. States with the highest inequality levels like Tamil Nadu, Kerala, Karnataka, and Maharashtra were also ranked highest and were amongst the best endowed states in terms of road density. The same cannot be said for electricity and health infrastructure. However, when we analyzed more recent periods, this pattern became even more pronounced especially for 2004-05 and was particularly true for road density. States with the lowest inequality levels fared relatively worse in infrastructure availability and states that had high levels of

inequality had higher road density and telecom density and for some states even higher electricity consumption. Since literature does not provide a conclusive nature of the relationship between inequality and infrastructure, these figures indicate the pattern that emerged during India's development story.

Infrastructure development as an instrument to reduce inequality, particularly in rural regions, has become prominent especially during the recent decade. In the pre-reform period, infrastructure development focused on removing specific bottlenecks, which started to negatively affect the economic growth process. Nevertheless, India needs a forward looking approach where infrastructure is built one step ahead of demand.

With this background information, this paper attempts to shed light on the relationship between developments in infrastructure and inequality in India, as the empirical research done on the subject has not been unequivocal in its findings. Since, 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 as we assume that an increase in income increases consumption.

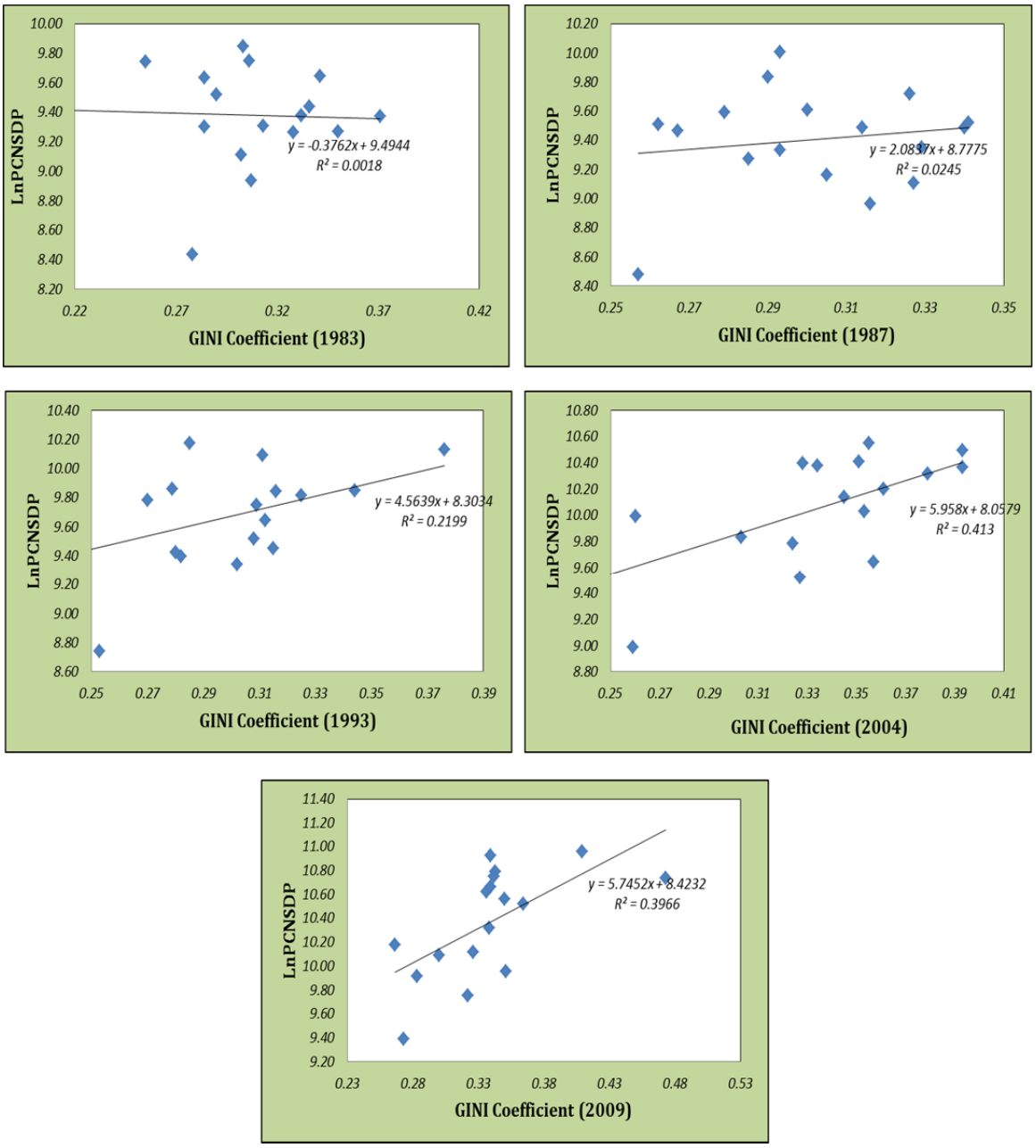
Table 1: Ranking of states according to Gini and Infrastructure Availability

1983					1993				
States	Gini	Road	Elec	health	States	Gini	Road	Elec	tele
TAMIL NADU	1	2	5	8	MAHARASHTRA	1	6	3	1
RAJASTHAN	2	13	10	11	TAMIL NADU	2	2	5	6
MAHARASHTRA	3	6	3	5	HIMACHAL PRA	3	16	11	8
KERALA	4	3	13	17	KERALA	4	3	15	2
KARNATAKA	5	5	6	6	MADHYA PRAD	5	12	8	10
ANDHRA PRADE	6	10	7	12	ANDHRA PRADI	6	10	7	12
WEST BENGAL	7	7	12	15	HARYANA	7	4	4	7
MADHYA PRADI	8	12	8	3	KARNATAKA	8	5	6	5
HARYANA	9	4	4	16	WEST BENGAL	9	8	14	11
PUNJAB	10	1	1	9	UTTAR PRADESI	10	9	13	15
UTTAR PRADESH	11	9	15	14	PUNJAB	11	1	1	3
HIMACHAL PRA	12	16	14	1	ORISSA	12	15	9	14
GUJARAT	13	8	2	13	RAJASTHAN	13	13	12	13
ORISSA	14	14	9	4	GUJARAT	14	7	2	4
BIHAR	15	11	16	7	JAMMU & KASI	15	17	10	9
JAMMU & KASH	16	17	11	2	BIHAR	16	11	16	17
ASSAM	17	15	17	10	ASSAM	17	14	17	16

2004					2009				
	Gini	Road	Elec	Tele		Gini	Road	Elec	Tele
KERALA	1	1	12	2	KERALA	1	1	14	1
MAHARASHTRA	2	5	4	1	MAHARASHTRA	2	5	6	10
TAMIL NADU	3	3	5	6	ANDHRA PRADI	3	10	7	8
KARNATAKA	4	6	7	5	MADHYA PRAD	4	15	11	14
MADHYA PRADI	5	14	9	10	KARNATAKA	5	7	9	5
HARYANA	6	4	3	7	GUJARAT	6	9	1	7
WEST BENGAL	7	7	15	11	TAMIL NADU	7	3	5	4
PUNJAB	8	2	1	3	HARYANA	8	8	4	6
ANDHRA PRADE	9	10	6	12	PUNJAB	9	2	2	3
GUJARAT	10	9	2	4	WEST BENGAL	10	4	13	15
HIMACHAL PRA	11	11	11	8	HIMACHAL PRA	11	11	3	2
UTTAR PRADESH	12	8	14	15	ORISSA	12	16	10	12
ORISSA	13	16	8	14	UTTAR PRADESI	13	6	15	13
RAJASTHAN	14	13	10	13	RAJASTHAN	14	12	12	9
JAMMU & KASH	15	17	13	9	ASSAM	15	13	17	17
BIHAR	16	12	16	17	BIHAR	16	14	16	16
ASSAM	17	15	17	16	JAMMU & KASI	17	17	8	11

Source: Author's calculation based on Gini coefficient computed per state by using the 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 Gini values were also cross checked with Motiram and Vakulabharanam, 2011. The states were also ranked based on their stock of particular infrastructure variable.

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



Source: Author's calculation

5. ECONOMETRIC ANALYSIS

To analyse the proposed relation between infrastructure and inequality in a selection of Indian states, the choice of explanatory variables follows a collection of the existing empirical literature on the determinants of inequality (Milanovic, 2000, Calderon and Serven, 2004). The dependent variable for this paper is a combined (urban and rural) Gini coefficient that has been computed state-wise using the data on Monthly Per Capita Consumption Expenditure (MPCE). As the value of Gini lies between 0 and 1, we calculate the (log) odds ratio of Gini coefficients (as this will give a normal-distribution of the error term) and consider that as the dependent variable.

As for 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 interest for this paper, that is, measures of infrastructure variables mentioned in the sections above. As part of the control variables we have included:

- **(log) level of NSDP per capita**; and its square, which helps to test for non-linear effects, a sign of conventional inverted U-shaped Kuznets curve effect. Theoretically, at initially very low levels of income, income inequality should behave concomitantly as everybody lives at or close to the subsistence level. An increase in income, during the initial development stages, raises inequality as scarce resources such as human and physical capital and returns from them are unequally distributed. However, after a tipping 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 a positive sign for coefficient of the level of NSDP (as income rises, inequality increases) and a negative sign for the square of NSDP per capita (after a point inequality starts decreasing conjointly with rising income) for Kuznets curve effect to hold.
- **Size of the modern (non- agricultural) sector.** This is calculated as the share of both industry and services sector in the economy's total NSDP. As the growth process begins, people migrate from the traditional agricultural sector where incomes are lower to the modern industrial sector where both the wages and wage differentiations are 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 the 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.

Along with these control variables, different physical infrastructure variables were also used as regressors. Infrastructure can have an impact on inequality, either positive or negative. If infrastructure is built in areas that are already abundant in physical and human capital, which also have a larger potential thanks to an already proven dynamism, it could then adversely affect inequality. However, if infrastructure is developed in regions that lack facilities and face a resource crunch, these regions can exploit new production possibilities better and hence, reduce inequality (Ferreira, 1995). In an environment with capital market imperfections, expanding public infrastructure services reduces the inequality of opportunity among entrepreneurs, increases the return on investment, and raises entrepreneurial activity among the less -favoured segments of society (Ferreira, 1995). Better transport infrastructure assists the lower income groups to connect to markets and expands the sets of opportunities available to them accordingly. 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 raises the income factor via an increase 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). Another theoretical model by Pi and Zhou (2012), which included infrastructure as an input in a production function both with skilled and unskilled labour, studied the impact on skill premium. Their findings suggest a higher supply of infrastructure raises the marginal productivity of both skilled and unskilled labour, while the effect on skill premium will depend on the factor intensity of the sector. To illustrate, if a sector using more unskilled labour utilizes infrastructure services more intensely, it will then experience an outflow of capital from the skilled to the unskilled sector, thereby increasing the wage rate of unskilled labour and reducing the skilled-unskilled wage gap inequality. It could also work in the opposite direction.

Channel through which electrification programs in rural areas had an impact on employment, especially female employment, was studied by Dinkelman (2011). Households with access to electricity were able to free up time otherwise spent on cooking and lighting, this extra time was then spent at work through self-

employment or micro-enterprises. In addition to the conventional channels through which infrastructure impacts the economy, some researchers have identified new channels like the beneficial impact on human capital, which in turn increases job opportunities and productivity (Brenneman and Kerf, 2002; Agenor and Moreno-Dodson, 2006).

In the following section, we analyze the relationship between infrastructure and inequality observed in the 17 major Indian states. As mentioned earlier, the nature of this relationship is not clear-cut (Brakman et al, 2002; Benerjee, 2004, World Bank, 2006); however, the relationship between infrastructure development and its impact in inequality, particularly whether it has led to a reduction in inequality in India, and its policy implications, is of utmost interest.

Estimation Results

The regression results where the dependent variable is the log odds ratio for Gini coefficient is presented in Table 2. In this paper, three equations were estimated: for all states, for the high income states (states which had PCNSDP higher than the all-India PCNSDP in 2009-10), and for the low income states (states which had PCNSDP lower than the all-India PCNSDP in 2009-10). The first column presents the results for the 17 states (Model 1). The second column shows the results for high income states (Model 2) and the third column presents the results for the low income states (Model 3). Our discussion focuses on the results from random effect estimators as the Breusch-Pagan LM test, which tests for heteroskedasticity in a model. In this case, it suggests a random effects model for the data over simple Ordinary Least Squares (OLS), as well as the Hausman test, which tests for consistency of estimators and in this case, suggests the use of random effect over fixed effect for the dataset.

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, for any of the three models. 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 for Model 1 and 2 but not significant for Model 3. 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 as a whole. This result holds especially true for high income states that have seen a higher share of a modern sector in the total economy compared with the low income states (See Appendix).

The result for per capita expenditure on social services by state government is interesting; as it has a negative impact on inequality. This is especially significant in low income states as 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.

In Model 1, 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). This has not been reflected in full in the data of analysis, as the drastic change in tele density occurred only after the late 1990s and remained fairly static before. This suggests that the data showed change and impact for only two time periods: 2004-05 and 2009-10.

Thus, from Model 1 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, results not shown here but available upon request) however these benefits were not equally shared by the regions. States that had better roads and power infrastructure are those in the high income category (data available upon request) and higher income states have seen an increase in inequality particularly in the post-reform period (see Figure 1, Scatter plot between income and Gini coefficient). In order to see if this relation between infrastructure and inequality differs among high and low income states, we divided the states into two

categories based on whether their PCNSDP was above or below the Indian average PCNSDP in 2009-10. Similar exercise was also undertaken for the beginning of period – 1983-84 – where not much difference in the states that fell into either of the categories except for Andhra Pradesh was observed, - it moved from low to high income-; Assam and J&K,moved from high to low income states, between 1983 to 2009. A list of these states is available in Appendix.

Model 2 provides the results for the higher income states where the Gini coefficient is the dependent variable. Several results are of interest. For these states, the relation between inequality and share of non-agriculture sector is positive and almost the same as for the combined dataset and significant at 1 percent level. This further supports the argument that in higher income states, larger share of a modern (non-agriculture) sector has resulted in an increase either in inequality or consumption distribution. We find that in higher income states, infrastructure development has had no significant impact on inequality.

The results for the low income states in Model 3 provide contrast to the ones for high income states. Considering the infrastructure variables, the relation between electricity and roads was positive and highly significant with inequality. As shown earlier that inequality has increased even in low income states in the post reform period. With infrastructure development taking place, people with more resources or higher incomes were able to incur in higher expenditures on luxury goods or had more access to markets around them, as well as more investment opportunities that could have resulted in an increase in inequality. This however, does not suggest that infrastructure development is a cause for increased inequality and should thus be curtailed. It can mean that regions that were long deficient in basic infrastructure facilities offer more benefits to a few members than to others, over time this gap reduces, as benefits become shared more equally, and those in disadvantaged situations begin to gain access to more productive opportunities. In conclusion, the impact of infrastructure on consumption inequality across states differs not only for the type of infrastructure under consideration but also for the income category that the state belonged to.

6. CONCLUSION

This paper attempts to understand the relation between available infrastructure 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 through which infrastructure development leads to a favourable impact on the distribution of income and helps to decrease inequality however, the evidence of this is lacking. In the case of India, we could not prove the same negative relation between infrastructure and inequality in consumption expenditure for all infrastructure variables.

The impact of infrastructure variables on a consumption inequality measure indicates that some components of infrastructure, mainly power and roads, tend to increase interpersonal inequality at the regional level. This is especially true for lower income states. 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. 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. 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.

However, for higher income states the impact of infrastructure was largely insignificant. It can therefore be inferred from the study, that expansion of regional infrastructural facilities may enhance the average consumption level among segments of the population but these impacts are not uniform across the populace, and is accompanied by increased inequality within the states. Improvement in expenditure on social services helps bring convergence through reduced interpersonal inequality.

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 with a better endowment for infrastructure facilities – roads, electricity, railways and telecommunication infrastructure. These states continued to remain in the rich income category with an average PCNSDP much above India's average PCNSDP, and these states managed to grow in terms of their infrastructure endowments. They however, also showed higher levels of inequality. In terms of impact of infrastructure on inequality, the same mechanism that we have highlighted for lower income states may not hold as these states have had better infrastructure development to begin with and such distributional effect may not be very widespread in these states.

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 2 Infrastructure stocks and Consumption Inequality: Panel Regression Analysis

Dependent variable: log (odds ratio for Gini Coefficient)

Sample of 17 Indian states, Gini computed using MPCE for the years 1983, 1987-88, 1993-94, 2004-05 and 2009-10

	(1) LogOdds	(2) LogOdds	(3) LogOdds
lnPCNSDP	-1.209	0.236	0.453
	(1.056)	(3.129)	(2.126)
Sq(lnPCNSDP)	0.0635	0.00605	-0.0168
	(0.0531)	(0.152)	(0.114)
Lnelec	0.0553	-0.151	0.189***
	(0.0520)	(0.0926)	(0.0515)
Lnroad	0.212***	0.0951	0.199***
	(0.0549)	(0.0899)	(0.0654)
LnRail	-0.121***	-0.110	-0.0900**
	(0.0399)	(0.0681)	(0.0390)
lntele	0.00974	0.0675	0.0255
	(0.0342)	(0.0537)	(0.0508)
Mod Sec/NSDP	0.775**	0.799***	0.383
	(0.342)	(0.288)	(0.530)
lnPCSocX	-0.126	-0.196*	-0.262**
	(0.0783)	(0.104)	(0.127)
Constant	3.968	-2.636	-4.218
	(5.379)	(15.97)	(10.27)
Observations	51	27	24
Adjusted R-squared			

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

LnPCNSDP = Log Per Capita Net State Domestic Product; sqLnPCNSDP = square (LnPCNSDP); lnelecgencap = Ln(Electricty Generating Capacity); lnroad = ln(Road density); Lnrail = ln(Rail density); lntele = Ln(Teledensity); modsecnsdp = Share of Modern sector in NSDP; lnimr = Ln(Infant mortality rate); lnger = Ln(Gross enrolment ratio)

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