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IS URBANISATION SANS INFRASTRUCTURE A MYTH? EVIDENCE FROM INDIA

ABSTRACT: *This study examines the determinants of urbanisation in Indian states with special emphasis on infrastructure and infrastructure investment, using data on 17 Indian states for 1991 to 2017. The fixed effects regression model shows that physical infrastructure is an important determinant in high income states, while social infrastructure is important in high-income and low-income states (where the magnitude is negative). Electricity consumption and teledensity positively affect urbanisation in high- and low-income states, while the infant mortality rate in high-income states and the enrolment ratio in low-income states affect urbanisation negatively. The supply-led inverted-U hypothesis of infrastructure-investment-led urbanisation is only disproven for middle-income states while applying strongly in all other cases, particularly low-income states. Hence, the impact of infrastructure on urbanisation differs across states not only by type of infrastructure but also by the state's income category.*

KEY WORDS: *infrastructure, urbanisation, India*

JEL CLASSIFICATION: O18, C38, G21, L91, Q40, O43

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No country has grown to middle income without industrialising and urbanising. None has grown to high income without vibrant cities. The rush to cities in developing countries seems chaotic, but it is necessary.

Angel et al. 2010

1. INTRODUCTION

Urbanisation is often regarded as a major driver of higher productivity and economic growth. Better employment opportunities, a better work environment, and a better lifestyle attract people to urban areas, contributing to the growth of urban centres and to urban incomes. Development of an ever-increasing number of cities drives economic growth through economies of scale in infrastructure, labour, and capital, amplifying the contribution of cities to overall economic growth. The popular Tiebout hypothesis (1956) posits that better provision of public facilities such as education and roads attract not only more residents but also more businesses, thereby accelerating city growth. The Indian experience of the cities Bangalore, Pune, and Hyderabad suggests that the accumulation of human capital caused the cities to grow by attracting firms to their skill pools (Black and Henderson 1999; Li and Cheng 2006; Bertinelli and Strobl 2007; Leitão 2013; Sekkat 2013; Liu et al. 2015; Quintana and Royuela 2014; Quintana 2017).

Urbanisation as a process also propels economic growth by transforming the economy from agriculture-driven to non-agricultural-based (Henderson 2003). Urbanisation per se may be less significant for economic growth because to some extent it depends on an existing enabling environment in the form of institutions (Turok et al. 2013). These institutions might take the form of infrastructure or governance, or both. Thus, public investment in infrastructure plays a crucial role in urbanisation. Zhang (2002) has shown that economic growth together with urban policy reforms, Foreign Direct Investment, and structural changes significantly contributed to rising urbanisation in China, especially post-reforms. Chakravorty (2007) also conjectured that the increased urbanisation of India's coastal cities was the result of a high level of Foreign Direct Investment (FDI).

There are three main channels of the phenomenon of growing urbanisation in India (Table 1). The first and most important is the increasing size of the population. Population increase can be defined as the difference between the crude birth rate and crude death rate: if the birth rate is higher than the death rate the population increases, while if the death rate exceeds the birth rate the population shrinks.

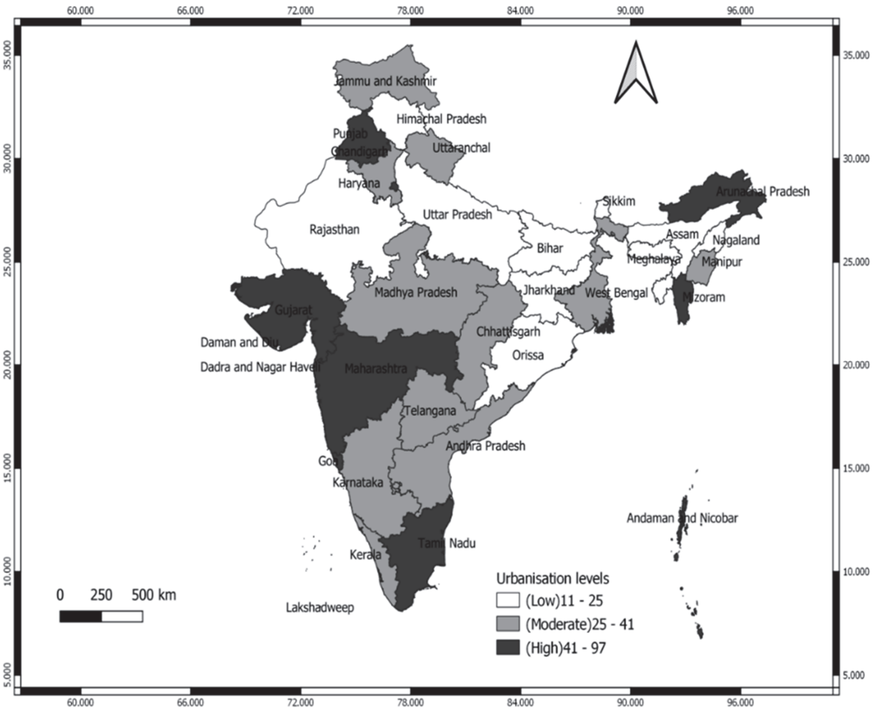
Table 1: Share of Urban Population in India

	1901	1951	1991	2001	2011
Total population (in millions)	238	361	846	1,028	1,211
Urban share (in %)	10.84	17.30	25.72	27.71	31.15

Source: Colmer 2017.

The second channel is the emergence of new urban areas, known in India as Urban Agglomerations. The third channel is demographic change: the migration of the rural populace to urban areas. The pace of urbanisation in India is not uniform across the country. Figure 1 below shows the diverse spread of urbanisation across Indian states.

Figure 1: Urbanisation in the Indian sub-continent 2019, in percentages



The urbanisation levels in the Indian states vary between 65.2% in Goa to as low as 10.6% in Bihar. The highest urbanisation rate is in Delhi (96.7%) and the lowest in Daman and Diu (20.9%).

These different rates of urbanisation bring into question the role played by infrastructure in the urbanisation process in Indian states. If infrastructure is an influence, is it uniform across states, or do states differ according to income? A number of papers have examined the determinants of urbanisation at the national level as will be discussed in the next section, but none has addressed this issue at the sub-national level, and none has addressed determinants at the sub-national level after segregating the states according to income. The present research not only discusses the determinants of urbanisation at the national level but also examines the asymmetrical importance of infrastructure across states according to different income brackets. Also, previous research has only used panel regression at one time point, whereas this paper uses urbanisation variables from sources other than the census.

The following section 2 reviews the relevant literature. Section 3 presents the database and methodology. The results are given in section 4, and the conclusions and policy implications in section 5.

2. LITERATURE REVIEW

While the earlier theories of Todaro (1969) and Harris and Todaro (1970) posited the rural–urban wage differential as a major factor behind urbanisation, Krugman (1991) talks about the agglomeration effect leading to the mushrooming of urban centres. Moomaw and Shatter (1996) explain how Gross Domestic Product (GDP) influences urbanisation in two ways: through the agglomeration benefit that arises due to increasing market size and through the impact of industrialisation. Demurger (2001) shows that infrastructure investment leads to the growth of both urban and rural areas but has a higher impact in urbanised provinces. Xie et al. (2009) examines the short-term and long-term relationship between electricity consumption and urbanisation using an error correction model, the Granger causality test, impulse response, and variance decomposition. They find a steady long-term relationship between the two for China with a feedback effect; i.e., bidirectional causality only in the long run. Hofmann et al. (2013) show the strong influence of per capita GDP growth, education, and industrialisation on urbanisation, but find no significant effect of road density. Tan et al. (2014) show that all levels of road network have had a considerable effect on the shape and density of the urban landscape of Wuhan, China. Chen (2016) finds road density and distances to transportation services, banks, and hotels to be the most important factors in the urbanisation of the city of Guangzhou. Wan & Zhang (2017) study the role of ICT in facilitating the process of urbanisation and find that information enrichment is important in explaining the worldwide acceleration of urbanisation, with conventional factors losing importance over time. Li (2017) investigates two opposing hypotheses explaining the infrastructure–urbanisation relationship in the Chinese economy for the period 2000–2012: that infrastructure investment drives/does not drive urbanisation. The study uses fixed-effect panel data regressions and the results support the second hypothesis that infrastructure investment pushes urbanisation. The implied turning point of the inverse-U shape relationship was 0.47. In other words, when the urbanisation rate of a Chinese city is lower than 0.47, rising urbanisation is accompanied by rising infrastructure investment intensity in GDP. After the urbanisation rate surpasses 0.47, the infrastructure investment intensity starts to decline due to decreasing demand.

Liddle et al. (2013) show that energy consumption is likely to foster the urbanisation process in two ways: energy and electricity availability improves the quality of life (air conditioning, refrigeration, machinery), and energy consumption is essential for manufacturing to prosper and provide jobs. Wang et al. (2019) find a strong feedback effect between road infrastructure and urbanisation for the Pakistani economy. Shen (2020) differentiates between determinants of state-sponsored and instantaneous urbanisation for the province of Fujian (China) and shows that state-sponsored urbanisation is strongly path-dependent, based on the initial level of urbanisation and development, while spontaneous urbanisation is more dynamic and depends on manufacturing sector expansion. Grekou et al. (2020) explain how FDI inflows significantly influence the momentum of urbanisation on the African continent.

Regarding India, Pandey (1977) attempts to assess the determinants of urbanisation in India and finds that industrialisation positively influences the level of urbanisation, while cropping intensity shows a negative impact.

Surprisingly, the average worker's income has no effect. Sridhar (2005) suggests that the growth centres in India have mushroomed due to infrastructure availability in the form of power, telecommunications, roads, and banking. Pradhan (2007) verifies the existence of a strong relationship between infrastructure and urbanisation in India, with the coefficient of determination concluding that about 27% of the systematic variation in the level of urbanisation is explained by infrastructure availability. Narayana (2011) shows that ICT positively influenced growth in Bangalore by urbanising the city. Tripathi (2017) studies the determinants of urbanisation at the city level and concludes that infrastructure facilities, measured by the number of electricity connections, educational institutions (schools, colleges, and universities), and sanitation facilities promote the pace of urbanisation. For India, Maparu and Mazumder (2017) show that transport infrastructure shared a causality with urbanisation over the period 1991–2017. Hasan et al. (2018) show that cities with a larger share of employment in manufacturing than services tend to grow faster. Diversified manufacturing adds another dimension to the growing urbanisation of cities. Human capital and infrastructure provision (transport and power) within cities fail to produce any significant effect. On the contrary, better connectivity measured by market access systematically affects the growth of cities. Guha (2020) finds that improvements in health infrastructure and energy consumption have led to de-urbanisation across the districts of Assam, while improvements in educational infrastructure and warehousing facilities complemented the growth of urbanisation in the state.

A paper by Liu et al. (2015) deserves special mention. They discuss how in China economic growth affects the pace of urbanisation heterogeneously, with the relationship between economic growth and urbanisation assuming varying patterns. In the northern coastal region and most of inland China, urbanisation Granger causes economic growth, whereas economic growth does not have a significant effect on urbanisation except in the southern coastal and inland regions. The provinces in the southern coastal region do not show a Granger causality relationship between urbanisation and economic growth, thus implying that the effect of economic growth on urbanisation is restricted by administrative intervention.

The two hypotheses we test in this paper are:

H_{01} Infrastructure influences urbanisation uniformly.

H_{02} Infrastructure investment is subject to increasing returns.

3. DATABASE AND METHODOLOGY

This study uses a panel dataset for the 27-year period 1991–2017 for 17[1] Indian states. The states are grouped based on income criteria (Bajar 2013)[2] and are categorised as high-income, middle-income, and low-income. The relationship between the variables is analysed using fixed effects regression. The model is specified in the following form:

$$U_{it} = \alpha + \mu_i + \lambda_t + \beta_1 X + \beta_2 I + \varepsilon_{it} \tag{1}$$

where U_{it} represents the urbanisation rate of state 'i' in time period 't', μ_i represents state fixed effect, λ_t denotes year fixed effect, X includes the control variables based on previous work by Hofmann (2013) and others, and I represents the variable of interest, which in the present case is infrastructure. The list of control variables and the interest variables are specified in Table A2 in the Appendix. The Physical Infrastructure Index (in per cent) comprises teledensity, electricity consumption, and road density; the Social Infrastructure Index (in per cent) comprises Infant Mortality rates and Gross Enrolment Ratio, and ε_{it} is the error term.

The index is constructed based on Principal Component Analysis (PCA), which assigns weights to the broad indicators in an unbiased manner. PCA that is used to compute factor loadings and weights requires that data be unit-free or normalised. After having normalised the data, the index is constructed. The

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1 Andhra Pradesh, Assam, Bihar, Gujarat, Assam, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal

2 States are classified as rich if their average PCNSDP is more than India's mean (PCNDP+0.5 (standard deviation)), poor if it is less than India's mean (PCNDP−0.5 (standard deviation)), and middle income if it lies in between.

dimension index formula given by UNDP is used to normalise the data. The normalised values of each variable lie between 0 and 1.

$$\text{Index}=\frac{Actual\,value-Minimum\,value}{Maximum\,value-Minimum\,value} \tag{2}$$

Thereafter the index is prepared using the formula:

$$II=\sum W_iX_i/\sum W_i \tag{3}$$

where II means infrastructure index (Physical and Social).

After preparing the index it is important to check the time series properties of the individual variables before proceeding, so as to avoid any spurious estimates at the later stage. The results of the unit root tests guide the choice of econometric techniques. For this, the study employs the Augmented Dickey-Fuller (ADF) test using the Levine-Lin-Chu (LLC) (2002) and the Im-Pesaran-Shin (IPS) (2003) methods to check the stationarity properties of the variables. Fisher-ADF, Fisher-PP, and Breitung techniques are also implemented to check the consistency of the results. Here the null of the unit root is tested. The test follows the estimation using the following equation:

$$\Delta Y_t=\alpha_i+\beta_i Y_{it-1}+\sum_{j=1}^{p}\beta_{ij}\,\Delta Y_{it-j}+\delta_i t+\varepsilon_{it} \tag{4}$$

where i= 1,2,3……N; t= 1, 2 , .T; and Δ is the first difference operator.

4. RESULTS AND DISCUSSION

We first conduct the stationarity tests of our variables so as to avoid spurious results in the analysis. The most popular tests for this available in the literature are in the first-generation testing procedure category. These include IPS (2003) and LLC (2002). Though both of these have different hypotheses they verify the presence or absence of a unit root in the data-generating process. The results from the panel unit root tests are presented in Table 1.

Table 1: Panel Unit Root Statistics

Variable	LLC		IPS	
	Level	Δ	Level	Δ
Ln (Road density)	2.504	−15.336***	5.962	−13.828***
Ln (Rail density)	0.940	−16.455***	2.068	−14.349***
Ln (PCEC)	−0.085	−17.704***	3.383	−17.008***
Ln (Teledensity)	−1.946**	−9.709***	1.799	−9.640***
Ln (PCNSDP)	6.853	−13.941***	12.8081	−14.625***
I/GDP	5.234	0.067	9.928	−3.015***
Infant Mortality Rate	2.998	−5.609***	8.349	−6.522***
Gross Enrolment Ratio in Upper Primary School	1.730	−7.124***	2.713	−9.509***
Agriculture Sector	0.557	−7.912***	4.678	−12.680***
Urbanisation	4.783	−0.664	13.273	−1.368*
PII	1.166	−15.791***	0.919	−17.690***
SII	0.520	−14.433***	−1.572	−15.263***

Note: Model with only constant is adopted.

After checking the stationary properties of the panel data, we report the results arrived at by fixed effects panel regression methodology. In the full sample analysis (Table 2) we find that the indicators infant mortality ratio (IMR) and Enrolment Ratio in Schooling both negatively affect the level of urbanisation in the economy, though the Social Infrastructure Index itself fails to show any significant impact on the dependent variable. The lower IMR value favourably affects our urbanisation level. A lower IMR means that the health of infants is improving. This could be attributed to higher healthcare expenditure by the state government (Barenberg et al. 2017).

On the other hand, the Physical Infrastructure Index shows a positive and significant coefficient. A percentage point improvement in the physical infrastructure is associated with a roughly 0.04% higher urbanisation rate. Unfortunately, social infrastructure does not further the urbanisation level for India as a whole. Positive and significant coefficients for Electricity Consumption and Teledensity reinstate the promise made by Liddle (2013) and Wan (2017). Liddle identified the importance of electricity consumption for the process of urbanisation while Wan justified the importance of telecommunications for urbanisation by way of reducing information asymmetries. On the other hand, the road infrastructure regressor has a negative and significant coefficient. This could be explained by a better road network (particularly all-weather roads) making travel easier, especially in rural areas where better roads facilitate transportation between home and work and lessen the incentive to relocate. We reject the assertion that growth supports urbanisation, in line with Onjala and Akumu (2016), who in their research reject the credo of growth-led urbanisation in Sub-Saharan Africa, asserting that only developed economies support the hypothesis that growth leads to urbanisation. We find that, overall, in India's urbanisation process physical infrastructure matters more than growth.

The share of the agriculture sector has no significant impact. Another axiomatic finding for the full sample in our case is the validation of an inverse U-effect of infrastructure investment on urbanisation for all 7 regressions. This conclusion is based on the coefficient of the Investment-to-GDP ratio and the square of this ratio represented by Inv Sq. which is in line with Hulten (1994). The coefficient of the linear term is positive (15.75 to 22.05) and ranges between 7.44 and 10.21 for the non-linear term. Both coefficients are significant at the 1% level. Thus, there is no threshold level of Investment to GDP. This means that if the Investment-to-GDP ratio is lower than the threshold level, more investment per GDP will engender urbanisation. However, after the investment/GDP ratio surpasses the threshold level the urbanisation intensity tends to decline.

Table 2: Fixed effects regression model with urbanisation as dependent variable (full sample)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln PCNSDP	−0.65*	−0.62*	−0.81**	−0.60*	−0.67*	−0.04	−0.79**
	(0.296)	(0.299)	(0.270)	(0.281)	(0.293)	(0.042)	(0.299)
Agri	−0.01	−0.03	0.02	−0.01	−0.04	20.39***	−0.01
	(0.044)	(0.044)	(0.041)	(0.042)	(0.044)	(2.880)	(0.045)
I/GDP	21.73***	22.05***	15.75***	17.02***	19.87***	−0.76**	21.16***
	(2.975)	(2.985)	(2.804)	(2.913)	(2.994)	(0.284)	(3.034)
Inv Sq	−9.80***	−10.21***	−7.56***	−7.75***	−8.91***	−9.28***	−9.65***
	(1.819)	(1.828)	(1.689)	(1.762)	(1.826)	(1.760)	(1.846)
IMR	−0.05**						
	(0.017)						
GER		−0.02**					
		(0.009)					
PCEC			0.01***				
			(0.001)				
TELE				0.07***			
				(0.010)			
Rden					−0.08***		
					(0.002)		
PII						0.04***	
						(0.007)	
SII							0.01
							(0.012)
Constant	30.09***	28.79***	24.80***	26.46***	28.33***	26.54***	26.89***
	(2.163)	(2.031)	(1.827)	(1.880)	(1.967)	(1.903)	(2.067)
N	459	459	459	459	459	459	459
Adj R^2	0.514	0.512	0.590	0.557	0.520	0.546	0.505
AIC	1894.4	1896.1	1816.7	1851.9	1889.1	1862.9	1902.8
F	17.14	17.03	22.75	20.09	17.49	19.30	16.59
Rmse	1.878	1.881	1.726	1.793	1.867	1.815	1.895
T. effect / S. effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses. Rmse is the Root Mean Square Error, Ln is logarithm, PII is Physical Infrastructure Index, SII is Social Infrastructure Index, Agri is share of agriculture sector in GDP, I/GDP is Investment-to-GDP ratio, Inv Sq is square of I/GDP ratio, IMR is Infant Mortality Rate, GER is Gross Enrolment Ratio in upper primary, Rden is Road density, PCEC is Per Capita Electricity Consumption, TELE is Teledensity.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We move from the full-sample regression to an income-specific regression where the Indian states are grouped as high-income, middle-income, and low-income. Tables 3–5 provide circumstantial evidence on the determinants of urbanisation in each cluster.

Table 3: Fixed effects regression model with urbanisation as dependent variable (High-income states)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln PCNSDP	−1.05	−2.64**	−2.20**	−2.79***	−2.74**	−2.49**	−3.01***
	(0.670)	(0.903)	(0.834)	(0.750)	(0.853)	(0.788)	(0.864)
Agri	−0.13*	−0.05	−0.12	−0.00	−0.16	−0.24**	-0.02
	(0.066)	(0.090)	(0.084)	(0.075)	(0.088)	(0.082)	(0.085)
I/GDP	14.76***	19.15***	19.23***	27.07***	21.92***	29.08***	14.75**
	(3.756)	(5.161)	(4.714)	(4.328)	(4.851)	(4.654)	(5.034)
Inv Sq	−5.06*	−7.44*	−6.66*	−9.86***	−7.01*	−10.16***	−5.46
	(2.124)	(2.907)	(2.677)	(2.414)	(2.739)	(2.547)	(2.812)
IMR	−0.32***						
	(0.027)						
GER		0.01					
		(0.019)					
Rden			−0.00***				
			(0.000)				
PCEC				0.01***			
				(0.001)			
TELE					0.10***		
					(0.027)		
PII						0.08***	
						(0.012)	
SII							0.09***
							(0.024)
Constant	55.78***	43.13***	46.55***	37.87***	47.00***	42.16***	40.30***
	(4.325)	(5.739)	(5.344)	(4.838)	(5.505)	(5.038)	(5.536)
N	216	216	216	216	216	216	216
Adj R^2	0.804	0.644	0.687	0.746	0.671	0.719	0.669
AIC	849.7	978.3	950.5	905.5	960.8	927.0	962.2
F	29.60	13.76	16.43	21.56	15.40	18.97	15.26
Rmse	1.648	2.219	2.081	1.875	2.131	1.971	2.138
T. effect / S. effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses. Rmse is the Root Mean Square Error, Ln is logarithm, PII is Physical Infrastructure Index, SII is Social Infrastructure Index, Agri is share of agriculture sector in GDP, I/GDP is Investment-to-GDP ratio, Inv Sq is square of I/GDP ratio, IMR is Infant Mortality Rate, GER is Gross Enrolment Ratio in upper primary, Rden is road density, PCEC is Per Capita Electricity Consumption, TELE is Teledensity.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Fixed effects regression model with urbanisation as dependent variable (Middle-income states)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln PCNSDP	−0.35	−0.29	−0.27	0.49	0.11	0.22	−0.26
	(0.477)	(0.471)	(0.449)	(0.431)	(0.429)	(0.464)	(0.475)
AGRI	0.08	0.11***	0.07*	0.12***	0.14***	0.13***	0.10**
	(0.042)	(0.033)	(0.035)	(0.029)	(0.031)	(0.032)	(0.034)
I/GDP	−1.85	−1.34	0.88	−1.54	−1.15	−2.27	−1.48
	(2.990)	(3.069)	(3.133)	(2.677)	(2.768)	(2.887)	(3.103)
In Sq	0.08	−0.12	−1.63	0.81	0.52	0.68	−0.06
	(1.786)	(1.821)	(1.888)	(1.600)	(1.648)	(1.728)	(1.842)
IMR	0.01						
	(0.013)						
GER		−0.008					
		(0.008)					
Rden			−0.001*				
			(0.0005)				
PCEC				−0.004***			
				(0.0009)			
TELE					−0.07***		
					(0.018)		
PII						−0.02**	
						(0.007)	
SII							−0.006
							(0.008)
Constant	19.63***	20.31***	21.28***	16.29***	16.99***	17.04***	20.14***
	(2.301)	(2.480)	(2.362)	(2.131)	(2.180)	(2.338)	(2.563)
N	135	135	135	135	135	135	135
Adjusted R^2	0.680	0.678	0.694	0.743	0.726	0.701	0.676
AIC	301.4	302.2	295.0	271.7	280.1	292.2	303.0
F	10.29	10.21	10.95	13.61	12.59	11.24	10.14
Rmse	0.681	0.683	0.665	0.610	0.629	0.658	0.685
T. effect/ S. effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses. Rmse is the Root Mean Square Error, Ln is logarithm, PII is Physical Infrastructure Index, SII is Social Infrastructure Index, Agri is share of agriculture sector in GDP, I/GDP is Investment-to-GDP ratio, Inv Sq is square of I/GDP ratio, IMR is Infant Mortality Rate; GER is Gross Enrolment Ratio in upper primary, Rden is road density, PCEC is Per Capita Electricity Consumption, TELE is Teledensity.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Fixed effects regression model with urbanisation as dependent variable (Low-income states)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln PCNSDP	–0.03	0.17	0.19	0.30	0.35	0.23	0.32
	(0.324)	(0.348)	(0.386)	(0.320)	(0.361)	(0.369)	(0.309)
Agri	0.16**	–0.02	0.04	–0.04	0.05	0.04	–0.01
	(0.055)	(0.060)	(0.056)	(0.053)	(0.054)	(0.056)	(0.048)
I/GDP	46.25***	36.47***	32.92**	19.96*	29.13**	32.60**	46.66***
	(9.69)	(10.16)	(10.78)	(9.61)	(10.37)	(10.51)	(9.28)
Inv Sq	–49.59***	–42.65***	–37.07**	–36.55***	–37.60**	–37.52**	–55.18***
	(10.31)	(11.04)	(11.56)	(9.92)	(11.01)	(11.77)	(10.17)
IMR[3]	0.14***						
	(0.030)						
GER		–0.02*					
		(0.011)					
Rden			0.000				
			(0.000)				
PCEC				0.01***			
				(0.002)			
TELE					0.11*		
					(0.057)		
PII						0.006	
						(0.030)	
SII							–0.06***
							(0.012)
Constant	–0.616	18.78***	14.52***	15.75***	13.66***	14.34***	16.92***
	(4.013)	(3.063)	(2.776)	(2.374)	(2.641)	(2.708)	(2.321)

[3] When the analysis is carried out in all other states using urban mortality rates the results are the same, except for in the low-income states where the coefficient is negative instead of positive.

N	108	108	108	108	108	108	108
Adj R^2	0.378	0.264	0.196	0.380	0.238	0.196	0.423
AIC	319.2	337.4	347.0	318.9	341.2	347.0	311.2
F	3.198	2.336	1.937	3.212	2.175	1.939	3.625
Rmse	0.959	1.044	1.091	0.958	1.062	1.091	0.924
T. effect/S. effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses. Rmse is Root Mean Square Error, Ln is logarithm, PII is Physical Infrastructure Index, SII is Social Infrastructure Index, Agri is share of agriculture sector in GDP, I/GDP is Investment-to-GDP ratio, Inv Sq is square of I/GDP ratio, IMR is Infant Mortality Rate; GER is Gross Enrolment Ratio in upper primary, Rden is road density, PCEC is Per Capita Electricity Consumption, TELE is Teledensity.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 shows the importance of both physical and social infrastructure in high-income Indian states. The regression coefficient tells us that a percentage point improvement in physical and social infrastructure can further urbanisation by 0.08 and 0.09 percentage points respectively. While almost all other infrastructure regressors are equally significant, only the enrolment ratio is largely positive, although not significant. The inverse U-effect of investment on urbanisation remains strong even in the case of high-income states. Agriculture likewise is largely negative, and not at all significant. Thus, the results for the high-income states are as observed for the overall panel.

Switching to the regression results for middle-income states (Table 4) unravels various aspects of the urbanisation determinants. The most significant are:

1. The impact of GDP on the level of urbanisation is insignificant. Also, the results seem to offer plural conclusions. In some regression results the coefficient is positive while in others it is negative.
2. The coefficient on the agriculture regressor is positive and significant. The most likely explanation is the age-old linkage between agriculture and industry that was first talked about by Nurkse and Lewis in balanced growth theory, which posits that linkages between the two economic sectors are more of a norm than an exception.[4] This effect seems to be more prominent in

4 Refer to Isaksson (2009) for details of the linkage effect between agriculture and industry.

middle-income states because the agriculture sector is under-developed, while most, but not all high-income states predominate agriculturally.

3. The inverted-U hypothesis of infrastructure-led urbanisation is vacuous. This conclusion is mainly drawn on the basis of insignificant values for I-GDP ratio and its quadratic term.
4. Regarding the infrastructure regressors, the results are checkered. Social infrastructure has very little effect on urbanisation. Even the indicators of the social infrastructure index in isolation are extraneous to our dependent variable, while on the other hand the physical infrastructure index is negative and significant at the 1% level. This means that a percentage point improvement in physical infrastructure leads to a decline in urbanisation by 0.02 percentage points. All indicators of physical infrastructure are negative and of a significant size, implying that improvement in any physical infrastructure indicator, be it roads, electricity, or tele density, will decrease urbanisation. Hence, we can say that for middle-income states infrastructure is no less than a 'cog in the wheel'.

Lastly, looking at the regression results for low-income states (Table 5), we find that a percentage point improvement in social infrastructure reduces urbanisation intensity by 0.06 points. The value is highly significant at 0.1%. On the other hand, physical infrastructure has no effect at all, while better teledensity and per capita electricity consumption significantly promote urbanisation. The inverted U-shape of infrastructure investment is explained by the ginormous magnitude of the I/GDP ratio and its square term. Interestingly, the magnitude of the two terms is largest in the low-income states. This implies that the return to investment and urbanisation is highest in the low-income states, presenting an investment opportunity that would stimulate both urbanisation and economic [5]. Similarly, GDP and the share of the agriculture sector in overall GDP are very small.

To sum up, physical infrastructure is an important determinant of urbanisation in high-income states and overall; social infrastructure is important for high-income states and low-income states (where the magnitude is negative); and electricity consumption and teledensity significantly and positively affect urbanisation in high- and low-income states. Road infrastructure in high- and

[5] The infrastructure investment and growth literature is explained in Li (2017).

middle-income states, IMR in high-income states and overall, and enrolment ratio in low-income states and overall affect urbanisation negatively. The supply-led inverted-U hypothesis of infrastructure-led urbanisation is only invalid for middle-income states and holds strongly in all other cases, and most strongly in low-income states. Neither gross domestic product nor share of agriculture in overall GDP significantly affect urbanisation.

In conclusion, the impact of infrastructure on urbanisation across states differs not only according to type of infrastructure but also according to the state's income category. Thus, our hypothesis that infrastructure uniformly influences the level of urbanisation in Indian states is rejected. Regarding the other research hypothesis that infrastructure investment is subject to increasing returns, we strongly reject the null hypothesis, with evidence in favour of decreasing returns. Diminishing returns to infrastructure have also been validated in previous research (Sutherland et al. 2009; Canning and Fay 1993; Hulten and Schwab 1993).

The present research follows the direction of Liu et al. (2014), who find that economic growth plays a heterogeneous role in facilitating urbanisation across Chinese regions. Similarly, our analysis investigates the asymmetrical role played by infrastructure investment and infrastructure in influencing urbanisation in Indian states.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The present globalised world is witnessing rapid urbanisation. Some regions urbanise rapidly while others proceed at a slower pace. Because the process is omnipresent, various possible determinants have frequently appeared in the literature. It is imperative to know which are the important factors affecting the urbanisation process in India.

The present paper addresses this concern in a holistic way. Using data on 17 Indian states for 1991–2017, the study aims to discover possible determinants of urbanisation, with special emphasis on infrastructure and infrastructure investment.

The findings suggest various ways forward for policy planners. Relying on the findings of the whole sample can be very misleading because the determinants of urbanisation are not uniform across all Indian states. Because the findings vary between states a 'one policy fits all' approach is inadvisable. The priorities of the states vis-a-vis the urbanisation process will differ.

On the basis of the above research on the determinants of urbanisation in the Indian states, the following recommendations can be made.

1. For high-income states, physical infrastructure (overall), teledensity, electricity consumption, and social infrastructure (overall) positively influence urbanisation, while road network and infant mortality rate have a negative effect. This means that for these states having better infrastructure points to possible future urbanisation and they need to plan accordingly in order to prevent congestion in the later stages of growth, because urban overcrowding can adversely affect human productivity. Any decision regarding infrastructure investment should by default address urbanisation concerns because they work in tandem.
2. For middle-income states, the policy implication is slightly different from that for high income-states. Because in their case the infrastructure components have a negative sign, this does not obviate the need to invest in infrastructure. Rather, it indicates a serious problem with infrastructure quality in these states, which is why even the I/GDP ratio is not significant.
3. For low-income states what is important as of now is improving the level of social services, because the impact of social infrastructure on urbanisation is negative. The reason for this negative impact is the high infant mortality rates of low-income states. On the other hand, because physical infrastructure in isolation positively affects the dependent variable (percentage of urbanisation), the emphasis needs to be on physical infrastructure rather than social infrastructure if these states want more urbanised centres.
4. Lastly, the government needs to be mindful that the infrastructure investment they make in their respective economies has an upper limit beyond which the positive benefits and propensity to urbanise will decline. Thus, ill-considered infrastructure investment will prove wasteful for the economies.

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APPENDIX

A1: List of states according to income bracket

High-income states	Middle-income states	Low-income states
Gujarat Haryana Himachal Pradesh Karnataka Kerala Maharashtra Punjab Tamil Nadu	Andhra Pradesh Jammu and Kashmir Odisha Rajasthan West Bengal	Assam Bihar Madhya Pradesh Uttar Pradesh

Source: Author's Compilation

A2: Data sources of the variables used in the study

Variable	Data Source
• Investment (Capital Expenditure + Outstanding Credit in Scheduled Commercial Banks)	RBI Handbook of Statistics on Indian States
• Agriculture Sector (Share of agriculture in overall NSDP) (in per cent)	Computed using data on overall GDP and Sectoral GDP
• Per Capita Net State Domestic Product (Expressed in 2011–12 prices) (log form)	RBI Handbook of Statistics on Indian States
• Infant Mortality Rate	Sample Registration System Bulletins
• Gross Enrolment Ratio in Upper Primary School	Economic Survey Series of India
• Road Density (per 1000 sq. km of geographical area)	Handbook of Statistics on Indian States
• Per Capita Electricity Consumption (In KWh)	Handbook of Statistics on Indian States
• Teledensity (Per 100 population)	Handbook of Statistics on Indian States

• Urbanisation	The value is interpolated for 1991–2000. Post 2000 the population projections are taken from the Report of the Technical Group on Population Projections Constituted by the National Commission on Population.

Source: Author's Compilation